REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS AND ELECTRIC POWER
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

PRELIMINARY SURVEY REPORT
ON
CENTRAL SOUTH SULAWESI WATER RESOURCES DEVELOPMENT PROJECT

JULY 1974

OVERSEAS TECHNICAL COOPERATION AGENCY

JAPAN

Preface

At the request of the Indonesian Government, the Government of Japan decided to conduct a preliminary survey for a water resources development project in Central South Sulawesi, Sulawesi Island, and entrusted the execution of the survey to a governmental organ, Overseas Technical Cooperation Agency.

The Agency organized a ten expert team headed by Mr. Seiichiro Nakamoto, Chief of the Planning Division, Tokyo Agricultural Administration Bureau of the Ministry of Agriculture and Forestry, and dispatched it to Indonesia for thirty days from January 30 to February 28, 1974.

With the cooperation of the authorities concerned, including the Indonesian Government and the Local Government of South Sulawesi, the survey team completed the field survey, and after returning to Japan, made various studies based on the data collected and the opinions of the persons concerned. The team prepared a draft in June 1974, and explained its contents to the Indonesian Government for comments.

With some modifications made, the draft is here compiled as a final report.

In view of the basic direction of the regional development, this report deals with the preparation of a basic plan for water resources development that will be needed in the near future, and describes the necessity of feasibility studies for the individual projects considered to deserve high priority. It will be my greatest pleasure if on the basis of the report, the persons concerned of both the Japanese and the Indonesian Government positively embark upon the development of the region.

Finally, I express my deepest gratitude to the related offices of the Indonesian Government, the Japanese Embassy in Jakarta, the CP experts in Indonesia, the Ministry of Foreign Affairs, the Ministry of Agriculture and Forestry, and the Ministry of Construction, which all extended positive support and cooperation to the execution of the surveys.

July, 1974

Keiichi Tazuke
Director General
Overseas Technical Cooperation Agency

Letter of Transmittal

Mr. Keiichi Tazuke
Director General
Overseas Technical Cooperation Agency

Submitted here is a completed survey report on the planning of a water resources development project in Central South Sulawesi, the Republic of Indonesia, in which we conducted a field survey from January 30 to February 28, 1974 at your request.

This report principally deals with the possibility of the stable development of agriculture by securing water for the paddy fields along the Walanae and Bila rivers, which flow into Lake Tempe, and along the Cenranae River, which empties into Bone Bay. (The Cenranae River System in South Sulawesi covers approximately 7,700 square kilometers.)

Further, this report treats the possibility of restoration and augmentation of water fishery resources in Lake Tempe and the way of overall development of the rivers, centering on flood control, from an extensive point of view.

