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REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MASTER PLAN FOR THE CENTRAL SOUTH SULAWESI WATER RESOURCES DEVELOPMENT PROJECT

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MAIN REPORT

MARCH 1980

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO-JAPAN

国際協力事業団
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P r e f a c e

The Japan International Cooperation Agency performed a study for preparation of the master plan on the Central South Sulawesi Water Resources Development Project in Indonesia for ten months from September 1978 to June 1979.

During this period, the survey team consisting of twenty experts headed by Mr. Tadashi Sakamoto, carried out a field survey for the preparation of the master plan in close cooperation with the Indonesian authorities concerned.

The present report has been prepared on the basis of the results of the field survey as well as on the subsequent studies made in Japan.

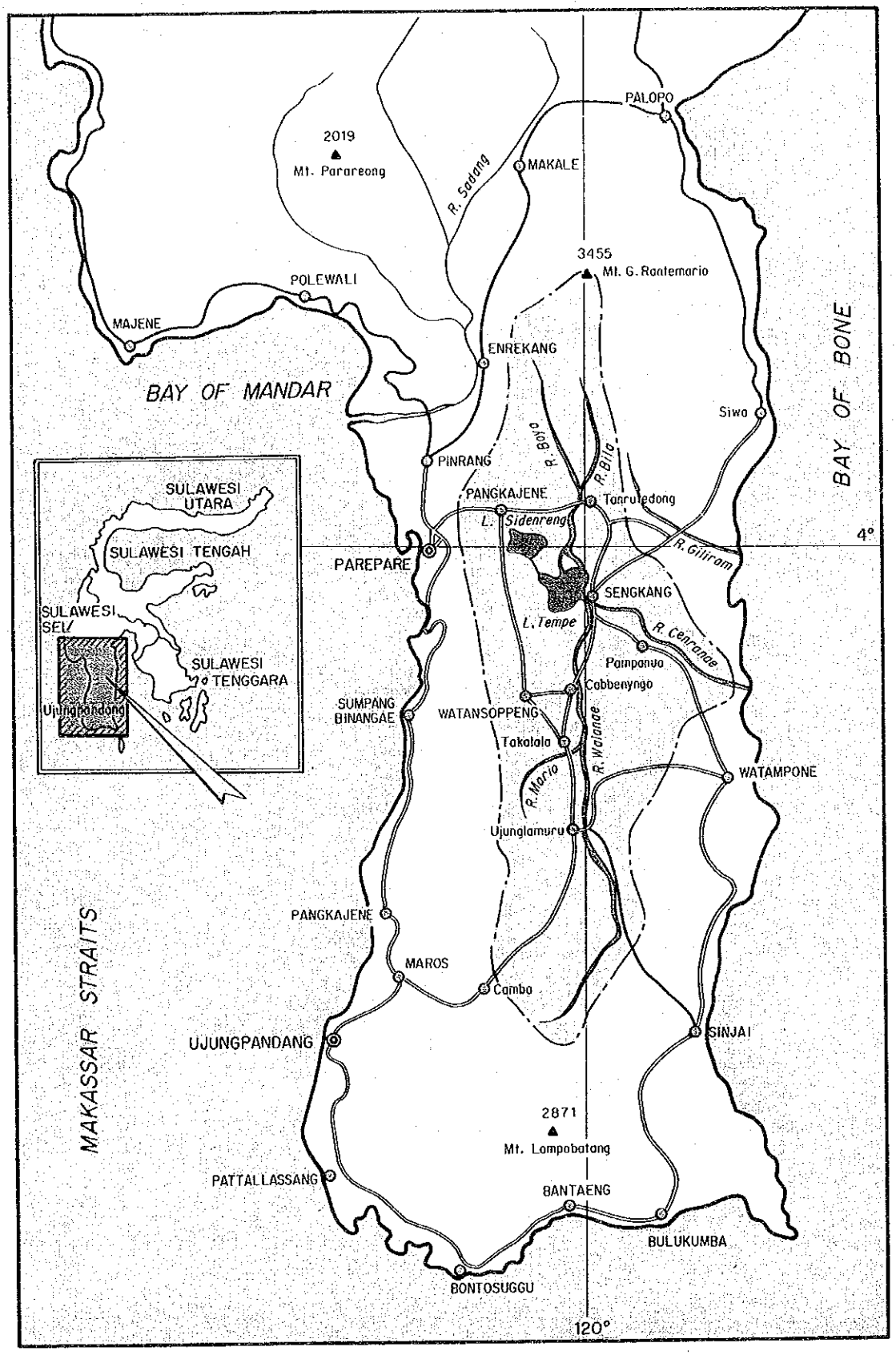
I hope that the report will prove to be useful and contribute to the social and economic development of the Central South Sulawesi and to the further promotion of friendly relations between the two countries.

I wish to express my deep apprecation to the Government of Indonesia and other authorities concerned for their close cooperation extended to the team.

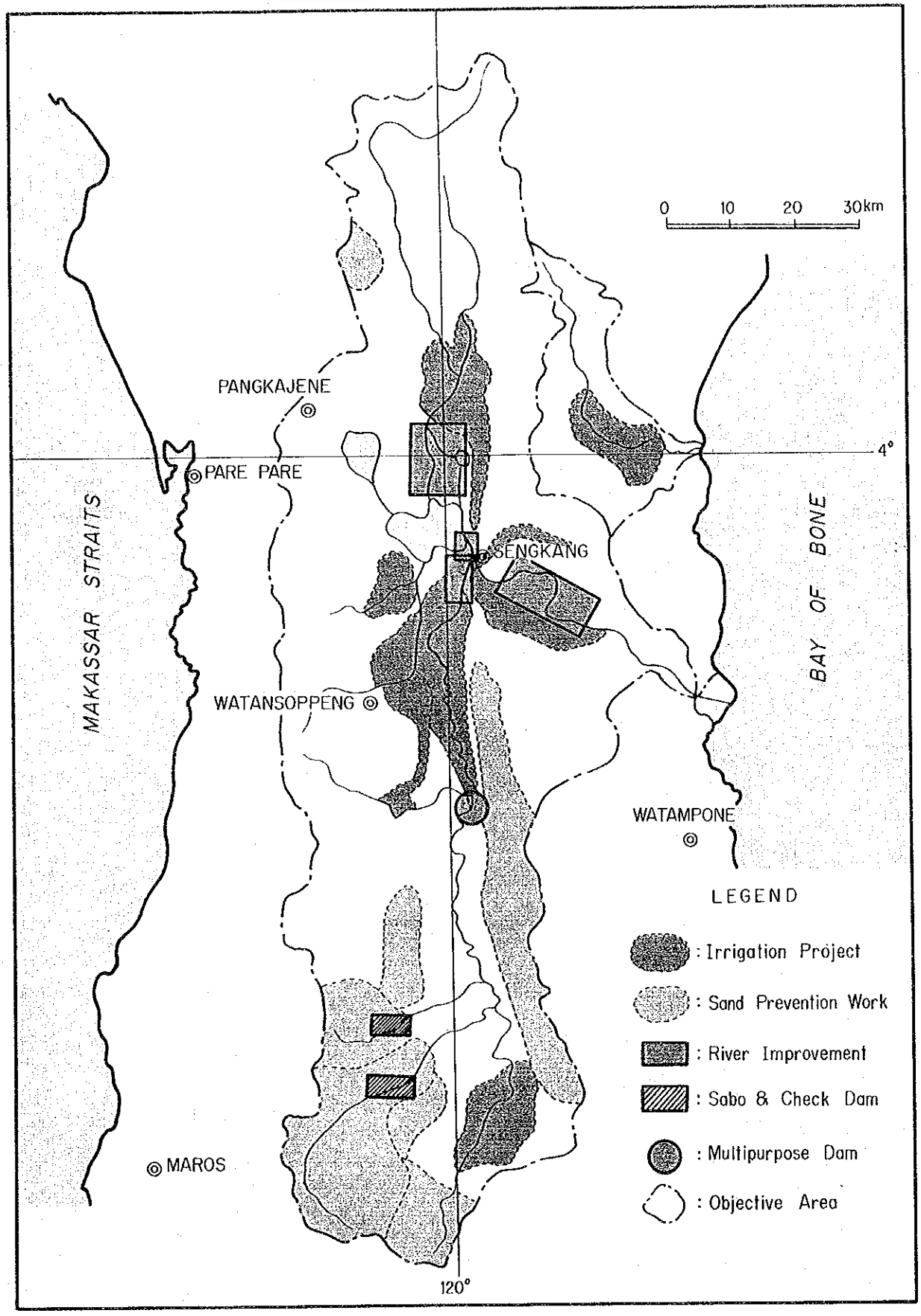
March 1980

Keisuke Arita
President
Japan International Cooperation Agency
Tokyo Japan

LOCATION MAP



PROPOSED PROJECTS



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Supporting Report (Volume 4)	Part Four	Inland Fisheries
Supporting Report (Volume 5)	Part Five	Multipurpose Dam
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	Part Seven	Sand Prevention
Supporting Report (Volume 6)	Part Eight	Socio-Economy
Supporting Report (Volume 7)	Part Nine	Geology

GLOSSARY OF TERMS AND ABBREVIATION

Local Terms of Administrative Area

Prop = Propinsi	:	Province
KAB (Kab.) = kabupaten	:	District
KEC (kec.) = kecamatan	:	Sub District
DES (Des.) = Desa	:	Village
WUD (Wilud) = Wilayah Unit Desa	:	Village Unit
BUUD = Badan Usaha Unit Desa	:	Village Unit Executive Body
KUD = Koperasi Unit Desa	:	Agricultural Cooperation Organization
BIMAS = Bimbingan Massal	:	Intensification Program with Credit
INMAS = Intensifikasi Massal	:	Intensification Program without Credit
BPP = Balai Penyuluhan Pertanian	:	Rural Extension Center
PPS = Penyuluh Pertanian Specialis	:	Subject Matter Specialist
PPM = Penyuluh Pertanian Madya	:	Extension Supervisor
PPL = Penyuluh Pertanian Lapangan	:	Field Extension Worker
P3A = Perkumpulan Petani Pemakal Air	:	Water User's Association
DPMA = Direktorat Penyelidikan Masalah Air	:	Directorate of Hydraulic Engineering
PMA = Penyelidikan Masalah Air	:	Hydraulic Engineering (SUB DIVISION)
PMG = Pusat Metreorologi & Geofisika	:	Meteorology & Geophysic Center
DIPERTA = Diperta = Dinas Pertamian Pakyat	:	Ministry of Agriculture
PU Seksi Pengairan	:	Irrigation Section of P.U.
Bupati	:	Local Government
P.L.N. = Perusahan Listrik Negara	:	State Electricity Cooperation

Abbreviation

DPU = Departemen Pekerjaan Umum	:	Ministry of Public Works
DGWRD	:	Directorate General of Water Resources Development
CSSWRDP	:	Central South Sulawesi Water Resources Development Project
DPUP Sul-Sel = Dinas Pekerjaan Umum Propinsi Sulawesi Selatan	:	Ministry of Public Works South Sulawesi
DOLOG	:	Provincial Rice Purchasing Agency
AWLR	:	Automatic Water Level Recorder
BM	:	Bench Mark
MPA	:	Master Plan Area
Sub-P3SA, Sul-Sel	:	Sub-P3SA South Sulawesi Province
PELITA I (Repelita I)	:	First Five Year Development Plan
PELITA II (Repelita II)	:	Second Five Year Development Plan
PELITA III (Repelita III)	:	Third Five Year Development Plan
BAPPENAS = Badan Perencanaan Pembangunan National	:	National Development Planning Board
SAPPEDA = Badan Perencanaan Pembangunan Daerah	:	Regional Development Planning Board
EL	:	Elevation
WL	:	Water Level
LWL	:	Low Water Level
F/Y	:	Fiscal Year
CA	:	Catchment Area

Natural Features

G = Gunung	:	Mountain
S = Sungai	:	River
Sawah	:	Rice field, paddy field
Tegal	:	Upland field
Danau	:	Lake

Others Local Terms

Polowijo	:	Upland crop
Gabah	:	Paddy
Padi Kering	:	Dry stalk paddy

CONVERSION FACTORS AND ABBREVIATIONS

1) Length

mm = millimetre

cm = centimetre

m = metre

Km = Kilometre

2) Area

Ha = ha = 10^4 m^2 = hectare

Km^2 = square kilometre

3) Volume

lit = 1,000 cm^3 = litre = l

m^3 = cubic metre

4) Weight

mg = milligramme

g = gramme

Kg = Kilogramme

t = 1,000 Kg = ton

5) Time

sec = second

min = minute

h = hour = hr.

d = day

yr = year

6) Money

$ = US dollar

Rp. = Rupiah

¥ = Yen

US$1 = ¥200 = Rp. 625

7) Electrical Measure

V = Volt

A = Ampere

H = Hertz (cycle)

kV = Kilovolt

W = Watt

kW = Kilowatt

mW = Megawatt

kWH = Kilowatt hour

mWH = Megawatt hour

GWH = Gigawatt hour

8) Others Measures

ppm = Parts per million

o/o = Per cent

o/oo = Per thousand

PS = Horse power (75 mKg/S)

PH = Scale for Acidity

°C = Degree centigrade

10^3 = Thousand

10^6 = Million

10^9 = Billion (milliard)

CEC = Cation Exchange Capacity

BSD = Base Saturation Degree

9) Derived measures are based on the same symbols.

m^3/S = Cubic metre per second

t/ha = Ton per hectare

kWh/yr = Kilowatt hour per year

kVA = Kilovolt Ampere

SUMMARY AND CONCLUSIONS

GENERAL

1. This report is prepared in accordance with the Scope of Works of the Master Plan on the Central South Sulawesi Water Resources Development Project (hereinafter called Master Plan) agreed upon between the Government of Indonesia and the Government of Japan.

   This report presents the result of the field investigation and intensive study by the Team in close cooperations with the Indonesian authorities concerned.

2. Japan International Cooperation Agency organized the Team consisting of twenty (20) experts headed by Mr. T. Sakamoto and dispatched it to Indonesia to make out the Master Plan.

   The Team conducted the field study in the objective area for ten (10) months from September 7, 1978 to June 30, 1979.

3. The objective of the study is to formulate the Master Plan with principal emphasis on Agricultural Development, River Development and Inland Fisheries Development for the purpose of raising the regional economic development and public welfare.

4. The objective area is situated in the Central South Sulawesi and covers the river basin of about 8,000 km^2 of the Walanae, the Bila. the Boya and the Cenranae Rivers which flow into or out of Lake Tempe included in 4 Kabupatens - Wajo, Bone, Soppeng and Sidrap.

5. In the framework of the Master Plan, the Draft Final Report was prepared by the Team and submitted to the Government of Indonesia in December 1979.

6. All comments and recommendations on the Draft Final Report suggested by the Government of Indonesia were considered in the study of the Master Plan and presenting this report.

BACKGROUND

Rice production in the objective area must be increased for the purpose of self-sufficiency in Indonesia. Especially in the eastern part of Indonesia, rice supply is short for present and future demand.

The objective area is blessed with abundant water and land resources suitable for agricultural development.

However, because of the lack of effective irrigation system, greater parts of the paddy field in the objective area are still engaged in the rainfed farming. Furthermore, some parts of the objective area are damaged by flood discharge every year. Such conditions are big limiting factors for agricultural development. Agricultural development, flood control, inland fisheries development and development of small scale industries through hydropower supply are strongly required not only for the purpose of economic development and public welfare of the people in the objective area but also for the national demand.

DEVELOPMENT GOALS

The development goals must meet the above-mentioned needs. The goals, in the target year of 2000, are summarized in the following items;

(1) To increase rice production and to increase farmer's income through the provision of irrigation facilities: Increase of rice production through this project satisfies the rice deficit 240,000 tons in the year of 2000 in the command area of DOLOG, South Sulawesi, and this project also plays an important role as rice supply center in Indonesia.

(2) To support the irrigation plan and to increase social welfare through effective way of flood control.

(3) To increase fish production and to improve fishermen's income. Target production increase of fish for this project is 10,000 tons in 2000.

(4) To generate 70,000 MWh energy in the target year for the purpose of not only industrialization of this project area, but also the support of Bakaru hydropower project.

(5) To equalize regional development gap.

GEOLOGY

1. General Geology

The objective area is geomorphologically and geologically divided into three regions: --- Tempe depression region, extending from the Sadang River to the Cenranae River, northern mountain region and southern region. The Tempe depression is a flat plain forming terrace and alluvial flood plain and its deposits are mainly composed of soft clay and uncemented sand. The northern region is mountainous and hilly masses. The mountain is composed of hard sedimentary rocks and the hill masses are composed of mudstone, sandstone and conglomerate. The southern region of the Tempe depression is divided into five (5) zones of N-S trend: --- West coast, Western mountains, Walanae depression, Bone mountains and East coast. The hilly area and flat plains of the Walanae depression are composed of weakly cemented siltstone, sandstone, coral limestone and etc.

2. Groundwater

Domestic water supply in most of villages in the objective area depends on groundwater. Groundwater sources are classified into two types.

The one is rich fissure water in open cracks and caves in thick limestone formation. The other is aquifers in the weathered zone of Plio-Pleistocene formations and in alluvial deposits. The latter source is usually seepage water of small discharge. Artesian aquifers have been found around Pangkajene, north of Lake Sidenreng.

3. Alluvial Deposits

An extensive alluvial deposits are developed around middle- and lower-reaches of the Walanae, Cenranae River basin and around Lake Tempe and Lake Sidenreng. The alluvial deposits extend over the land of natural levee, back marsh, paddy field and village ground. Swedish sounding and cone penetrometer survey, carried out in these grounds show that the thickness of the alluvial deposits sometimes exceeds 10 m and its compressive strength is less than 5 t/m^2.

4. Geology of Mong and Walimpong Damsites

Surface geological survey and preliminary test borings reveal that the both damsites are composed of Plio-Pleistocene alternation of claystone, siltstone, sandstone and limestone. Some differences were found in their mode of alternation as follows;

(1) Mong Damsite

(a) There is porous limestone exposed at an elevation higher than 68 m on the left bank slope. The limestone is not suitable for dam foundation due to its permeability.

(b) The alternation consists of siltstone, sandstone and limestone of several meter to 10 m thickness. They are moderately consolidated.

(c) There underlies rather permeable limestone layer of 10 m thickness at the depth of 30 m under riverbed.

(2) Walimpong Damsite

(a) Porous limestone exposure is located at an elevation of 82 m, which is higher than that of the Mong damsite.

(b) Foundation rock formations are mostly alternation of claystone and siltstone with rather low consolidation. Sandstone layers are minor member of the alternation under the right bank slope.

(c) Permeable limestone layer is intercalating with less than one meter thickness. No thick limestone layer is found.

Comparison of the two damsites reveals that the Walimpong damsite is more preferable because it is mostly composed of alternation of claystone and siltstone and no permeable limestone layer.

But consolidation and impermeability of the base rock in both damsite is rather low. Sufficient foundation treatments would be necessary before embankment of dam body. Further detailed investigation is necessary to establish necessary conditions in design and treatments.

5. Geological Conditions of Various Water Works in the Project Area

Geological reconnaissance survey was made on the intake structure sites at Langkemme, Bila, Sanrego, Lawo, Boya, Gilirang, Padangeng and Batu Pute.

No difficult problem in engineering geological point of view was found, except at the Batu Pute site. Unstable cliff of welded tuff on the left bank slope of the proposed site has ever slided, leaving many open cracks on the slope. It will slide again during and after construction of new intake dam. It seems to be hazardous to construct intake structure here.

SOIL

The soils in the objective area are classified into 11 soil units, according to the FAO-UNESCO soil classification system, namely, Eutric Fluvisols, Thionic Fluvisols, Dystric Gleysols, Chromic Vertisols, Orthic Luvisols, Chromic Luvisols, Ferric Luvisols, Ferric Acrisol, Dystric Nitosols, Rendzinas and Lithosols. The studies for land capability are carried out on the basis of the standard classification system of Ministry of Agriculture, Forestry and Fisheries of Japan. About 80% of the land is suitable for irrigation farming, the balance not suitable.

WATER RESOURCES

1. Distribution of Precipitation

According to the data collected at 45 rainfall gauging stations, the general situation and distribution of the rainfall, from the viewpoint of water resources, may be briefly described as follows;

(a) The average annual rainfall in most of the area is 1,800 mm to 2,000 mm. Exceptionally, a small portion along the Menraleng River in the upper Walanae basin receives a relatively high annual rainfall of about 2,400 mm, while the area around Lake Tempe has a low annual rainfall of 1,500 mm to 1,600 mm.

(b) Almost whole basin experiences the dry season from August to October and the wet season from April to June or July.

2. River Discharge

The total number of water level gauging stations in the objective area is 29. The discharge rating curves were prepared by the Team at 12 water level gauging stations to prepare converted daily discharge data for the planning of irrigation and flood control.

Generally, the annual pattern of mean monthly discharges varies widely according to the year at each station. The fluctuation is large in the rivers within the northern and northwestern parts of the objective area, especially in the case of small rivers.

3. Water Quality

Two series of water sampling were carried out by the Team at 11 locations in October 1978 during the low-water flow and in March 1979 during the high-water flow conditions. The result of the water quality analysis of the dry season flow indicates relatively high values of organic solid and total nitrogen, except in the upstream reaches of small rivers.

The salinity intrusion along the Cenranae River is estimated by calculation to reach to the point about 35 km upstream from the estuary during an extraordinarily severe drought.

4. Hydrological Consideration on Study Period of Irrigation Planning

The study period of irrigation planning was examined as follows;

(a) As for the dry season, from October to March, the study period of irrigation planning (1974/75 - 1977/78) belongs to the dry years in the upstream basin of Sengkang, and to the average years in the R.Gilirang basin.

(b) As for the wet season, from April to September, the study period of irrigation planning (1975 - 1978) belongs to the average years in both of the upstream basin of Sengkang and the R.Gilirang basin.

AGRICULTURE AND IRRIGATION

1. The objective area has four Kabupatens with 29 Kecamatans. There exist paddy field of about 159,000 ha and upland field of about 86,000 ha in the said area for which the agricultural studies are carried out.

2. The land holding of the most of farmers is less than 2 ha. Average farming size is 1.74 ha of which 1.13 ha is paddy field. Paddy cultivation is concentrated in wet season and is limited in dry season. The cultivation pattern is strongly affected by distribution of rainfall. The planted area or harvested area of paddy varies year by year depending on rainfall. The harvested area of paddy is averaged to 105,000 ha or 66% of total paddy field and 29,000 ha or 18% in wet and dry seasons respectively.

After harvest of wet season paddy, about 32,000 ha or 20% of paddy field are under cultivation of polowijo crops. Present multi-cropping index of paddy field is 1.06. As for upland area, annual harvested area amounts to 75,000 ha or 0.85 of multi-cropping index.

3. Improved high yielding varieties of paddy have been widely spread over the objective area through the extension of BIMAS and INMAS programmes and occupied over 70% of total paddy field. Unit yield of paddy is however as low as 3.0 ton/ha for wet season paddy, 4.3 ton/ha for dry season paddy and 1.5 ton/ha for upland rice.

4. Out of 159,000 ha of paddy field, 36,400 ha or 23% is beneficial area of the existing irrigation systems. There are 5 technical and 22 semi-technical irrigation systems in the objective area.. Out of them, two technical systems supply 13,400 ha of paddy field with irrigation water from water sources outside the objective area. Remaining 23,000 ha or 15% of total paddy field are served irrigation water of which sources are almost surface runoff of the tributaries and small scale rivers.

5. Agricultural development in the objective area is principally envisaged to extend technical irrigation area throughout a year utilizing land and water resources as much as possible. Double cropping of paddy per year is proposed on the irrigable land of the objective area.

6. With maximum utilization of water resources taking technical and economic feasibility into account, the following nine irrigation projects are formulated in the objective area.

   (1) Bila Irrigation Project in Northern Area,
   (2) Boya Irrigation Project in Northern Area,
   (3) Padangeng Irrigation Project on the West of L.Tempe,
   (4) Lawo Irrigation Project on the West of L.Tempe,
   (5) Langkemme Irrigation Project on the South of L.Tempe,
   (6) Walanae Irrigation Project on the South of L.Tempe and in Eastern Area,
   (7) Sanrego Irrigation Project in Southern Inland,
   (8) Cenranae Irrigation Project in Eastern Area and
   (9) Gilirang Irrigation Project in North-Eastern Area.

   In five projects, the irrigation water will be diverted by each intake weir to be constructed across the respective rivers. In the remaining projects the irrigation water will be supplied from

one multipurpose dam, two single purpose dams and one pump station.

7. The total beneficial area of those projects is 81,000 ha. Irrigation area in the objective area including beneficial area of existing system becomes about 100,000 ha or 60% of expected total paddy field of 167,000 ha. Due to the unstable discharge in the rivers, irrigable area in the dry season is limited in case of without flow regulation. Irrigable area in dry season averages 73,000 ha or 90% of beneficial area by the proposed projects.

8. The anticipated yield of paddy is laid out at 6 tons of dry stalk paddy per ha. After the completion of proposed irrigation projects, production will increase about 590,000 tons of dry stalk paddy.

9. The outline of the proposed nine irrigation projects is summarized below;

Proposed Irr. Project	Intake Structure	Irrigable Area Wet.S	Irrigable Area Dry.S	Construction Cost	Annual Benefit
		(ha)	(ha)	(10^3US$)	(10^3US$)
Langkemme	Weir	5,000	3,700	22,400	4,603
Bila	Weir	10,500	6,600	42,000	11,760
Sanrego	Weir	10,000	8,600	37,500	15,782
Lawo	Weir	3,000	1,800	10,500	1,959
Boya	Weir	10,000	9,800	23,900	3,803
Walanae	M-dam	26,000	26,000	105,900/1	36,504
Gilirang	S-dam	10,000	10,000	65,200	15,712
Padangeng	S-dam	4,200	4,200	20,900	2,935
Cenranae	Pump	2,300	2,300	13,600	3,456
Total		81,000	73,000	340,400	96,514

/1: Specific construction cost only. Total construction cost is US$215.62 million including the cost allocated to the irrigation function of the Walimpong multipurpose dam.

FLOOD CONTROL

1. The area around Lake Tempe is an alluvial zone formed by sediments transported by the Walanae, the Bila and other rivers, and it seems that the Lake is still in a sedimentation stage. The average sedimentation thickness of Lake Tempe is estimated at 1.0 cm/yr by the Team. Therefore, the sedimentation in the lake is not a serious problem from the viewpoint of flood control function. When the proposed dam on the Walanae River is completed, the sedimentation in Lake Tempe will be diminished with decrease in sediment transport of the Walanae River.

2. In the objective area, some efforts were made for development of irrigation in such areas as Boya and Sadang, while flood control measures have been left rather retarded. Inundation of fertile farm lands always causes a lot of damages to important agricultural products and others. The annual flood damages in the area are estimated at US$10.3 million on the average under the conditions without irrigation and flood control projects. However, the area has a potential of high production in agriculture. If the proposed irrigation projects in flood-vulnerable area are completed without flood control, the flood damages must be increased to US$13.5 million.

3. To diminish the flood damages, the following flood control plans are proposed in the framework of the Master Plan.

   (i) Flood control plan of the Bila River
   (ii) Flood control plan of the Walanae River by means of channel improvement and flood regulation by dam
   (iii) Flood control plan of the Cenranae River

Proposed Flood Control Project	Length of Channel Improvement	Construction Cost	Annual Benefit
	(km)	(10^3US$)	(10^3US$)
Bila River	42	19,680	2,987
Walanae River	39	22,080/1	4,413
Cenranae River	36	15,792	2,046
Total	117	57,552	9,446

/1: Specific construction cost only. Total construction cost is US$35,861 x 10^3 including the cost allocated to the flood control function of the Walimpong multipurpose dam.

INLAND FISHERIES

1. At present, several kinds of water area are being used for the inland fisheries in the objective area. Out of them, lakes - Tempe, Sidenreng and Buaya, and irrigated paddy field are suitable area for setting inland fisheries development plan.

2. Present fish production from these area is 13,500 tons for the lakes and 27 tons for the irrigated paddy field. But it is estimated that the potentiality of fish production of the lakes is about 17,500 t/year and that of paddy field is about 3,200 t/year.

3. The target amount of inland fish production increase is set about 10,000 t/year from the viewpoint of fish demand in the year of 2000.

   The following inland fisheries development plans are proposed in the framework of the Master Plan.

   (i) Lake fish production by fishing is increased more 4,000 tons to the maximum lake potentiality by setting fish protection area, and introducing new type of fish which might be fitted to the lake conditions.

   (ii) Paddy field fish culture produces carps more 2,700 tons which is the maximum amount from the supply of 120 x 10^6 pcs. of carp fry.

   (iii) The remaining 3,300 tons are produced by carp culture in the lakes from the supply of 20 x 10^6 pcs. of carp fry.

   (iv) Hatchery pond produces and supplies 150 x 10^6 pcs. of carp fry to fish culture mentioned above.

   (v) To organize the total development plan and make advance practically, some kind of organization (temporarily call it "Inland Fisheries Development Center") should be established.

4. The outline of the proposed inland fisheries development plan is as follows;

(a) Size of construction

Fish protection area	ha	300
Hatchery pond (including laboratory and office)	m^2	4,140

(b) Construction costs

	(10^6Rp.)
Fish protection area	131.0
Hatchery pond	182.6
Lake culture	0.0
Total	313.6

(c) Benefit

	(10^6Rp.)
Fish protection area	3,494.9
Hatchery pond	893.0
Lake culture	279.7
Total	4,667.6

MULTIPURPOSE DAM

1. A multipurpose dam is planned in the middle reaches of the Walanae River to achieve the following;

   (1) To irrigate the area of 26,000 ha of Walanae irrigation project perenially, including 16,000 ha of the irrigable land on the right bank of the Cenranae River.

   (2) To mitigate the flood damages in the downstream area of the Walanae River.

   (3) To generate hydropower.

2. The site of proposed dam is first selected at Mong site immediately downstream from the confluence of the Mario River.

   However, the geological survey and some drilling investigation conducted by the Team have revealed the geological uncertainty of the foundation for the construction of a dam of envisaged scale at Mong dam site. Especially, the poor geological conditions on

the left bank will restrict the height of the proposed dam, resulting in a limited reservoir storage capacity of 122 million m^3 at maximum.

3. Hence, an alternative damsite at Walimpong, located 1.5 km upstream from Mong site, is selected taking account of the results of the drilling investigation conducted by the Government of Indonesia.

4. The effects and the principal features of the proposed Walimpong dam are briefly summarized in the following;

Storage allocation of Walimpong dam

Items	Unit	Case-2
Flood Control	10^6 m^3	200
Irrigation	10^6 m^3	122
Hydropower	10^6 m^3	218
Total Eff. Storage	10^6 m^3	540
Sediment	10^6 m^3	165
Gross Storage	10^6 m^3	705

Effects of Walimpong dam

Items	Unit	Case-2
Irrigation		
Area	ha	26,000
Intake Rate (max.)	m^3/s	33.3
Flood Control		
Peak Inflow	m^3/s	2,100
Peak Outflow	m^3/s	1,000
Peak Reduction	m^3/s	1,100
Hydropower Generation		
Firm Discharge	m^3/s	25.0
Firm Output	kW	8,000
Max. Output	kW	20,000
Annual Energy Prod.	10^6 kWh	148

Main features of Walimpong dam

Type of dam		Rockfill dam
Height of dam	m	71
Length of dam	m	900
Dam volume	10^3 m^3	3,520
Catchment area	km^2	2,199
Gross storage	10^6 m^3	705
Effective storage	10^6 m^3	540
Construction cost	10^3 US$	139,230

HYDROPOWER

1. The purpose of the hydropower development project in the Master Plan is to supply power for the industrialization and rural electrification in the objective area.

   The electric power supply will not be sufficient for its demand in the whole South Sulawesi at the year of 2000.