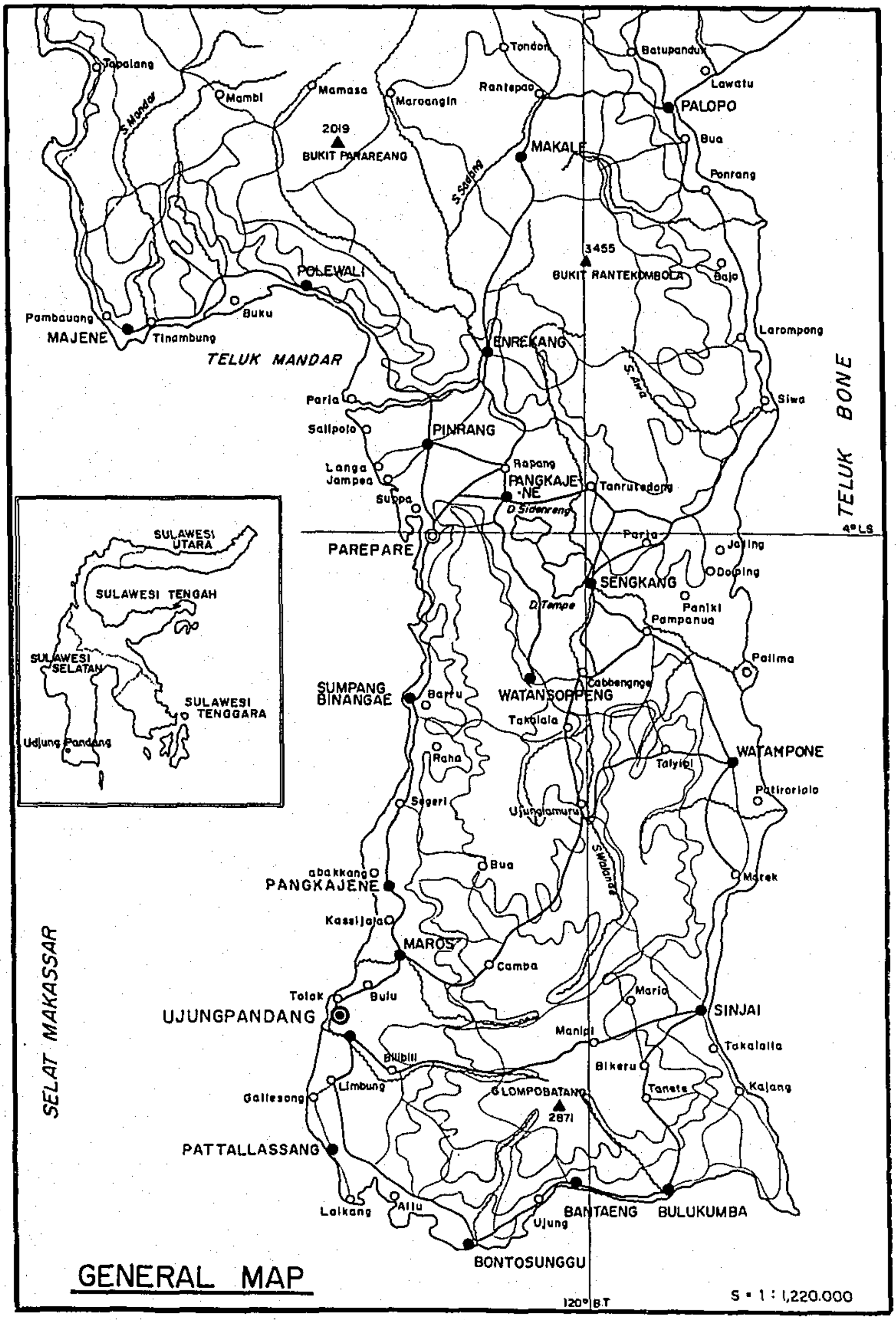
This is an area to the development of which the Indonesian Government attaches great importance as one of the major domestic regions to produce rice, for which demands are expected to increase. At the same time, as mentioned in detail in this report, we firmly believe that the development will be of great social importance, contributing to the social development of the region as a whole and giving an inmeasurably large impact to the future overall development of the Republic of Indonesia.

We sincerely hope, therefore, that this program will be carried out as early as possible with the cooperation and understanding of the Republic of Indonesia.

Finally, we express heartfelt gratitude to the Director General of Water Resources Development of the Ministry of Public Works and Electric Power, the Republic of Indonesia, other related departmental bureaus, the Government of South Sulawesi, the Wajo, Soppeng, Sidrap, and Bone regencies, and the Japanese Embassy, which all rendered cooperation in the execution of our field survey and in the preparation of this report. We are also deeply grateful to the Japanese experts in Indonesia who kindly gave valuable advice to our survey team.

July, 1974

Seiichiro Nakamoto
Team Leader of Japanese Survey
Team for Central South Sulawesi
Water Resources Development



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I. Introduction

1. Purposes of the Survey

The purposes of this preliminary survey for water resources development projects in the areas around Lake Tempe located in Central South Sulawesi are to formulate the basic conceptions of development of the area, to recommend the survey matters needed in the preparation of a master plan, and to find excellent projects that can be carried out soon.

2. Background

The Indonesian Government intends to powerfully push forward a regional promotion policy in its second five-year development program starting in fiscal year 1974/1975. As a part of its efforts, the Indonesian Government requested the Japanese Government to cooperate in the execution of this plan, which conforms to Technical Assistance List BTA-33 submitted by the Indonesian Government.

This plan was proposed when a survey conducted in 1969 for the conservation of the fishing grounds in Lake Tempe showed the acute necessity of establishing an overall development program concerning the Bila-Sidenreng-Tempe-Walanae-Cenranae water resources system to control the flowing of sand into the lake.

In March 1973, basic conceptions for the development of the area were suggested by the two experts of the Indonesian project survey group dispatched by Overseas Economic Cooperation Fund. Their conclusion was as follows:

"The Central South Sulawesi water resources system covers a vast area of about 200,000 hectares that has potentialities of multipurpose water resources development such as irrigation reservoir, multipurpose water storage, cultivation, inland waters fishery, inland navigation, and livestock raising (cow breeding)."

In May 1973, referring to the fact-finding survey conducted by the Fund, the Director General of Water Resources Development DPUTL, of the Republic of Indonesia contacted the Japanese Embassy in Jakarta as to the possibility of carrying out a feasibility study.

At the request of the Indonesian Government, The Government of Japan agreed to cooperate in the agricultural development of South Sulawesi, following Central and Eastern Java and Lampung. Accordingly, the Japanese Government dispatched a preliminary survey team to grasp the overall potentialities of water resources development in the area centering around Lake Tempe and to consider the policy for future co-operation.