2. The principal features of the hydropower station are summarized as follows;

Description		Walimpong Case-2
1. Effective reservoir storage	(10^6 m^3)	540
(1) Irrigation	(10^6 m^3)	122
(2) Flood control	(10^6 m^3)	200
(3) Hydropower	(10^6 m^3)	218
2. Annual mean water level	(m)	67.0
3. Tail water level	(m)	26.0
4. Gross head	(m)	41.0
5. Loss head	(m)	2.5
6. Effective head	(m)	38.5
7. Firm discharge	(m^3/s)	25.0
8. Normal output	(kW)	8,000
9. Firm annual energy production	(GWh)	70

3. The main features of the transmission lines are as follows;

Route	Walimpong - Watansoppeng - Parepare Watansoppeng - Sengkang (Approx. 60 km)
Voltage	150 KV: Power station - Watansoppeng - Parepare 20 KV: Watansoppeng - Sengkang

4. Construction cost of the Walimpong power station is US$20,069 x 10^3.

SABO

About 47% of the objective area is covered with grassland, upland and estate crop land. These lands mostly extending over the upper basin of the Walanae River result in the main source of sediment yield. Further there exist potential of landslide or landfall in the said basin.

Reforestation and afforestation are the principle method for soil erosion control. The way of planting trees, however, requires such long time for their growing up that the effective and successful results for soil conservation will not be expected in a short period. Early implementation of sand prevention works such as sabo dam or check dam along with planting trees is necessary for the future progressive developments in the objective area.

For such purpose, 12 of sabo dam and about 140 of check dam will be required in the objective area.

OVERALL DEVELOPMENT PLAN

As mentioned in previous chapter, the development projects in each sector are formulated as potential project in the objective area.

Taking into consideration relationship among each sectoral project technically and socio-economically, some sectoral projects are integrated as compound and multipurpose dam projects.

Based on the results of the economic evaluation for sectoral, compound and multipurpose dam projects, following nine development projects are proposed in the Master Plan.

(1) Bila-Boya Irrigation/Flood Control Project as a compound project
(2) Langkemme Irrigation Project
(3) Lawo Irrigation Project
(4) Cenranae Irrigation Project
(5) Gilirang Irrigation Project
(6) Sanrego Irrigation Project
(7) Padangeng Irrigation Project
(8) Cenranae Flood Control Project
(9) Walimpong Multipurpose Dam Project (Case-2)

Annual benefit, total construction cost and internal rate of return for each proposed project are shown below.

	Annual Benefit 10^3 US$	Construction Cost 10^3 US$	IRR %
1. Bila-Boya Irrigation Flood Control Project	18,550	85,580	13.5
2. Langkemme Irr. Project	4,603	22,400	13.5
3. Lawo Irr. Project	1,959	10,500	13.0
4. Cenranae Irr. Project	3,456	13,600	14.5
5. Gilirang Irr. Project	15,712	65,200	14.0
6. Sanrego Irr. Project	15,782	37,500	18.5
7. Padangeng Irr. Project	2,935	20,900	9.5
8. Cenranae Flood Control Project	2,046	15,792	10.5
9. Walimpong Multipurpose Dam Project (Case 2)	44,753	287,279	9.4

The target year for the Master Plan is set to be 2000. The development schedule for the proposed component projects is formulated basically based on the value of internal rate of return and further is assessed by the following items;

(a) Effect on equalization of social and public welfare among the regions

(b) Necessity of infrastructural supports required for early implementation and smooth operation of the project, such as access to the project area and power supply for pumping irrigation scheme

(c) Unfamiliarity with pumping irrigation practice of farmers

(d) Assurance of resettlement area for inhabitants in the reservoir area of the multipurpose dam

(e) Function of a core project for development of adjacent areas

After examination of the project assessment, the stage plan for project implementation is proposed as follows;

(a) First Stage

During the period of PELITA III, the following projects are proposed to enter into implementation.

a) Langkemme Irrigation Project
b) Bila-Boya Irrigation/Flood Control Project

(b) Second Stage

During the period of the Fourth Five Year Development Plan (provisional name), the following three projects will be implemented.

a) Sanrego Irrigation Project
b) Lawo Irrigation Project
c) Gilirang Irrigation Project

(c) Third Stage

During the period of the Fifth Five Year Development Plan (provisional name), the following four projects will be realized.

a) Walimpong Multipurpose Dam Project
b) Cenranae Irrigation Project
c) Cenranae Flood Control Project
d) Padangeng Irrigation Project

RECOMMENDATION

It is recommended that the proposed Projects will be implemented based on the proposed stage plan as soon as possible. These projects will contribute national as well as regional economic growth and public welfare for the people in the objective area.

CHAPTER I INTRODUCTION

1.1 AUTHORITY

This Report is prepared in accordance with the "Scope of Work" of the Master Plan agreed upon between the Government of Indonesia and the Government of Japan.

This Report presents the result of the field investigation and intensive study in the objective area and the subsequent study in Japan carried out by the Team organized by the Japan International Cooperation Agency (hereinafter called JICA).

1.2 PROJECT HISTORY

The Government of Indonesia has intended to formulate the Master Plan as a regional development and requested the Government of Japan to extend a technical aid in preparing the Master Plan.

In response to the request, JICA dispatched the Preliminary Study Team in 1973 and it was recommended that basic data such as topographic maps and hydrological data should be prepared as early as possible in order to make the Master Plan.

In response of the request made by the Government of Indonesia in accordance with the above recommendations, JICA dispatched two (2) hydrologists as Colombo Plan Experts in 1976, in order to collect and arrange hydrological data.

And also, JICA started to carry out a topographic survey from 1976 and prepared topographic maps on a scale of 1/25,000 on September 1978.

After the preparation of the basic data such as topographic maps, hydrological data, the study for Master Plan formulation was started at September 1978.

Accordingly, JICA organized the Team consisting of twenty (20) experts headed by Mr. T. SAKAMOTO and dispatched it to Indonesia to prepare the Master Plan.

The Team conducted the field survey in the objective area during the period of ten (10) months from September 1978 to June 1979. At the end of the period, the Interim Report presenting the result of the field survey was submitted to the Government of Indonesia. Taking into consideration the comments and recommendations submitted by the Government of Indonesia, the Team drafted up the Master Plan and prepared the Draft Final Report in December 1979 after the intensive study in Japan.

The Team proceeded in further study in Japan based on the comments and recommendations made by the Government of Indonesia on the Draft Final Report.

This report submitted herein comprises the results of the study.

1.3 OBJECTIVE OF THE STUDY

The objective of the study is to formulate the Master Plan with principal emphasis on Agricultural Development, River Development and Inland Fisheries Development for the purpose of raising the regional economic development and public welfare.

1.4 THE OBJECTIVE AREA

The objective area is situated in the Central South Sulawesi and covers the river basin of about 8,000 km^2 of the Walanae, the Bila, the Boya and the Cenranae rivers which flow into or out of Lake Tempe included in 4 Kabupatens - Wajo, Bone, Soppeng, and Sidrap. The objective area is shown in location map.

1.5 SCHEDULE OF MASTER PLAN STUDY

The activities of the Team are divided into the field work in the job site and office work in Japan.

Overall time schedule is as follows;

(1) The field work in the job site was carried out from September 7, 1978 to June 30, 1979.

(2) The office work in Japan was carried out from July 1979 to March 1980.

In accordance with the plan of operation on the Master Plan, the Team submitted the following reports to the Government of Indonesia.

(1)	Inception Report	October, 1978
(2)	Progress Report	February, 1979
(3)	Interim Report	June, 1979
(4)	Draft Final Report	December, 1979
(5)	Final Report	March, 1980

1.6 PERSONNEL

Experts and counterpart personnels who have taken part in the survey and study on the objective area during the field work of ten (10) months are listed in Table 1.1.

CHAPTER II GENERAL BACKGROUND

PELITA II terminated successfully in 1978/1979. Followed by PELITA II the Government has set up PELITA III for the period of 1979/1980 - 1983/1984.

PELITA III is formulated based on the development philosophy for 1) Higher Economic Growth, 2) Achievement of National Stability and 3) Equalization of Social Justice. This plan is in pursuit of the following economic growth.

(1) Real economic growth rate is about 6.5%/year.

(2) Annual per capita national income increase is about 4.5%/year.

(3) Ratio of population increase is 2.0%. It means that total population is 137 x 10^6 in 1978 and estimated at 151 x 10^6 in 1983 in whole Indonesia.

According to the historical change of national economic policy, consolidation of social infrastructure was the basic need during the period of PELITA I. And then in PELITA II, higher economic growth was strengthened. In PELITA III, as above-mentioned, more intention was set not only in the economic growth, but also in the stabilization of socio-economic conditions.

Concerning Water Resources Development Sector of PELITA III, the following development policy is raised to accomplish the national goals.

(1) To increase the food production especially for rice

(2) To encourage the transmigration program

(3) To accelerate industrial development

(4) To keep the domestic and industrial water supply required for the urban areas

Along to the national needs for water resources development, the Team has formulated the Master Plan for the Water Resources Development in the Central South Sulawesi in consideration of the regional and local characteristics as follows;

(1) From macro socio-economic point of view as above-mentioned, increase of rice production in the objective area is effective for the achievement of the purpose of self-sufficiency in Indonesia. Especially in the east part of Indonesia, rice supply is in short at present and will not meet with future demand.

The objective area is abundant in water and land resources suitable for agricultural development. However greater parts of the paddy field in the objective area are still engaged in rainfed farming because of the lack of effective irrigation system. Furthermore, some parts of the objective area are damaged by flood.

Such conditions are big limiting factors for agricultural development.

(2) From micro socio-economic point of view, income growth of the people in the objective area is most important not only for the improvement of their living-standard, but also for the national stabilization.

(3) Lake Tempe, located in the central part of the objective area, has a high potentiality of fish production. Increase of fish production is required for the improvement of health conditions of the local people by supplying nutritious proteins.

For the achievement of such purposes, effective use of the water resources and protection against flood damages in the objective area become key factors.

Agricultural development, flood control, inland fisheries development and development of small scale industries through hydro-power supply are required for the purpose of economic development and public welfare of the people in the objective area as well as for the national demand.

CHAPTER III PRESENT CONDITIONS

3.1 NATURAL RESOURCES

3.1.1 Topography

The objective area is situated in the central part of the South Sulawesi Province in latitude 3°20' - 5°10' South and longitude 119°45' - 120°20' East, surrounded by mountain ranges with elevations between 1,500 to 3,000 m. In the center of such ranges, there exist low depression areas forming Lakes Tempe, Sidenreng and Buaya. Along the valleys of the ridges, two main streams flow into Lake Tempe; the Walanae from south and the Bila from north. The Cenranae originates from Lake Tempe and flows directly to the Bay of Bone.

Most of the objective area is covered with mountainous areas. The flat area is limited and situated over narrow belts of mountain skirts, the alluvial plains of the Walanae, the Bila and the Cenranae, and the flood plains of the lakes.

The northern area is bounded by relatively high and steep mountain ranges with elevations of about 3,000 m. The Bila and the Boya, one of main tributaries of the Bila, originate from them. Such rivers flow down toward south with steep slopes and create meanders after flowing into flat areas. The flat areas extend over the area along the rivers with elevations of less than 40 m, descending to south with slope of 1/2,000 approximately. The low lying area is contiguous to Lake Tempe and annually inundated in a high water season of the Lake.

The southern area is a mountainous area. The area is bounded on east, west and south sides by ridges with elevations between 1,000 m and 2,000 m. The higher ridges stretch to the central low areas on both east and west sides, decreasing in their altitudes. The small rivers originating from the southern mountains gather into

a flat inland basin, then they joint with the Walanae. The Walanae flows down to north, collecting the flows of small streams from the eastern and western slopes.

Downstream from the confluence of the Mario and the Walanae, flat areas extend about 10 km on both sides. In the flat area, the Walanae meanders and joins with the Cenranae at Sengkang after traveling of about 25 km. The southern area of Lake Tempe is a low lying area which is annually inundated.

The Cenranae, originating from Lake Tempe, runs across the east coastal area with flat topography. It flows towards southeast and discharges itself into the Bay of Bone meandering with very mild slope, bringing about swampy areas on its midway.

3.1.2 General Geology

The objective area is geomorphologically and geologically divided into three parts, namely, the Tempe depression, the northern part and the southern part.

The Tempe depression is a flat plain forming terrace and flood plains extending from the debouchment of the Sadang River at north-west to the Cenranae River at southeast through the Lake Tempe. The alluvial plain along the river course is formed of natural levees and back marshes and that around the lakes is formed of marsh only. The deposit of this region is mainly composed of soft clay and uncemented sand. The basins of the Cenranae and a part of the Walanae extend over this depression.

The northern part is formed of mountains and hill masses. The mountains are composed of hard sedimentary rocks formed in the period from Obligocene to Miocene in Tertiary and metamorphic rocks of Pre-Tertiary. The hill masses developing over the skirt of the mountains are composed of molasse deposit of the alternation of mudstone, sandstone and conglomerate of Pliocene. The basins of the Bila, the Boya and the Gilirang extend over the hill masses in the northern part.

The southern part of the Tempe depression is further divided into five zones, namely, West coast, Western mountains, Walanae depression, Bone mountains and East coast. The West and East coasts are the coastal flat plain. The western flank of Western mountains is composed of the complex of various rocks including huge masses of limestone. The eastern flank is formed by andesite and its tuff breccia from Oligocene to Miocene. The Bone mountains consist mainly of andesite, tuff breccia and limestone from Oligocene to Miocene. The Walanae depression is formed of hilly areas and flat plains of terrace and alluvial deposits. Hilly areas and flat plains are composed of alternation of weakly cemented siltstone, sandstone, coral limestone, etc. of Pliocene. The basins of the Lawo, the Langkemme, the Sanrego and a part of the Walanae, and Mong and Walimpong damsites are located in the southern part.

Geological map in the objective area is illustrated in Fig. 3.28.

3.1.3 Soil

The soils in the objective area are classified into 11 soil units, according to the FAO-UNESCO soil classification system, namely, Eutric Fluvisols, Thionic Fluvisols, Dystric Gleysols, Chromic Vertisols, Orthic Luvisols, Chromic Luvisols, Ferric Luvisols, Ferric Acrisols, Dystric Nitosols, Rendzinas and Lithosols. The studies for land capability are carried out on the basis of the standard classification system of Ministry of Agriculture, Forestry and Fisheries of Japan. About 80% of the land is suitable for irrigation farming, the balance not suitable. Outline of the soils and their capabilities are as follows: Details are explained in Supporting Report Part Two.

Eutric Fluvisols mainly extend over the alluvial plains of the Bila, the Boya, the Walanae and the Cenranae Rivers and of their tributaries. These soils have very deep to deep effective soil depth with fine soil textures. These soils have the highest soil inherent fertilities in the objective area. The soils are very suitable for irrigation farming.

Thionic Fluvisols develop over the swampy land along the coastal line with less than two meters above sea level. These soils are so called as acid sulfate soils which are not suitable for agricultural land economically at present.

Dystric Gleysols occur in the depressed land which develops over both sides of the Cenranae. The soils having fine soil texture show typical hydromorphic properties. Proper drainage will be required for these soils in agricultural development.

Chromic Vertisols occupy the gently sloping land enclosed with flat plains and hilly lands, extending over the sloping land lying south of Lake Tempe and the Cenranae River. These soils have deep effective soil depth with very fine soil texture. Except difficulty in physical properties due to higher content of clay, these soils have high inherent fertilities and are suitable for irrigation farming.

Orthic Luvisols and Chromic Luvisols extend over the sloping and hilly lands lying south of Lake Tempe and the Cenranae River. These soils derived from calcareous materials have high value in pH and high base saturation degree. However effective soil depth is generally shallow due to soil erosion.

Ferric Luvisols develop over both sides of the Walanae River between Ujung Lamuru and Palattae. The soils also have relatively shallow effective soil depth. However these Luvisols are suitable for irrigation farming.

Dystric Nitosols extend over the isolated high land near Camming. The soils have effective soil depth with fine textures. pH value and cation exchange capacity are relatively low. These soils are poor in inherent soil fertility. However these are suitable for irrigation farming under application of proper farm input.

Ferric Acrisols occupy the hilly area lying north of the Cenranae and Lake Tempe. The soils have low pH value with light to fine soil texture. The soils are relatively deep in effective soil depth.

However gravel layers near the surface are often found at the higher elevated land to some extent. Except shallow soil, these soils however are suitable for irrigation farming under proper farm inputs.

Rendzinas mainly extend the hilly land covered with limestone between Ujung Lamuru and Watampone. Lithosols are found in the mountain area lying south of Lake Tempe. The land covered with Rendzinas and Lithosols is the stony land with very shallow effective soil depth. These soils are not suitable for irrigation farming.

3.1.4 Soil Conservation

(1) Land Use Condition

Soil conservation is subject to the great influence by the land use condition. Among various use of land, the forest is well-known to function to foster water resources or reserve sediment yield. As for the objective areas of approximate 8,000 km^2, the forest covers 22% of the objective area. These forest lands have no serious soil erosion problem because of mostly covering with dense natural forest. The grassland with thin turf develops to wide extent in the objective area and occupies about 30%. In this area the head and sheet erosion are visible at any places due to poor vegetation. The grassland is considered to be one of the major sources of sediment yield. Upland and estate field occupy 17% of the objective area, which also become one of major sources because of exposed and unprotected land to raindrops.

As a result, about 47% of the objective area is subject to the influence of soil erosion, of which areas will become critical in the future in proportion as various developments will be carried out.

(2) Geological Conditions

The objective area is broadly divided into two parts, namely the Bila River basin and the Walanae River basin in view of soil conservation aspects. The Bila River basin consists of mainly hard sedimentary rocks. The Walanae River basin comprises mainly weakly-cemented sedimentary rocks, andesite and tuff breccia of which

distribution is rather complex. Geologically the Walanae River basin is subject to more soil erosion in comparison with the Bila River basin. Further it is considered that the upper basin of the Walanae River has potential of landslide or landfall.

(3) Sediment Yield

Based on the result of studies for sediment yield, the annual average sediment discharge of the Walanae River is calculated at 528 m^3/km^2 at Cabenge with the catchment area of 2,846 km^2 and that of the Bila River is estimated at 243 m^3/km^2 at Tanru Tedong with the catchment area of 1,123 km^2. The sediment discharge in the Walanae basin is two times that of the Bila basin.

It is considered that this figure may result from the different conditions of geology and land use in both basins as mentioned previously.

With regard to sedimentation in Lake Tempe, annual sedimentation is estimated at about 600,000 m^3.

(4) Soil Conservation

The prevention of natural forest and movement of greening which have been promoted by the Government of Indonesia, are effective measures against soil erosion. During the PELITA II period, reforestation for 11,800 ha and afforestation for 56,000 ha were carried out in four Kabupatens of Sidrap, Bone, Soppeng and Wajo. Soil conservation is carried out to small extent. The works for movement of greening are highly appreciated. However, due to shortage of budget and lack of trained staff, these programmes are not more improved than would be expected.

3.1.5 Climate

(1) General

Climate in the objective area is characterized by tropical monsoons, having distinct dry and wet seasons. Climate in the objective

area is largely affected with two different climatic patterns prevailing in the east and west coastal areas of South Sulawesi. The east monsoon prevailing from May to June brings about the rainiest month of May in the east coastal area. Whereas, in the west coastal area, the rainiest month occurs on January due to west monsoon prevailing from November to April. The objective area belongs to the transitional zone of such climate.

The rainfall data are available at 45 gauging stations in and around the objective area, but observation periods vary in each station and are short. The data covering a long period are selected for the Master Plan.

Other meteorological data, such as temperature, relative humidity, sunshine, wind velocity and pan-evaporation are available at four stations in the objective area; Kanyuara, Sengkang, Ujung Lamuru and Camming, and at a station in east coastal area outside the objective area; Arasoe. These data are available for three to nine years except at Ujung Lamuru for one year.

The general climatic characteristics of the objective area are described hereunder and the monthly mean values of the meteorological elements are shown on Tables 3.1 and 3.2.

(2) Rainfall

The rainfall patterns in the area are broadly classified into four categories; eastern area, northern area, southern part of Lake Tempe and southern inland. The rainfall distribution pattern of the northern and southern inland areas are generally similar, showing the rainiest month on May and the driest month on September or October. The annual rainfall in those areas ranges from 2,000 mm to 1,500 mm. The wet seasons last from March or April to July. About 60% of rainfall occurs during the wet season. This pattern is generally consistent with predominant pattern in the east area with the distinctive dry and wet seasons.

The rainfall distribution in the southern part of Lake Tempe differs from other areas. Rainfall distributes almost evenly over

a period of November to July. A shift of wet and dry seasons is not clear. Annual rainfall averages to 1,600 mm.

(3) Temperature

The annual mean temperature ranges from 26°C to 27°C with little seasonal variation. Both the absolute maximum and minimum recorded at Camming in the dry month are 32°C and 21°C, respectively. The daily fluctuation gets greater toward the inland and high altitude.

(4) Relative Humidity

The annual mean relative humidity is high, 92% at Kanyuara and 75% at Camming. The monthly average reaches its maximum in June at Kanyuara and is approximately 95%. The minimum occurs at Camming in September, and is approximately 68%.

(5) Sunshine

Annual average sunshine percentages are 53% at Sengkang to 55% at Camming (6.4 hr/day to 6.7 hr/day). The monthly average sunshine hours, however, vary widely from 9.9 hr/day at maximum in dry season and to 4.2 hr/day at minimum in wet season.

(6) Wind Velocity

The wind velocity is generally low. The annual averages of wind velocity are in the range of 2.5 m/sec to 1.0 m/sec. The monthly mean wind velocity reaches its maximum at Kanyuara in September and is 2.7 m/sec. The minimum is 0.7 m/sec at Camming in August.

(7) Evaporation

The annual evaporation observed in the objective area ranges from 1,600 mm (4.4 mm/day) at Camming to 2,100 mm (5.7 mm/day) at Kanyuara. The monthly average evaporation reaches its maximum in October at Kanyuara and is approximately 6.6 mm/day. The minimum occurs in May at Camming and is 3.6 mm/day.

3.1.6 Water Resources

(1) Distribution of Precipitation

Most part of the project river basin is surrounded by mountain ranges which shield the basin from the direct influence of the west and the east monsoons. Hence, amounts and annual patterns of the rainfall in the objective area vary widely according to the location with marked variation by the year.

The rainfall data were collected at 45 rainfall gauging stations in the objective area. Among them, the daily rainfall is observed at 33 gauging stations and 38 stations provide the monthly rainfall data. The collected data are compiled in Supporting Report Part One and Data Book Part II. The locations of these gauging stations are shown in Fig. 3.1. Table 3.3 shows amounts of monthly rainfall in the objective area in terms of the average, maximum and minimum values during the observation period.

The general situation and distribution of the rainfall in the objective area, from the viewpoint of water resources, will be briefly described as follows;

(i) The average annual rainfall in most of the objective area is 1,800 m - 2,000 mm. Exceptionally, a small portion in the upper Walanae basin near Camba receives higher annual rainfall of around 2,400 mm, while the area around Lake Tempe has a slightly lower annual rainfall of 1,500 mm - 1,600 mm.

(ii) Almost whole basin experiences the dry season from August to October with average monthly rainfalls of 60 mm - 80 mm. The wet season appears from April to June or July in most of the area.

(iii) However, a small portion in the upper Walanae basin near Camba has the wet season from December to March or April, and the dry season from July to October affected by the

west and the east monsoon patterns. Also, some parts of the basin near the western mountain range have slightly rich rainfalls during December and January affected by the west monsoon. The upstream basin of the Bila River seems to have a slightly different rainfall pattern affected by the northern mountain range.

An isohyetal map is shown in Fig. 3.2, which was prepared by the Team based upon the isohyetal map published by Meteorological and Geophysical Institute (1911 - 1940 rainfalls) taking the newly collected rainfall data by the Team into consideration.

(2) River Discharge

(a) General discharge characteristics

The total number of water level gauging stations in the objective area is 29. The location of these gauging stations are shown in Fig. 3.1. The discharge rating curves were prepared by the Team at 12 water level gauging stations out of said 29 gauging stations. The selected water level gauging stations are closely related to the envisaged irrigation projects or considered as important for the study of flood control and sedimentation.

The daily water levels were converted into daily discharges using the discharge rating curve of each gauging station. The results are compiled in Supporting Report Part One and Data Book Part III.

For the convenience to know the general situation of the river discharges in the objective area, the mean monthly discharges at selected stations are presented in Table 3.4 in terms of the average, maximum and minimum values during the observation period. Fig. 3.3 shows their general annual patterns of average and minimum values.

Generally, the annual pattern of mean monthly discharges varies widely according to the year at each station. The minimum values of each mean monthly discharge during the observation period, presented in Table 3.4, show that there are considerable fluctuation in many

months. The deviation is large in the rivers within the northern and northwestern portion of the objective area, especially in the case of small rivers.

(b) Discharge characteristics of each river basin

The annual pattern of the mean monthly discharges of each river basin has slightly different characteristics according to the location. They will be briefly described as follows;

(i) The Bila River

The wet season flow appears from April to June or July, but occasionally July has a small mean monthly discharge. The drought flow appears from September to November, and the minimum values of each mean monthly discharge during said months decrease severely below the average values. Another low-water flow appears from January to March. (Bila, Bulu Cenrana, Tanru Tedong)

(ii) The Walanae River

The Sanrego River in the upper basin of the Walanae River shows a relatively flat pattern throughout the year, with some wet season flow from April to June. The low-water flow appears from September to November. The minimum values of each mean monthly discharge do not decline so much throughout the year. (Sanrego)

In the middle reaches of the Walanae River, the wet season flow appears in January, February and from May to July and the low-water flow appears from August to November. The minimum values of each mean monthly discharge during the low-water flow decrease considerably. (Ujung Lamuru)

In the lower reaches of the Walanae River, the wet season flow appears in January, February and from April to July, but occasionally May and July have small discharge. The minimum values of each mean monthly discharge in the low-water flow period decrease considerably. (Lakibong, Cabenge)

The tributaries in the western portion of the central Walanae basin have the wet season flow from December to February. The low-water flow appears from August to November. The minimum values of each mean monthly discharge are small except December and January. (Langkemme)

(iii) The small rivers in the western portion of the objective area

The small rivers in the western portion of the objective area, which flow into Lake Tempe directly, have the wet season flow from April to June and from December to January or February, and the low-water flow from August to November. However, because of the small size of catchment areas and due to the topographic conditions, the minimum values of each monthly discharge decrease severely to zero in some months in a year. (Lawo, Batu-Batu)

(iv) The Cenranae River

The discharge of the Cenranae River is largely related to the water level of Lake Tempe. The river has a rich flow from May to July. The minimum values of mean monthly discharge during these months do not fall so much. The river discharge decreases from September to December. The minimum values of each mean monthly discharge decline considerably during these months especially in October and November. (Sengkang)

(v) The Gilirang River

In the Gilirang River, the wet season flow appears from May to July, but occasionally the mean monthly discharge decreases severely around June. The low-water flow appears from August to April with a remarkable drought flow in November and December. The minimum values of each mean monthly discharge become very small in most of the months during this period. (Tarumpakkae)

(3) Rainfall, River Run-off and Irrigation Intake Discharge

The relation between the rainfall and the river run-off in the upstream basin of Sengkang, and the utilization percentage of the

river run-off for irrigation within the said basin are briefly summarized in the following.

(a) Annual rainfall and river run-off in upstream basin of Sengkang

The average depth of annual rainfall on the upstream basin of Sengkang is estimated, with observed rainfall data within the basin, as 1,807 mm for the period of 1975 - 1977 by Thiessen method.

While, the total annual run-off discharge of the Cenranae River at Sengkang is calculated, taking the storage and supplement effect of Lake Tempe during the said period, as 5,971 million m^3 for the period of 1975 - 1977, which corresponds to the average depth of 973 mm over the upstream basin of Sengkang.

Hence, the annual run-off coefficient, or the ratio of the corresponding depth of the total run-off to the average depth of annual rainfall over the upstream basin area of Sengkang, is calculated as follows;

Year	Average annual rainfall (mm)	Total annual run-off (million m^3)	Equivalent depth, ann. run-off (mm)	Annual run-off coeff. (%)
1975	2,146	8,311	1,354	63
1976	1,522	3,723	607	40
1977	1,754	5,878	958	55
Average	1,807	5,971	973	53

The result of the calculation gives the average annual run-off coefficient of 53% for the period of 1975 - 1977. The table shows that the annual run-off coefficient varies according to the year; relatively large in the wet year and relatively small in the dry year.

The difference between the rainfall and the run-off can be regarded as the evaporation, transpiration, percolation and other losses, which is estimated as 834 mm or 47% of the annual rainfall according to the table.

(b) Utilization percentage of river run-off for irrigation

The irrigation area and its intake discharge depending upon the river flow in the upstream basin of Sengkang are estimated as 21,337 ha and 186.5 million m^3/yr /1 at present, and 75,150 ha /2 and 879 million m^3/yr after the development.

While, the original river flow before the irrigation intake will be estimated as 6,117.5 million m^3/yr /3.

Hence, according to the preceding figures, the utilization percentage of the river run-off for irrigation will be estimated as 3% at present and 14% after the development /4.

(4) Water Quality

(a) Water quality

To know the water quality of the rivers in the objective area, two series of water sampling were carried out by the Team at 11 locations during October 1978 in their low-water flow and during March 1979 in their high-water flow conditions.

Sample Number	Name of River	Name of Location	Date of Sampling
1.	R.Boya	Bulu Cenrana	20 Oct. 1978, 8 Mar. 1979
2.	R.Gilirang	Gilirang	18 Oct. 1978, 8 Mar. 1979
3.	R.Walanae	Pacongkang	21 Oct. 1978, 9 Mar. 1979
4.	R.Sanrego	Sanrego	24 Oct. 1978, 7 Mar. 1979
5.	R.Cenranae	Solo	17 Oct. 1978, 7 Mar. 1979
6.	L.Sidenreng	in the lake	20 Oct. 1978, 8 Mar. 1979
7.	R.Bila	Bila	19 Oct. 1978, 8 Mar. 1979
8.	R.Mario	Langkemme	21 Oct. 1978, 8 Mar. 1979
9.	L.Tempe	in the lake	19 Oct. 1978, 9 Mar. 1979
10.	R.Lawo	Watansoppen	20 Oct. 1978, 8 Mar. 1979
11.	R.Cenranae	Sengkang	17 Oct. 1978, 9 Mar. 1979

/1: Average value for 1974/75 - 1977/78
/2: Planned irrigation area 71,000 ha
Out-of-plan irrigation area 4,150 ha
/3: Net consumption for irrigation (present) 186.5 mil. m^3/yr
Observed total run-off (1975 - 1978) 5,931 mil. m^3/yr
Estimated original river flow 6,117.5 mil. m^3/yr
/4: 186.5/6,117.5 = 3% (present condition)
879/6,117.5 =14% (after development)

The samples were sent to the Hydrochemical Laboratory, Institute of Hydraulic Engineering, Bandung for analysis. The results of water quality analyses are compiled in Supporting Report Part One.

Table 3.5 shows the result of analyses of the samples collected during the low-water stage in October 1978, which indicates relatively high values of organic solid and total nitrogen except in the upstream reaches of small rivers.

(b) Estimation of salt water intrusion into Cenranae River

The result of a series of salinity measurement of the Cenranae River on 10-11 January 1979 showed the salinity intrusion only up to 2 km upstream from the estuary. A very small figure of salinity-affected distance will be principally due to the rich flow of the river on these dates, which was estimated as 260 - 270 m^3/s at Sengkang.

Hence, an estimation of the possible uppermost distance of the salinity intrusion along the longitudinal profile of the Cenranae River is prepared by calculation as follows;

At first, some assumptions will be necessary to simplify the calculation. They are as follows;

(i) The tide level is assumed to be fixed as constant at the Mean High Water Springs, EL.0.67 m.

(ii) The river discharge is assumed as 15.4 m^3/s, that is the lowest flow recorded at Sengkang in November 1977.

(iii) The density current in the estuary will take a form of the steady stratified flow.

(iv) The cross section of the river is assumed to be rectangular.

The basic equations of the stratified flow near the estuary and the critical depth of fresh water at the estuary are presented in Supporting Report Part One with their solutions. The result of the calculation indicates the salinity intrusion during a severe drought

reaching to the point about 35 km upstream from the estuary at maximum.

(5) Hydrological Consideration on Study Period of Irrigation Planning

A hydrological consideration, mainly from the viewpoint of rainfall, on the study period of irrigation planning (1974/75 - 1977/78) will be presented in the following.

(a) Average rainfall according to river basin and season

The average depth of rainfall over the basins of R.Bila, L.Tempe, R.Walanae and R.Gilirang is estimated, according to the rainfall data collected by the Team, in terms of average monthly rainfall in the dry season (October - March) and the wet season (April - September) for the rainfall observation period of 1917 - 1977.

The figures of average depth of rainfalls thus obtained are rearranged in the order of magnitude as shown in Fig. 3.4.

The average depth of rainfall over each river basin during the study period of irrigation planning is summarized as follows;

(Unit: mm/month)

	R.Bila	L.Tempe	R.Walanae	R.Gilirang	R.Cenranae
Dry season (Oct. - Mar.)					
1974/75	153	83	98	102	111
1975/76	119	110	109	109	123
1976/77	111	114	131	145	119
1977/78	99	79	111	120	112
Average	121	97	111	120	112
Wet season (Apr. - Sep.)					
1975	216	199	202	361	206
1976	118	124	157	253	133
1977	106	113	163	162	127
1978	183	213	187	257	194
Average	156	162	177	258	165

(b) Hydrological consideration on study period of irrigation planning

A hydrological consideration on the belonging period - whether the wet years, the average years or the dry years - of the study period of irrigation planning in the Master Plan will be made clearly by plotting the preceding figures of each season on the distribution curves of Fig. 3.4 according to the river basin.

The results of plotting reveals the following;

As for the dry season, from October to March, the study period of irrigation planning (1974/75 - 1977/78) belongs to the dry years in the upstream basin of Sengkang, and to the average years in the R.Gilirang basin.

As for the wet season, from April to September, the study period of irrigation planning (1975 - 1978) belongs to the average years in both of the upstream basin of Sengkang and the R.Gilirang basin.

3.2 SOCIO-ECONOMY AND HUMAN RESOURCES

3.2.1 Economic Plan

PELITA II was commenced in 1974/75 and terminated in 1978/79.

The Government of Indonesia has prepared PELITA III for the further economic growth and national stability.

This new plan is formulated based upon the following philosophy

- Equal distribution of the achievement of social justice
- Higher economic growth
- Achievement of national stability.

The Government has especially laid stress on the equal distribution of social justice being composed of following eight principles.

(1) To equalize the satisfaction of basic needs for foods, clothes and houses

(2) To equalize the opportunity to be able to get educational and public health service

(3) To equalize income distribution among people

(4) To equalize the opportunity to participate for the private business activities

(5) To equalize the employment opportunities

(6) To equalize the participation opportunities of the young generations and women for the economic development

(7) To equalize the regional development gap

(8) To equalize the opportunity to accept the justice

In the field of the water resources development, following viewpoint for the development goals has been taken into considerations in PELITA III.

- To increase food production, especially rice production
- To encourage the transmigration program

- To accelerate industrial development
- To keep domestic and industrial water supply required for the urban areas

South Sulawesi Province has made an important role as a rice supply centre in the eastern part of Indonesia. The Government of Indonesia expects the following development policy for South Sulawesi Province.

- Agricultural development, mainly for strengthening the role as a rice belt in the eastern part of Indonesia through the expansion of technical irrigation area for rice production
- Industrial development depending upon the development of electric power resources in order to establish the required conditions for the industrialization

According to PELITA II, South Sulawesi is divided into 4 characteristic areas from the economic development point of view.

South development area with the central city - Ujung Pandang is a core not only in Sulawesi but also in the whole east Indonesia. However, this area, excluding Kotamadya Ujung Pandang, is highly depressed with comparatively higher population density.

Western development area has the big trade center for inter-insular trade of rice - Pare-Pare. This port will have close contact with the objective area of the Master Plan being prepared.

East development area with Watampone as a regional centre is producing not only much rice but also maize and industrial goods produced by small scale industries.

North development area including the Luwu Project is comparatively abundant in forest and mineral resources. And because of a lack of labor power, expansion of paddy production area has been implemented with transmigration project.

The objective area is included in the west and east development area. For the objective area, the Government of Indonesia is willing to build up newly developed project based on the adequate water supply.

Development policy for the Project must be thought for the following sectors for the completion of development goals of PELITA III.

- Irrigation development plan for the purpose of paddy production increase
- Flood control plan for the protection of paddy damage, public facilities and the establishment of social welfare
- Inland fisheries development plan including Lake Tempe not only from the nutritions point of view but also for the income increase of fishermen
- Hydro power development plan for industrialization, especially of small scale industrial units

According to the draft PELITA III, following projects are put into higher development priority.

- Central South Sulawesi Water Resources Development Project
- Sadang Irrigation Project
- Tabo-Tabo Irrigation Project
- Kelala Irrigation Project
- Luwu Irrigation Project
- Palm Oil Project of Wotu
- Tana Toraja Coffee Project
- Clove Development Project
- Cattle Development Project
- Fisheries Development Project

The Government of Indonesia sets importance on the Central South Sulawesi Water Resources Development Project being prepared.

3.2.2 Macro Socio-economic Analysis

(1) Present Condition

Present needs for the project are summarized from the viewpoint of national economy and regional economy as follows;

(a) National economy

Most important role of the project is to improve the deficit of rice supply. Import of rice in Indonesia is recorded during recent 14 years from 1963 to 1976, maximum 1,860,000 tons in 1973, minimum 120,000 tons in 1971. Average quantities of imported rice during these 13 years are about 763,000 tons as shown in Fig. 3.5. Problems judged from these phenomena are not only the shortage of rice required for self-sufficiency, but also the unstable conditions of rice production. Central South Sulawesi has a higher potentiality to increase rice production and must be the core of the rice supply in order to resolve these problems.

South Sulawesi Province is a suitable and convenient place for the rice supply to the deficit area of it. This province is surrounded by the rice deficit area - East Kalimantan, Maluku, Irian Jaya and other provinces of Sulawesi as shown in Fig. 3.6 and 3.7. Total supply of surplus rice in South Sulawesi is estimated at 71,000 tons in 1976 and 76,000 tons in 1977. The quantities transferred from South Sulawesi as interinsular trade corresponds to 4% of maximum imports and 63% of minimum recorded imports.

Expansion of irrigable area in the objective area is indispensably required, not only in wet season but also in dry season. Furthermore, stabilization of paddy production must be taken into consideration, because the fluctuation of paddy production and its price is remarkable in South Sulawesi as shown in Fig. 3.8 and Fig. 3.9.

Needs for the rice increase and stabilization of its production are urgent from the viewpoint of self-supply of food, national economic growth and also the stabilization of farmer's living standard.

(b) Regional economy

The objective area is included in 4 Kabupatens - Wajo, Bone, Soppeng and Sidrap. The objective area is composed of 29 Kecamatans and its total population is 1,056,000 in 1977. Total area is about 8,000 km^2 and population density is 125 persons per km^2/1.

Characteristics of South Sulawesi Province and the objective area are shown in the following figures.

(i) Agriculture

Main agricultural product in South Sulawesi Province is paddy, but its yearly productivity is unstable because of weather conditions, damage through drought, flood, insects, etc.

Generally speaking, each Kabupaten has following characteristics.

- Sidrap — Rice is produced both in wet and dry season because of well irrigation water supply accrued from Sadang Project and the other technical irrigation projects.
- Soppeng — Rice is produced both in wet and dry season because of abundant water supply from natural rainfall.
- Wajo — Rice is produced only in wet season because of the lack of irrigation system.
- Bone — Rice is produced only in wet season as same as Wajo.

The former two Kabupatens are developed areas and the latter two Kabupatens are depressed areas.

Damaged ratio of wet season paddy is extremely high in Wajo and Bone. Soppeng and Sidrap are not so much damaged in paddy production through drought and other causes.

/1 Average value of South Sulawesi Province is 133 persons per km^2 as shown in Table 3.6 and Fig. 3.10.

- Wajo In 1976, 30,000 ha out of planted area of 67,000 ha, was damaged and in 1977, 33,000 ha out of 65,000 ha of planted area was damaged mainly through drought (Damaged ratio is about 50% of paddy planted area).

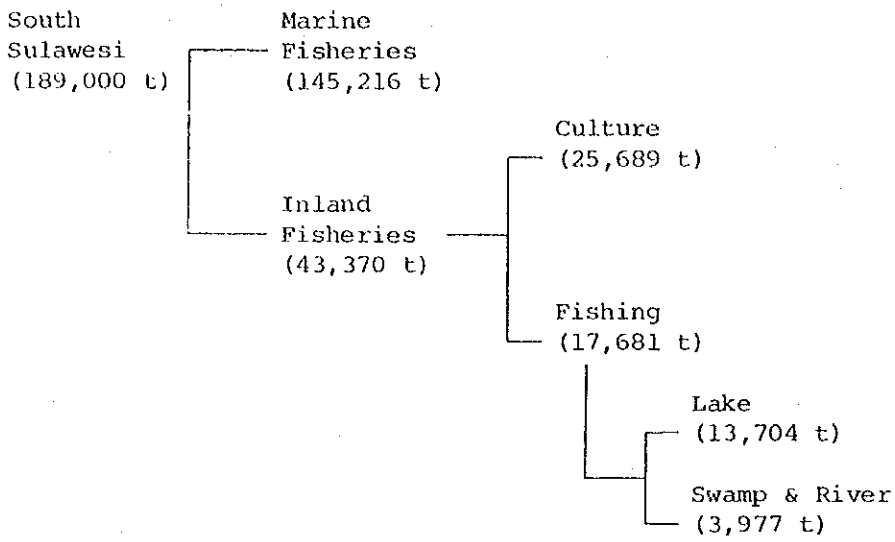
- Bone In average of 1976 and 1977, paddy damaged ratio of paddy planted area is less than 20%. Main cause of damage is drought and flood.

Producers of Wajo and Bone with much rainfed paddy field concentrate their farming in a limited period. Therefore paddy is easy to be suffered seriously from damage at a same time and human resources are not effectively used in a whole year. People of Sidrap and Soppeng with much irrigated area does not concentrate their farming in a limited period in any season. According to this farming method, risk suffered from damage of drought and flood is less, and human power is used evenly in a whole paddy growing period.

(ii) Fisheries

Only 7% of total fish production in South Sulawesi Province, is produced from Lake Tempe as shown in the following figure.

To increase fish production in Lake Tempe is required for local consumers of the objective area and fishermen being engaged in lake fishing. Around Lake Tempe, 4,400 households get much income from lake fishing. Total family members of these households are around 22,000 persons, and labor productivity of inland fisheries is very low being compared with that of marine fisheries.



(iii) Human Resources

Human resources are especially in short of economic development in the northern part of this province. And south of this province, with depressed economic conditions, is densely populated. In the middle part of the province including the objective area, population density is almost as same as that of average in South Sulawesi Province.

Transmigration project must be introduced into northern area including Luwu and Mamuju. In these areas, acceptance of new human resources is expected more for the development of newly irrigated land and for the resolution of overpopulation problems in the advanced area. In the objective area, population density is comparatively high and higher unemployment ratio can be seen in dry season -- out of season of paddy production. In view of these conditions, transmigration project is not in a higher priority for the success of the project being prepared.

(iv) Balance of supply and demand of rice

Total rice production in South Sulawesi is about 1,100,000 tons in 1976, and 1,220,000 tons in 1977.

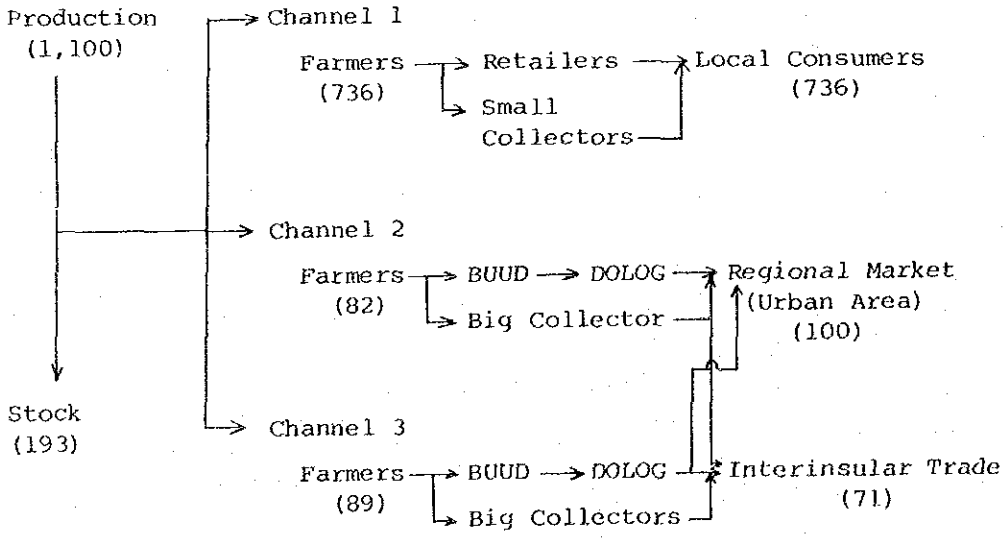
Surplus of rice is about 110,000 tons in 1976 and 180,000 tons in 1977. And rice for interinsular trade is estimated at about 71,000 tons in 1976, and 76,000 tons in 1977. 60% of these quantities comes from Sidrap with suitable irrigation water supply.

Rice consumption in South Sulawesi is increasing year after year, because of an increase in population and rising rice consumption ratio in main foodstuff as shown in Fig. 3.11. In 1967, per capita rice consumption ratio was less than 50% of main foodstuff. While, in 1976, it has increased to 90% during the past 10 years. On the other hand, maize consumption ratio has decreased to 10% in 1976 from 30% in 1967. The average per capita rice consumption in South Sulawesi is about 120 kg in 1976. As mentioned above, rice consumption goes on increasing year by year.

(v) Trade and marketing

Rice is sold through three kinds of main trading channels as shown in the following figure.

(Unit: 1,000 t)



In 1976, through this 1st channel, 736,000 tons were sold. As for the 2nd and 3rd channels, 82,000 tons were treated by BUUD - DOLOG in urban area and 89,000 tons by Big collectors in interinsular trade.

Rice for interinsular trade is transferred almost through Pare-Pare port. Ujung Pandang has not so important role for the interinsular trade of rice. Bajoe in Bone is rather important port for the export of rice to Southeast Sulawesi.

(vi) Industries

All of industrial units in 4 Kabs are small scale industries. Large scale industries were established in Ujung Pandang.

In 4 Kabs, majority of industries is rice mill. And the other industries are mainly wood and paper products, and textile industries.

- Rice Mill

Among 4 Kabs, average scale of rice mill is the biggest in Sidrap. And also in Bone, its scale is very large compared with other 2 Kabs. In Sidrap and Bone, rice production is not only high but also raised in a limited area. In these 2 Kabs. rice is produced intensively in a limited rice producing centre. Therefore, there is a possibility for the large scale rice mill units to be introduced. In Soppeng, rice production is divided into two seasons and total yearly products are not so high compared with Sidrap. Accordingly small scale rice mill units are enough to treat produced paddy. Especially in Wajo, total production is not so high and dispersed in wide rainfed area. Therefore, many small scale rice mills are established in each Kec. of this Kabupaten.

- Industries

In South Sulawesi, there are 2,526 units of small scale industries, 100 units of medium scale industries and 14 units of large scale industries. Especially, food manufactures

including rice mill are most prosperous industries in South Sulawesi. And wood products and paper industries are also main industries.

In 4 Kabs., total number of industrial units are 1,042, about 70% of these units are located in Wajo. 76% of total units of Wajo are rice mills. And many small scale textile and wood products units are in Wajo. Sengkang, the central town of Wajo, has very few job opportunity in agricultural production. There are many retailers, collectors of rice and fish and, laborers who are engaged in small scale industries. It is important for these small scale units to be centralized into a large scale unit in order to get more income.

(vii) Transportation

Main roads are in good conditions in Sidrap and Soppeng. Access roads to the main roads -- national and provincial roads -- are also well especially in dry season. In these 2 Kabs., there are no "constraints" for the transportation of rice and inputs for rice production in dry season. However, in wet season some access roads become muddy.

In Wajo, provincial roads are comparatively in good conditions. But, at present, rice production centre is far from the main roads and access roads to the main roads are muddy. Car cannot pass after heavy rainfall, because of the muddy conditions of road and destruction of bridge through big flood. Accordingly, people use two routes to big local markets - Sengkang and the other central markets. One is "north route" from rice production centre to north provincial road and the other is the way from the rice production area to the south provincial road after crossing the Cenranae River.

Bone is in the worst road conditions in these 4 Kabs. And rice producing area is far from Ujung Pandang and Pare-Pare. It happens that some parts of this Kab. are isolated from rice consumption centre. Especially in the south part of Bone,

roads and bridges for transportation are inevitably damaged. In south of Bone, there is one of the worst provincial roads of South Sulawesi, passing from Sinjai to Ujung Lamuru. In this provincial road, almost all bridges are broken and roads become muddy after heavy rainfall. In this road, even if in dry season, only jeep can pass crossing the rivers, but truck cannot pass easily. In wet season, transportation tools of this area are only horses and isolated from big local market.

(2) Future Conditions

(a) Planned period

Generally speaking, planned period is classified by types of plans.

Period	Classification	Type
More than 20 years	Ultra-long-range plan	Vision, Pilot Plan
10 - 20 years	Long-range plan	Master Plan
5 - 10 years	Interim plan	Program
3 - 5 years	Short-term plan	Project

In the economic standards of Indonesia, economic project life will be 20 to 30 years with 12% interest rate of long term loan by the Central Bank.

Based on such a way of approach for setting target year of project, following forecasting for demand and supply of rice, fish and hydro power is made for the year 2000.

(b) Irrigation plan

As a result of forecasting, 240,000 tons of paddy will be in short of demand in 2000 for the command area of South Sulawesi DOLOG as shown in Table 3.7.

The Central South Sulawesi Water Resources Development Project has a major role as a rice supply center for the command area of

DOLOG in South Sulawesi Province, and also this project will satisfy the rice deficit in whole Indonesia in the future.

(c) Inland fisheries development plan

As mentioned before, inland fisheries development plan has an important role for the following aspects. One is to supply protein to the inhabitants of the objective area for their health. The other is to increase fisherman's income to improve their living standards.

The result of forecasting the balance of supply and demand of fish in the objective area is shown in Table 3.8. In 2000, target year, 10,000 tons of fish are not satisfied for demand of fish, without Project.

Inland fisheries development plan will be expected to increase 10,000 tons of fish production in Lake Tempe and paddy field fish culture of the objective area.

(d) Hydropower development plan

This plan will be connected with the industrialization and improvement of living standards of inhabitants in the objective area.

According to the power demand and supply forecast, demand in whole South Sulawesi Province will be satisfied with the implementation of the Bakaru Hydropower Development Project until the year 2000. Therefore Hydropower Development Plan in the objective area has a role of industrialization and improvement of social welfare especially for the inhabitants of the objective area. From this viewpoint, following forecast for power demand and supply is prepared as shown in Table 3.9.

According to this estimation, the power project must generate about 70,000 MWh for the objective area in the year 2000. And also, this power project must have a role to support Bakaru Hydropower Project.

(e) Flood control plan

In the objective area, especially the area along the Bila River, the Walanae River and around Lake Tempe, flood control plan has an important role mainly for the protection of paddy damage. Especially planned area of future irrigation project must be protected from flood for the purpose of rice production increase and stabilization of rice production.

The objective area is rural area and paddy production center, and, therefore, flood control plan must be a supporting project as compound project with irrigation plan.

Lake Tempe is the main fishing ground of objective area, and therefore flood control plan must avoid a change for the worse of environmental condition of Lake Tempe. Especially to keep low water level in the suitable condition of dry season is important for the protection against the destruction of fish producing environment.

3.2.3 Micro Socio-economic Analysis

The objective area is composed of 29 Kecamatans as shown in Fig. 3.12 and Table 3.10.

Regional characteristics of socio-economic aspects in the objective area are as follows;

(1) Population Density

The area with higher population density is concentrated along the provincial road from Watampone to Pare-Pare as shown in Fig. 3.13. In the objective area, Kec. Tempe and Sabangparu have the highest population density. According to this figure, the provincial road from Pare-Pare port to Bajoe Port is the commercial belt with big market.

(2) Paddy Production

Paddy production centre is classified into two groups.

(i) Area producing both in wet and dry season

2 Kecamatans of Sidrap and 2 Kecamatans of Soppeng are in this group. These zones are advanced area of paddy production.

(ii) Area producing only in wet season

Eastern part of Wajo, along the coast, is the rice producing centre only in wet season because of a lack of irrigation water supply (as shown in Fig. 3.14 and Fig. 3.15).

(3) Irrigation Facilities

Rate of irrigation area to the total paddy field is too high in the west side of the objective area -- from Kec. Dua Pitue to Kec. Lili Riaja (as shown in Fig. 3.16).

(4) Productivity of Wet Season Paddy

Most advanced area with the highest productivity of wet season paddy is the same Kec. of the area producing paddy twice a year. And higher productivity area producing more than 3.5 tons/ha of paddy is the well irrigated area shown in Fig. 3.17.

(5) Change of Production of Wet Season Paddy

Increase of paddy production during 1974 and 1977 can be seen in the well irrigated area and in the south of Bone. Almost all Kecamatans in Wajo and north of Bone are decreasing paddy production in wet season (as shown in Fig. 3.18).

(6) Damaged Ratio of Wet Season Paddy

Area of paddy production decrease is in the highly damaged group. But south of Bone is highly damaged in spite of increase of paddy production (as shown in Fig. 3.19).

(7) Cause of Paddy Damage in Wet Season

According to the interview survey of head of each Kec., following characteristics can be seen.

Drought damage ratio is remarkable in the north of Wajo, north of Bone and south of Soppeng. The area around Lake Tempe, lower stream of Bila and Walanae River suffer from flood damage (as shown in Fig. 3.20).

(8) Farm Income

Farm income of the area, producing rice twice a year, is the highest and then paddy production centre in only wet season accomplishes higher income.

In double cropping area of paddy, only Lalabata has not succeeded to get higher income. According to Fig. 3.21, the more rice production, the more farm income will be brought.

(9) Manpower

Fig. 3.22 shows the unemployment conditions in paddy planting and harvesting time, higher unemployment ratio and extra manpower are in the underdeveloped area of paddy production.

(10) Surplus and Deficit of Paddy

Well irrigated area and high paddy production area have so much surplus of rice. Central part of the objective area is deficit of rice (as shown in Fig. 3.23).

(11) Transportation and Marketability

Almost all Kecamatans are convenient in the transportation of rice to Pare-Pare rather than Ujung Pandang. Comparison of marketability and convenience of transportation is shown in Fig. 3.24, Fig. 3.25 and Fig. 3.26.

3.2.4 Needs for the Regional Development

(1) Macro Socio-economic Point of View

(a) To decrease imports of rice and to accomplish self-supply of rice

(b) To stabilize productivity of rice

(c) To keep the role of rice supply centre for the east Indonesia

(d) To equalize the regional development gap between advanced area such as Soppeng and Sidrap and depressed area such as Wajo and Bone

(e) To decrease drought and flood damage of wet season paddy

(f) To resolve the higher unemployment conditions by expanding irrigable area in dry season

(g) To increase fish production for the purpose of acquisition of required protein and income increase of fishermen

(h) To increase paddy production for the income increase of farmers

(i) To make plan for paddy production increase, taking into considerations of population increase and increase of per capita rice consumption

(j) To strengthen public trade and marketing system in preparation for the future paddy production increase

(k) To improve small scale industries into effective units for the industrialization

(l) To exclude transportation constraints for the proposed projects

(2) Micro Socio-economic Point of View

Being taken into consideration the characteristics, the objective area is divided into 16 zones. Determination of project priority must be done from the viewpoint of the growth of national economy and from the optimization and equalization of development in each zone classified in Fig. 3.27.

Zone 1 - Maritengngae, Dua Pitue

(a) The most developed area in paddy production in a whole year with effective irrigation system

(b) The highest net farm income

Zone 2 - Lalabata, Lili Riaja

(a) The most developed area in paddy production in a whole year with the effective water supply from natural rainfall

(b) Lili Riaja with the highest net farm income

Zone 3 - Sajoanging, Takkalalla

(a) Rice production centre only in the wet season

(b) Access road conditions are not well.

Zone 4 - Barebbo, Palakka, Awangpone, Sibulue, Cina ⟶ Outside of objective area

Rice production centre only in wet season

Zone 5 - Belawa

(a) Comparatively higher rice production in wet season but higher flood damage

(b) Access road conditions to provincial road are not well.

(c) Most convenient for sales of agr. products through Pare-Pare to the external area of South Sulawesi

Zone 6 - Tanasitolo

(a) One of the lowest production areas of paddy

(b) One of the areas with the lowest farm income

(c) Serious drought and flood damage of paddy

(d) Lack of abundant human resources

(e) Rice deficit area

Zone 7 - Tempe

(a) The area with central town of this objective area -- Sengkang

(b) Small job opportunity in agricultural sector

(c) Many small scale industries -- Manufacture for food relating products, wood products and textile

(d) Trade centre of agricultural products and fish produced in Lake Tempe

Zone 8 - Sabang Paru, Lili Rilau

(a) Lower paddy production and productivity

(b) Damage of paddy field through drought and flood

(c) The lowest farm income of this objective area

(d) Rice deficit area

Zone 9 - Panca Lautang, Tellu Limpoe, Mario Riawa

(a) Higher paddy production area

(b) Higher farm income

Zone 10 - Watanpulu, Baranti

Outside of the objective area

Zone 11 - Majauleng, Maniangpajo, Pitumpanua

(a) Lower paddy production and productivity

(b) Higher damaged ratio of paddy planted area in wet season

(c) Lack of abundant human resources

(d) No surplus of rice

Zone 12 - Pammana, Ajangale, Dua Boccoe, Tellusiatinge, Cenranae

(a) Depressed area because of the lowest paddy production and productivity

(b) Higher drought damage

(c) Higher unemployment ratio even in wet season

(d) Deficit of rice

Zone 13 - Mario Riwawo

(a) Lower paddy production in Soppeng

(b) Rice deficit area

Zone 14 - Ulaweng, Lappa Riaja, Lamuru

Lower dependency on paddy production in earning income

Zone 15 - Ponre, Mare, Libureng, Tonra, Bontocani, Kahu, Salomekko, Kanyuara

(a) Highly depressed area

(b) Lower production and productivity

(c) Higher damage of paddy production

(d) Lack of human resources

(e) No surplus rice

(f) Convenient to Ujung Pandang compared with Pare-Pare for transportation, but very far from these big market

(g) Worst road and bridge conditions including provincial road

Zone 16 - Tanete Riatang

Watampone is included in this zone, but outside of the objective area.

Zone 17, 18 - Lake Tempe and Sidenreng

(a) High production and productivity of fish

(b) Lake with the role of supply of proteins to the inhabitants of objective area

(c) Lake for the maintenance of fishermen's life around the lake

(d) Higher potential damage of paddy field through the inundation for a long time

3.2.5 Development Goals

Development goals for the Central South Sulawesi Water Resources Development Project are summarized in the following items. These goals must meet the above-mentioned needs extracted through macro and micro socio-economic analysis. Target year for this project is 2000.

(1) To increase paddy production and to increase farmer's income. Increase of rice production through the implementation of the Project has to satisfy the paddy deficit of 240,000 tons in the year of 2000 for the command area of DOLOG in South Sulawesi Province. Furthermore the Project has a role of rice supply center in whole Indonesia.

(2) To increase fish production and to improve fishermen's income. Target production increase of fish for this Project is 10,000 tons in 2000.

(3) To support the irrigation plan and to increase social welfare through effective way of flood control

(4) To generate 70,000 MWh energy in the target year for the purpose of not only industrialization of the objective area, but also the support of Bakaru Hydropower Project

(5) To equalize regional development gap

3.3 AGRICULTURE

3.3.1 Present Land Use

The area of present land use in the objective area, about 8,000 km^2, was measured on the basis of topographic map on a scale of 1/25,000. The lands are classified by eight land use categories comprising paddy field, upland field, estate crop field, forest land, grassland, fish pond, swampy land and village land. The farm land comprising paddy field, upland area and estate crop area amounts to 41% of the objective area, and the balance in non-farm land. Table 3.11 shows the summary of land use in the objective area.

The area of paddy and upland fields mentioned above is assumed to contain the considerable area temporarily cultivated in swamp and grasslands at shooting time of aerial photo for the topographic map. These cultivated areas are not utilized constantly as farm land. Area of farm land utilized constantly is indicated in agricultural statistics in each Kecamatan. Twenty-nine Kecamatans in four Kabupatens are selected as the objective area for agricultural studies.

Presently 159,450 ha of paddy field extend over the objective area. Out of them, 36,420 ha or 23% are irrigated and the balance rainfed area or village irrigation area. The ratio served with irrigation facilities considerably varies, depending locations. It ranges from 60% at maximum in Kab. Sidrap to 4% in Kab. Wajo. Further upland areas of 85,720 ha mainly extend over the sloping and hilly land.

The main crop grown in the objective area is paddy, followed by polowijo crops such as maize, peanuts, soybeans, green beans, cassava and sweet potato. Other crops grown as an adjunct to rice farming are banana, coconuts, sugar cane, tobacco, kapok, kemiri, clove, coffee, pepper, sesame and vegetables.

Paddy cultivation is concentrated in wet season and is limited in dry season. The cultivation pattern is strongly affected by

distribution of rainfall. Further the planted areas or harvested areas of paddy vary year by year due to uneven distribution of rainfall. The wet season paddy is planted at the onset of the monsoon, generally April or May and harvested at August or September. The dry season paddy is planted at the period of November or December and harvested at February or March.

The average harvested area of paddy, from 1974 to 1977, amounts to 104,800 ha for wet season paddy and 29,350 ha for dry season paddy. These figures correspond to 66% and 18%, respectively, in view of the ratio of harvested paddy area to total paddy field. It is considered that these low figures mainly result from drought damages due to uneven distribution of rainfall, flood damages, damages caused by pest and diseases, etc. Basically, however, low figures are due to shortage of available irrigation water.

Following by paddy, polowijo crops are important crops in the objective area. Polowijo crops are grown on paddy field and upland area. About 32,000 ha or 20% of paddy field are under their cultivation after harvest of wet season paddy. This low cropping ratio in paddy field is considered to be accrued from poor drainage conditions due to high rainfall intensity and unstabilized price of crops. As for upland area, the planted or harvested areas also fluctuate year by year due to uneven distribution of rainfall. The harvested area amounts to 75,160 ha on an average of which about 60% is occupied by Kab. Bone.

Actual multi-cropping index in paddy field and upland area is 1.06 and 0.85, respectively for the objective area.

The land use is summarized in Table 3.12 and explained in Chapter Five, Supporting Report Part Two in detail.

3.3.2 Farming Operation

As mentioned in previous section, rice is the most important crop in the objective area, of which culture is simple and except for isolated instances, no mechanical equipment is used. Farming is carried out by labour intensive form from the stage of seeding

to harvest. All members of family contribute their labour. Buffaloes or oxen provide motive power for land preparation.

In the objective area, improved high yielding varieties (IR-series) have been widely spread over through the extension of BIMAS programme and occupied over 70% of total paddy field. Fertilizers and chemicals are practiced over the irrigated land through above programme. Generally no fertilizers are applied in rainfed area. Dosage of fertilizers varies largely depending on location. The estimated dosages per ha range from about 50 to 140 kg of urea and 5 to 80 kg of triple super phosphate. Application of agricultural chemicals is not always well extended in the objective area, in spite of considerable damages due to pests and diseases.

As for polowijo crops, their cultivation is also very simple. No fertilizer and nor improved varieties are used. Farming operation is entirely dependent on manpower. Management work consists solely of weeding.

Details are explained in Chapter Seven, Supporting Report Part Two.

3.3.3 Crop Yield and Production

Yield and production of major crops at present condition in the objective area are estimated after review of available data which are provided by Extension Services Offices. Yield and production of major crops fluctuate largely year by year due to affectation by variation of annual rainfall, unexpected big damages by diseases and insects, etc. Consequently present yield and production are estimated at average value from 1974 to 1977 with the exception of Kabupaten Bone.

(1) Rice

Yield and production of paddy are presented in Table 3.13. As shown in the table, unit yields are generally low except for isolated instances. It is considered from the analysis of field survey that these low unit yields are mainly accrued from the following matters.

- Insufficient irrigation water in volume and in time
- Improper water control
- Low farm input
- Damages caused by pest and diseases
- Limited extent of proper farming

Average unit yield of paddy in the objective area is 3.0 tons/ha for wet season paddy, 4.3 tons/ha for dry season paddy and 1.5 tons/ha for upland rice. The yield varies depending on the land condition, among which Sidrap and Soppeng have higher yield in both seasons. Total productions of paddy in the objective area amount to 445,300 tons as dry stalk paddy, comprising 309,800 tons for wet season paddy, 125,600 tons for dry season paddy and 9,900 tons for upland rice.

(2) *Polowijo Crops*

The yield and production of polowijo crops fluctuate depending on locations. However since no fertilizers nor chemicals are used, the yield is generally low. With the exception of cassava, unit yield of polowijo crops is less than 0.7 ton/ha. Past trend of their unit yield indicates negative in general. Total productions of major upland crops are 45,000 tons for maize, 10,000 tons for peanuts, 2,000 tons for soybeans, 7,000 tons for green beans and 31,000 tons for cassava.

(3) Estate Crops

Estate crops are grown under small holder system, mainly in and around the homestead area. Total productions of major estate crops in the objective area are 15,900 tons for copra, 1,200 tons for kapok, 70 tons for coffee, 2,700 tons for kemiri, 2,300 tons for tobacco and 1,400 tons for sugar cane.

Details are explained in Supporting Report Part Two.

3.3.4 Livestock and Forest

Livestock raising is not a main line of the agricultural activities in the objective area.

There are no large scaled livestock raising in the area and most of livestock are raised by farmers in and around the paddy field on a small scale. The livestock plays an important role in protein food supply and in provision of motive power and transportation measures. Raising of them is mainly dependent on straw of paddy, rice bran, and broken rice as feed. Therefore production is geographically related to rice production.

Number of major livestock in four Kabupatens related to the objective area is 69,000 of horse, 239,000 of cattle, 90,000 of buffalow, 64,000 of goat, 4,909,000 of chicken and 579,000 of duck.

With regard to forest, four Kabupatens related to the objective area have 172,000 ha of forest. Most of the forest products are timber of 1,260,000 m^3, followed by rottan of 806,000 tons, arenga palm of 203,000 ℓ and bamboo of 22,000 pieces.

During PELITA II reforestation and afforestation were carried out for the area of 67,800 ha. The Government has intention to make effort soil conservation during PELITA III.

Details are explained in Supporting Report Part Two.

3.3.5 Land Tenure and Land Holding

Since the data on the present land holding in the whole objective area are not available, the data of Agricultural Census, 1973 were used for study.

In South Sulawesi about 85% of total farmers are less than 2 ha of the holding size.

Total farm land of 245,170 ha excluding estate area are cultivated by 140,858 farmers at present. Average farming size is estimated at 1.74 ha of which 1.13 ha or 65% is paddy field including rainfed field. About 94% of total farmers are owner farmer and partially owner farmer. Pure tenant farmer is only about 6%. Tenant charge prevailed in the objective area is mostly share cropping system of 50% of product in case of paddy.

3.3.6 Agricultural Support System

(1) General

In Indonesia, basic administrative unit is the village headed by village chief who is elected from among the villagers. The village chief has the responsibility of agricultural development in the rural area as well as health and welfare, public education, etc. of inhabitants.

In the objective area, 203 villages are included under 29 Kecamatans of 4 Kabupatens such as Sidrap, Bone, Soppeng and Wajo.

(2) BIMAS and INMAS Programme

As for the agricultural development, the agricultural intensification programme so called "BIMAS and INMAS" has been promoted by Indonesian Government in order to facilitate production increase with coordination of all the efforts of agricultural support services so as to provide a "package" of agricultural inputs to the farmers since 1968. For further development of the BIMAS/INMAS Programme, the Government has initiated to organize a village unit (Wilayah Unit Desa) with one Field Extension Worker, village unit co-operative (KUD/BUUD), Kiosk/shop and village unit BRI (Indonesia People's Bank), as the lowest executive unit of the Programme since 1973.

In the objective area, there are 190 village units with 90 BUUD/KUD, 86 Kiosks, 59 village unit BRIs and 181 Field Extension Workers. Average paddy field, especially irrigated paddy field and number of farm household per village unit are 741 ha, 192 ha and 741 farm households, respectively. As compared with the general standard of the village unit, it is far intensified on size, however, on the aspect of functional institution, it has much rooms to be developed in the objective area. At least, the development of number and equipment of KUD and Kiosk would be recommended for the successful implementation of the irrigation projects.

Under these executive organizations, the BIMAS/INMAS Programme has been steadily developed, especially in the area where the irrigation facilities were developed. The area served by the BIMAS/INMAS Programme in the objective area is estimated at 35,000 ha or 33% for wet season paddy and 18,000 ha or 61% for dry season paddy.

Since the BIMAS/INMAS Programme is served nearly maximum extent of irrigated paddy field in the objective area at present it is indispensable to increase the new irrigated area for further development of the Programme.

(3) Research

Agricultural research work in Indonesia is undertaken by the Central Research Institute of Agriculture (CRIA) at Bogor in Java. There are six branch research stations conducting various agronomical research activities throughout the whole Indonesia.

South Sulawesi Branch Research Station of CRIA located at Maros about 50 km north from Ujung Pandang covers whole Sulawesi island. About 40% of experimental works are devoted to the experiment of rice such as variety test, fertilizer test, and test for control of pests and diseases on irrigated paddy in this Station with 110 ha of rice experiment field.

This Branch Research Station is playing an important role in technical aspects of increase of rice productivity through BIMAS Technical Team comprised research staff of rice in the Station.

(4) Extension Service

In order to promote and accelerate extension education activities on field level by separating extension service with general agricultural administrative services, the Agricultural Extension Development Programme has been launched in Indonesia since 1974.

The organization of Agricultural Extension Service in South Sulawesi is formed by two separate lines, i.e. administrative line and operational line under the supervision of Inspector of Provincial Agricultural Extension Service.

In the objective area, there are 14 Rural Extension Centers (BP2), 4 Subject-matter Specialists (PPS), 39 Extension Supervisors, and 181 Field Extension Workers. The Subject-matter Specialist staying each Kabupaten assists and advises about 10 Extension Supervisors of which 2 to 4 are working at Kabupaten office and remains are staying in the Rural Extension Center. 2 Extension Supervisors staying at each Rural Extension Center assist and advise about 10 Field Extension Workers.

Every Field Extension Worker is requested to visit a key farmer in each working area of which 16 areas make one village unit, 4 days a week and 2 working areas a day. Thus each key farmer would contact 10 progressive farmers and a progressive farmer would influence 20 farmers. Then, finally one Field Extension Worker may affect 3,200 farmers totally.

Taking the future agricultural development into consideration, it would be recommended that the practical rice cultivation technique of Field Extension Workers have to much raise up so as to be able to judge actual plant situation and advise properly to the farmers timely in their own fields.

(5) Seed Multiplication

The stock seeds of recommended varieties of paddy in South Sulawesi are produced at the Provincial Seed Center located at Maros by supplied foundation seed from CRIA at Bogor.

The Seed Center distributes these stock seeds to 37 Seed Stations managed by Kabupaten Offices. These Seed Stations produce the extension seeds and distribute them to seed growers. The seed growers produce paddy seeds and supply them to the farmers through BUUD/KUD according to the BIMAS/INMAS Programme.

In the objective area, total seed production is about 200 tons from 120 ha including the field of seed growers. Much amount of product in these Seed Stations were spent for management cost at present because of insufficient budget. Further efforts are

required for improvement of the amount and quality of multiplied seeds in order to realize future agricultural development including irrigation projects.

(6) Agricultural Credit

The Indonesia People's Bank (BRI) which is the main source of institutional credit to agriculture at present, is authorized to finance BIMAS package credit for farmers. The loan condition for BIMAS is fixed on amount of loan by the kind of package with 1% per month of interest rate and 7 months of loan period.

At Ujung Pandang, there is a Regional Office of BRI with 23 branch offices and 210 village unit BRIs, covering whole South Sulawesi Province. In the objective area, there are 4 branch offices with 59 village unit BRIs.

The loan amount of BIMAS Paddy has been steadily increasing and it exceeded Rp. one billion since 1976/77 in South Sulawesi. At the same time, the amount of outstanding has also been increasing. In the objective area, low percent of outstanding is found in such Kabupaten as bressed with irrigated paddy field like Sidrap. On the other hand, in Kabupaten Bone and Wajo which rainfed paddy fields are prevailed, high percent of outstanding is recorded.

One of the main reason of high percent of outstanding in these areas is considered to be unstable productivity of paddy because of insufficient irrigation facilities.

(7) Farmer's Organization

Supplies of agricultural inputs, processing and marketing of farm product are primarily made through the establishment of co-operatives which had been promoted in the rural area by the Government since 1945. However, the movement of co-operative has not been well developed yet, mainly because of weakness in management and shortage of operational fund.

In order to improve such stagnant condition, establishment of village unit co-operative (KUD) has been introduced by the Government in the area adopted the BIMAS/INMAS programme since 1973, as mentioned previously.

In South Sulawesi Province, out of 620 village units, 345 or 56% have been established BUUD/KUD by 1978.

In the objective area, 90 BUUD/KUD were already established by 1978. It is only 47% of village units in the objective area. Besides, number of member of BUUD/KUD is also extremely limited. The total number of members including candidates is 32,000 farmers which occupy only 17% of total farm household.

The main processing facility owned by BUUD/KUD is rice mill. The total milling capacity is estimated at about 600 tons/hour. From present milling capacity, it could be said that the present rice mills would be sufficient in both the capacity and number in the objective area, even after the completion of the proposed irrigation projects.

As for the Water Users Association, it is just started to organize the farmers cultivating irrigated paddy field under the guidance of Agricultural Extension Service Office since 1976/1977. In the objective area, number of Water Users Association counted only 7 with 2,400 members and 3,500 ha of irrigated field at present.

Details are explained in Supporting Report Part Two.

3.3.7 Marketing

(1) Distribution of Farm Input

Distribution of fertilizers and agricultural chemicals is handed by PT. PUSRI which is the governmental enterprise, in South Sulawesi Province.

According to the BIMAS/INMAS Programme, fertilizers and agricultural chemicals are supplied to 6 Sub-Distributors appointed by

PT.PUSRI at Ujung Pandang and then the Sub-Distributors provide necessary amount of fertilizers and agricultural chemicals to the retailers and/or BUUD/KUD at the local level.

The distribution price of agricultural inputs for agricultural intensification programme is set by the Government as the unit price in whole Indonesia. Distribution prices of urea and TSP to farmers is 70 Rp/kg at present. The amount of farm inputs distributed in the objective area is about 7,800 tons in total in 1978.

(2) Marketing of Farm Product

Main marketing farm product in the objective area is rice. The surplus of paddy produced by the farmers is sold to KUD and/or middle men through brokers. Collected paddy by KUD and/or middle men is sold to DOLOG and/or wholesaler after milling. Total surplus of rice is varied annually according to the variation of the yield of rice produced. However, the price of rice is stabilized by the Government through DOLOG.

The DOLOG in South Sulawesi would purchase and sell the rice when the price is down under the floor price or raised over the ceiling price at the central market of Ujung Pandang.

In 1978/79, the floor price is set to 119.5 Rp/kg and 140 Rp/kg, respectively, by the Government.

Present total capacity of warehouses for cereals in the objective area handled by the DOLOG would be sufficient, but after the development of irrigation projects, about 4 to 5 times of capacity would be required.

(3) Forecast of Supply and Demand of Rice

On the assumptions of population increase rate of 2% per year, annual consumption of rice of 130 kg per capita, production forecast by least square line method based on the average production from 1974 to 1977 and seed and waste rate of 7.5%, the estimation of forecast of supply and demand of rice was worked out. According

to this estimation, the shortage of supply of rice in the command area of DOLOG of South Sulawesi would still remain even in the year of 2000.

Details are explained in Supporting Report Part Two.

3.3.8 Farm Economy

According to the available data provided by the Agricultural extension Service Offices in Ujung Pandang and Sidrap, Bone, Soppeng and Wajo Kabupatens, and the results of farm interview survey, the present farm economic analyses were worked out.

The amount of the gross farm income is varied by average size farm of each Kecamatan from about Rp.12,000 to Rp.643,000. The main farm income is from paddy production which is occupied about 76% of the gross farm income on an average. However, the average size farm of the Kecamatan which the gross farm income of polowijo is exceeded than that of paddy is counted 7 out of 29 Kecamatans at present.

The farming expense is also varied by each farm reflecting the difference of productivity, but on an average about one third of the gross farm income is spent for farming expenses.

At present, the annual gross farm income of the typical size farmer in the objective area is estimated at bout Rp.238,280.

In addition to the farm income, farmers get their income from non-farm activities such as temporary hired labour for the sugar plantation, small holder's plantation and other large farms, and other miscellaneous works such as fishing, livestock and trade, etc.

The farming expenses except family labour cost are around Rp.83,540 on the typical size farmer. Accordingly, the net income is estimated at Rp.225,380 which is nearly same amount of living expense.

Details are explained in Supporting Report Part Two.

3.4 EXISTING IRRIGATION AND DRAINAGE SYSTEMS

3.4.1 Existing Facilities and Water Sources

In the objective area, there are 5 technical and 22 semi-technical irrigation systems of which beneficial area is about 36,400 ha or 23% of total existing paddy area of 159,450 ha, at present as shown in Table 3.14 and Fig. 3.29. Out of 36,400 ha, 13,400 ha is served by two technical systems in Kab. Sidrap of which water sources are surface flow of the rivers outside the objective area. Water sources of the existing systems serving the remaining 23,000 ha are almost surface runoff of the tributaries in the objective area. Only one semi-technical system supplies 240 ha of paddy field with spring water. There are no reservoirs as water sources of the existing irrigation facilities.

Beneficial areas by respective sub-basins are summarized as follows;

(Unit: ha)

River Basin of the Water Source	Kabupaten				Total
	Sidrap	Soppeng	Wajo	Bone	
Bila River	6,553	-	2,149	-	8,702
L.Sidenreng	1,441	-	-	-	1,441
L.Tempe	-	6,200	-	-	6,200
Walanae River	-	3,584	-	1,170/1	4,754
Cenranae River	-	-	240	1,700	1,940
Sub-total	7,994	9,784	2,389	2,870	23,037
L.Sidenreng	13,387/2	-	-	-	13,387/2
Total	21,381	9,784	2,389	2,870	36,424

The above beneficial areas have been developed with rehabilitation works on old and damaged systems or small scale systems maintained under the regional government (Bupati) or inhabitants. Beneficial area developed during recent five years since FY 1974/75 is totalod about 8,500 ha as shown as follows.

/1: Including a semi-technical system supply spring water
/2: Boneficial area in the objective area supplied irrigation water from the water sources outside the objective area.

(Unit: ha)

	Before PELITA II	1974/75	1975/76	1976/77	1977/78	1978/79
Kab. Sidrap/1	3,600	4,500	5,714/2	7,071/2	7,114/2	8,119/2
Kab. Soppeng	6,792	7,672	8,860	9,310	9,470	9,784
Kab. Wajo	1,500	1,500	2,264	2,264	2,264	2,264
Kab. Bone	2,630	2,630	2,870	2,870	2,870	2,870
Total	14,522	16,302	19,708	21,515	21,718	23,037

There are no systematic drainage facilities in the objective area excepting drainage canal network in the Sadang irrigation system. Excess water in the cultivated land is usually drained through natural drains, streams and rivers to the main drains in the objective area; the Walanae River, the Bila River, Lake Sidenreng, Lake Tempe and the Cenranae River.

The present conditions of 27 existing systems in the objective area are described in Supporting Report Part Two.

3.4.2 Water Consumption for Paddy Cultivation

Out of total beneficial area, area actually irrigated in the dry season is usually restricted every year to about 60% on an average in the whole objective area due to shortage of absolute amount of available water, excepting Bulucenrana area served with technical system, of which water source is river runoff of the Boya River, a major tributary of the Bila River, and the area is irrigated approximately to be 90% even in dry season.

In FY 1977/78 beneficial area of the existing irrigation systems amounted to about 21,700 ha of paddy field in the objective area excluding the area where water was supplied from the rivers outside the objective area in Kab. Sidrap. Out of them, irrigated area was 91% or 19,680 ha in wet season and 59% or 12,860 ha in dry season.

/1: Excluded beneficial area of the Sadang and Bulutimorang systems of which water sources are outside of the objective area.

/2: Included beneficial area of the Lancirang system located partly in Kab. Wajo (125 ha).

Water use on the said irrigated paddy field is estimated at about 214 million m^3 per year as present water consumption for paddy cultivation in 1977/78/1 in terms of the intake water from the source exclusive of effective rainfall on the field, as summarized below for respective basins;

River Basin	Beneficial Harvested Area			Water Consumption		
	Area (ha)	Wet S. (ha)	Dry S. (ha)	Wet S. (10^6m^3)	Dry S. (10^6m^3)	Annual (10^6m^3)
Bila & L.Sidenreng						
Kab. Sidrap	7,114	6,745	5,587	59.1	42.4	101.5
Kab. Wajo	2,264	1,935	521	12.2	1.0	13.2
Sub-total	9,378	8,680	6,108	71.3	43.4	114.7
L.Tempe & Walanae						
Kab. Soppeng	9,470	8,475	6,369	43.3	42.2	85.5
Walanae Upstream						
Kab. Bone	1,170	1,100	215	5.2	1.2	6.4
Cenranae						
Kab. Bone	1,700	1,428	172	5.1	2.2	7.3
Total	21,718	19,683	12,864	124.9	89.0	213.9

Out of annual consumption in Kab. Sidrap approximately 90 million m^3 or 40% of total consumption in the objective area is diverted from the Boya River by a Bulucenrana existing system. The remains are diverted from the small streams.

Out of 167,000 ha of total paddy field in the objective area in future/2, approximately 20,000 ha in Kab. Sidrap on the north and west of Lake Sidenreng will be supplied by irrigation water from sources outside the objective area of this study. At 147,000 ha of paddy field area, double cropping of paddy in a year is laid out.

/1: An average of 4 years during FY 1974/75 to FY 1977/78 is estimated at 186 million m^3 per year consisting of each 93 million m^3 in both wet and dry seasons.

/2: See Table 4.2.

Total needs of annual irrigation water from the source in the objective area is estimated at 1,920 million m^3 consisting of 680 million m^3 in wet season and 1,240 million m^3 in dry season as shown below.

River Basin	Area (10^3ha)	Wet Season (10^6m^3)	Dry Season (10^6m^3)	Annual (10^6m^3)
Bila R.	26	144	200	344
Walanae R. & L. Tempe	53	219	374	593
Lower Reaches of Cenranae R.	45	246	429	675
Sub-total (Cenranae Basin)	124	609	1,003	1,612
Gilirang R.	23	72	237	309
Total	147	681	1,240	1,921

As present water use for irrigation is 214 million m^3, about 1,700 million m^3 of water will be required in the future as potential needs for irrigation.

3.4.3 Present Plans of Irrigation Development

In the objective area, the Bila irrigation project and the Sanrego irrigation project are studied by the Government of Indonesia with scale of 9,000 ha and 3,500 ha, respectively. And the study of the Langkemme irrigation project is just started, after preparation of topographic maps of a scale of 1/5,000.

In addition to the above, provincial office of public works of South Sulawesi proposes to rehabilitate such existing irrigation systems of which intake facility is primitive or canal system is damaged, as old semi-technical systems, non-PU systems and village irrigation systems.

As of village irrigation system, about 150 projects in four Kabupatens are proposed to be rehabilitated with construction of new intake structures and gabion weirs during third five year development plan to be commenced from FY 1979/80. Beneficial area of such village irrigation projects ranges from 5 ha to 850 ha and totaled at approximately 18,000 ha, i.e. averaged to 120 ha per unit.

3.5 RIVERS AND FLOODS

3.5.1 Present Conditions of Rivers

(1) River System

The objective area is composed of the Cenranae River and the Gilirang River basins which are located in Latitude 3°30' to 5°10' South and Longitude 119°45'-120°20' East, and occupies the middle part of South Sulawesi.

The Cenranae River system comprises Lake Tempe located in the center of the basin, the Walanae River flowing into the lake from the south, the Bila River flowing into the lake from the north, other small rivers such as the Batu-Batu and the Lawo Rivers which also flow into the lake from the south and the west, and the Cenranae River flowing out from the lake to the Bay of Bone.

The Gilirang River basin is located in the north-east region of Lake Tempe and the river flows directly to the Bay of Bone.

The river systems in the objective area and the profiles of the rivers are shown in Fig. 3.30 and Fig. 3.31 respectively.

(2) Distinctive Features of Major Rivers

(a) Cenranae River

The Cenranae River runs into the Bay of Bone from Lake Tempe in direction of the south-east. The catchment area of the Cenranae River system at the river mouth is 7,293 km^2 in which the area of 1,155 km^2 is the catchment area of the lower reaches from Sengkang. The channel of the river is 69 km in length and is a natural channel with single section.

Based on the longitudinal profile of the channel, the average water surface slope is estimated as 1/20,000, 1/14,000 and 1/8,000 in drought, normal and flooding period. The carrying capacity of the channel is estimated to be in the ranges from 400 to 670 m^3/s by calculation.

The river bank material is clayey soil. However, the grain size investigation of river bed material indicates that the stream bed material is fine sand including silty soil and mean diameter of it ranges from 0.3 to 0.6 mm. Although some meanderings and bank erosions are found, the channel seems to be comparatively stable except the portion around the river mouth.

Many swamps of all size exist along the Cenranae River. Among them, a large swamp in the downstream area from Kampiri (41 km from the river mouth) acts as a natural retarding basin for the mainstream.

Near the river mouth, the Cenranae River branches mainly into three channels which are the Kae, the Ceppitengngae and the Watu Rivers. Among those channels, the Ceppitengngae River seems to be the main channel on a map of 1/50,000 scale surveyed around 1920. This channel is shallow at present due to sedimentation. The result of survey carried out by the Team in November 1978 shows that the Watu River is the main channel with a width ranging from 100 to 400 m and a depth ranging from 2.5 to 4.0 m in time of ebb tide.

The records of tidal action from May 1977 to February 1978 at T.Pallete, the Bay of Bone show that the mean high-water springs is El.0.67 m and the difference between mean high-water level and mean low-water level is 1.08 m.

(b) Lake Tempe

Lake Tempe is located in the center of the basin. During the dry season, the lake is divided into three lakes, Tempe, Sidenreng and Buaya. Lake Sidenreng and Buaya are connected to Lake Tempe with the water channels. However, they form one lake during the flood season. Based on the result of sounding survey of Lake Tempe carried out by the JICA Survey Team in February 1974, a contour map of Lake Tempe on a scale of 1/25,000 is prepared as shown in Fig. 3.32.

According the water level records during past 8 years from 1968 to 1971 and from 1975 to 1978 shown in Fig. 3.33, it is found

that high-water levels occur in a period from June to August and low-water levels occur from October to December. Annual maximum water levels occur in June, and the highest water level was recorded in June 1970 as 9.58 m in elevation during the above-mentioned period. The probable peak water level and its water surface area are estimated as follows;

Return period (yr)	:	2	5	10	20	50
Water level (EL m)	:	8.0	8.9	9.4	9.9	11.0
Water surface area (km^2)	:	368	425	451	474	521

On the other hand, low-water levels (average in 5 days) less than EL 3.0 m, EL 3.5 m and EL 4.0 m occurred once, twice and three times respectively during the above-mentioned period. The water surface area at low-water level is as follows;

Water level (EL m)	:	3.0	3.5	4.0	4.5
Water surface area (km^2)	:	6.1	27.9	49.2	63.2

The area around Lake Tempe is an alluvial zone formed by sediment from the Walanae, the Bila and other rivers. It seems that the Lake is still in the sedimentation stage. The sedimentation thickness is estimated as 1.0 cm/yr by the calculation of sediment discharges with the data of the period from 1975 to 1978, assuming that the difference of volume of sediment between those transported by the rivers to the lake and those flown out from the lake through the Cenranae River has deposited in the lake. On the other hand, the study made by PT. WASKITA KARYA/1 reports that the sedimentation thickness in Lake Tempe is 0.4 cm/yr, based on the almost same assumption as mentioned above.

In accordance with the result of the study mentioned above, the sedimentation in Lake Tempe is not a serious problem from the viewpoint of flood control function of Lake Tempe.

/1: Final report: Pre-rencana Sistim hidroteknik PENELITIAN DAN PENGUKURAN HIDROLOGI Danau Tempe, Maret 1975, PT. WASKITA KARYA

However, the sedimentation concentrates actually at the river mouths where the sedimentation forms an alluvial zone which is seen in the river mouth of the Walanae, the Bila and other rivers.

(c) Walanae River

The Walanae River is the largest river among those flowing into Lake Tempe with a catchment area of 3,190 km^2. The river, flowing through the central part of South Sulawesi, rises from a mountain zone in the south of Lake Tempe and joins to the Cenranae River at Sengkang. The shape of the basin is comparatively narrow, 30 km wide and 100 km long. There are three main tributaries in the Walanae River basin. They are the Sanrego, the Menraleng and the Mario Rivers.

The mainstream from Sengkang to Pacongkang has a mean width of about 100 m and an average river slope ranging from 1/3,000 to 1/5,000 on the longitudinal profile. The carrying capacities of the channel are estimated as in the ranges from 400 to 2,300 m^3/s. In the downstream reaches, the carrying capacity is extremely small under the influence of backwater from Lake Tempe.

The river has some developed meanderings with bank erosion along its course. However, they are relatively stable forming meanderings called floodplain. Around 60 km from the confluence of the Cenranae River, the river slope increases to 1/1,000 with sand bars and gravel on the river bed. The bank erosion is seen at many places along the middle and upstream reaches.

(d) Bila River

The Bila River rises from a mountain zone in the north of Lake Tempe and flows into the lake. The river system consists of four rivers which are the Bila, the Boya, the Lancirang and the Kalola Rivers. They run in parallel with and join to the Bila River in its downstream reaches. The total catchment area of the Bila River at its river mouth is 1,368 km^2.

In the downstream reaches from the confluence of the Boya, the river has a natural channel with single section. The mean width of

the channel is about 70 m and the average river slope is about 1/3,000 on the longitudinal profile. The carrying capacities of the channel are estimated as in the ranges from 340 to 1,130 m^3/s.

A delta is formed with sediment carried by the river flow near the river mouth. The river bifurcates in the delta into two channels leading to Lake Tempe. During a flood season, the downstream area from the bifurcation is submerged below the high-water level of Lake Tempe. In the stretch from the bifurcation to 10 km upstream, small scale levees exist on both banks. Repairing and reinforcement of these levees have been carried out occasionally.

As for the mainstream of the Bila, although some developed meanderings accompanied by bank erosion are found along the river course. Erosion and sedimentation are almost balanced in the reaches upstream from the above-mentioned bifurcation. But the river channel downstream from the bifurcation seems to be in a slight sedimentation stage.

3.5.2 Flood Discharge

Flood discharges under the present channel conditions of the rivers in the objective area are estimated by use of the correlation curves between specific discharge and catchment area. In making the correlation curves, discharges corresponding to selected return periods are estimated based on the observed discharges at Cabenge, Ujung Lamuru and Bila, taking into account the accuracy of the rating curves and record periods. Furthermore, for the extrapolation of the curves to the range of smaller catchment area as tributaries, discharges calculated by use of the rational formula at Batu-Batu and Langkemme are adopted for drawing the curves.

As the results, the following formulae are obtained.

Return period	Discharge formula
2 - year	$q = 21.744\ A^{-0.451}$
5 - year	$q = 26.214\ A^{-0.444}$
10 - year	$q = 33.176\ A^{-0.462}$
20 - year	$q = 41.308\ A^{-0.474}$
50 - year	$q = 53.634\ A^{-0.495}$
100 - year	$q = 62.762\ A^{-0.506}$

where, q: Specific discharge in $m^3/s/km^2$
A: Catchment area in km^2

The flood discharges of the Walanae, the Bila and other rivers except the Cenranae River are calculated by use of the above-mentioned formulae as shown in Tables 3.15 and 3.16. In case of the Cenranae River, the discharges depend on the water level of Lake Tempe. The discharges at Sengkang are estimated from the water level of Lake Tempe through a water level correlation curve between Lake Tempe and Sengkang. The estimated flood discharges of the Cenranae River at Sengkang are shown in Table 3.17.

3.5.3 Flood Damages

(1) Inundation Areas

Based on field investigation of all the areas along the rivers in the objective area, the following inundation areas are selected from the viewpoint of flood control, taking into consideration scale of inundation area, degree of damages and frequency of inundation.

(i) Area around Lake Tempe including Lake Sidenreng and Lake Buaya.

(ii) Downstream area of the Bila River including the right side of the Boya River, the downstream areas of the Lancirang and the Kalola Rivers.

(iii) Downstream area of the Walanae River including the downstream areas of the Belo and the Lawo Rivers.

(iv) Areas on both sides of the Cenranae River.

Based on the information collected from the officials in relevant Desa and Kecamatan or local people around the area, the map of the inundated area on the past remarkable floods is prepared as shown in Fig. 3.34.

The situation of inundation in each area is as follows;

(a) Area around Lake Tempe

During the flood season, the lands around Lake Tempe and the land along the downstream reaches of the rivers flowing into the lake are inundated due to the flood with high-water level of the lake. Many houses and farm lands existing around the lake suffer large damages from floods.

(b) Downstream Area of the Bila River

Inundated area along the mainstream stretches over both sides of the downstream reaches between the river mouth and Bila. Most of the causes of inundation are overtopping due to lack of carrying capacity of the channel, especially in the downstream area from Tanru Tedong.

In case of the Boya River, flood water overflows from the right bank in the upstream reaches from the confluence with the mainstream. Flooded water runs over the paddy fields toward low land forming submergence in depressions.

As the channel of the downstream reaches of the Lancirang River is too small, flooded water overflows the bank to form submergence in every flood season.

The Kalola River joins to the mainstream against ground slope so that the water surface slope gets extremely gentle during flood seasons. In every flood season, the downstream area of the river is inundated by flood due to lack of carrying capacity of the channel.

(c) Downstream Area of the Walanae River

Inundated area of the mainstream stretches over both sides of the downstream reaches from Lakibong. Most of the causes of inundation

are overtopping, especially in the downstream area from Cabenge. The overtopped flood water connects directly with the water of Lake Tempe, and forms one lake during a flood season. As flooding occurs almost in every flood season, inhabitants, farm land and other facilities in the area suffer large damages from floods.

(d) Areas on both sides of the Cenranae River

Inundation area along the Cenranae River is limited only to the areas on both sides of the river and swamps. The land on the left bank is comparatively high, while the land on the right bank has low elevation. Along the right bank of the Cenranae River, a road runs connecting Sengkang with Watampone accompanied by a continuous row of houses along both sides of the road. During a flood season, these high-floor-type houses are inundated by 1 to 2 m in depth.

(2) Flood Damages

The average annual flood damages under the present conditions of the areas are estimated as follows;

Area	Average Annual Flood Damages		
	Damages to paddy		Amount of damages (US$1,000)
	Decrease in yield (ton)	Damage area equivalent to 100 % damage in yield (ha)	
- Area around L.Tempe	10,550	3,010	4,490
- Downstream area of R.Bila	8,260	1,910	2,510
- Downstream area of R.Walanae	6,680	2,570	2,840
- Area along R.Cenranae	1,480	530	450
- Total	26,970	8,020	10,290

With the proposed irrigation projects and without flood control projects, the above-mentioned flood damages in the flood-vulnerable areas must be increased. The increased flood damages under this condition will be estimated as follows;

Area	Average Annual Flood Damages		
	Damages to paddy		
	Decrease in yield (ton)	Damage area equivalent to 100 % damage in yield (ha)	Amount of damages (US$1,000)
- Area around L.Tempe	10,550	3,010	4,490
- Downstream area R.Bila	12,990	2,400	3,390
- Downstream area of R.Walanae	17,170	3,090	5,040
- Area along R.Cenranae	1,480	530	450
- Total	42,190	9,030	13,370

3.5.4 Necessity of Flood Control

In the objective area, some efforts were made for development of irrigation in such areas as Boya and Sadang, while flood prevention measures of flood control and drainage have been left rather retarded. In fact, undertaken flood control works are limited only to small-scale emergency works in the downstream reaches of the Bila River.

Inundation of fertile farm lands always causes a lot of damages to important agricultural products. Some countermeasures for flood protection are therefore by all means required for securing agricultural development and stabilization of peoples livelihood. Habitual inundation will otherwise hamper intensive agricultural farming in the objective area.