3. Organization of the Survey Team

The survey team was composed of the following members:

1. **Seiichiro Nakamoto,** (Team Leader)
   Director, Planning Division, Kanto Agricultural Administration Bureau of the Ministry of Agriculture and Forestry

2. **Tomo Okada,** (River planning)
   Deputy Head, River Training Section, River Bureau of the Ministry of Construction

3. ***Junichi Kitamura,*** (*Irrigation planning*)
   Agricultural Engineer, Design Section, Construction Department, Structural Improvement Bureau of the Ministry of Agriculture and Forestry

4. **Kyozo Suga,** (Hydraulics and Hydrology)
   Head, River Research Office, Public Works Research Institute of the Ministry of Construction

5. **Toru Kawai,** (Water facilities)
   Head, First Research Office, Hydraulic Department, Agricultural Engineering Research Station of the Ministry of Agriculture and Forestry

6. **Yoshihiko Ogawa,** (Farming program)
   Official, Planning Section, Planning Department, Structural Improvement Bureau of the Ministry of Agriculture and Forestry.

7. **Masaharu Noda,** (Rice cultivation)

Head, Crop Condition Research Office, Crop Department, Hokuriku Agricultural Dxperiment Station of the Ministry of Agriculture and Forestry.

8. **Misao Tohyama,** (Dry-field cropping)

Head, Business Section, Dry-field Cropping Department, Agricultural Experiment Station of the Ministry of Agriculture and Forestry

9. **Yasuhiko Saeki,** (Inland waters fishery)

Marine Resources Conservation Engineer, Fishing Grounds Conservation Section of the Fishery Agency

10. **Toshiyuki Kasai** (Coordination)

Official, Second Execution Section, Development Survey Department of the Overseas Technical Cooperation Agency.

4. Survey Schedule

After arriving in Jakarta on January 30, 1974, the survey team made the following activities:

Activities of the Survey Team

No.	Date	Day	Stay in	Activities
1	Jan. 30, '74	Wed.	Jakarta	Arrived in Jakarta from Tokyo by JAL 711.
2	Jan. 31	Thur.	Jakarta	Paid a courtesy call to the Embassy of Japan. Held a preparatory meeting at DPUTL.
3	Feb. 1	Fri.	Jakarta	Paid a courtesy call to the Director General of Water Resources Development, DPUTL, and held consultation concerning the Memorandum.
4	Feb. 2	Sat.	Jakarta	Paid courtesy calls to the Director concerned at APUTL. Started collecting data.
5	Feb. 3	Sun.	Bandung Bogor	River & Irrigation Group moved to Bandung. Agriculture & Fishery Group moved to Bogor.
6	Feb. 4	Mon.	Bandung Bogor	River & Irrigation Group collected data at related agencies in Bandung. Agriculture & Fishery Group collected data at related agencies in Bogor.

No.	Date	Day	Stay in	Activities
7	Feb. 5, '74	Tues.	Jakarta	Moved to Jakarta.
8	Feb. 6	Wed.	Jakarta	Internal discussion, preparations for leaving for the sites.
9	Feb. 7	Thur.	Ujung Pandang	Moved to Ujung Pandang, South Sulawesi, by GA782.
10	Feb. 8	Fri.	Ujung Pandang	Paid courtesy calls to the local P. U. & Pertanian and the Provincial Government.
11	Feb. 9	Sat.	Sengkang	Moved to Sengkang. Paid a courtesy call to the Bupati Wajo.
12	Feb. 10	Sun.	Sengkang	Conducted a general survey of Lake Tempe.
13	Feb. 11	Mon.	Sengkang	Conducted a general survey of Bila and Cenranae River Basins.
14	Feb. 12	Tues.	Sengkang	Paid a courtesy call to the Bupati Soppeng. Conducted a general survey of the Walanae River Basin.
15	Feb. 13	Wed.	Sengkang	Four groups (river, irrigation, agriculture, and fishery) started individual surveys.
16	Feb. 14	Thur.	Sengkang	Paid a courtesy call to the Bupati Bone.

No.	Date	Day	Stay in	Activities
			Watam Pone	Conducted individual surveys.
17	Feb. 15	Fri.	Sengkang	Conducted individual surveys.
18	Feb. 16	Sat.	Sengkang	- ditto -
19	Feb. 17	Sun.	Sengkang	- ditto -
20	Feb. 18	Mon.	Sengkang	- ditto -
21	Feb. 19	Tues.	Ujung Pandang	Made a report to the Bupati Wajo. Inspected the Sadang irrigation project. Moved to Ujung Pandang.
22	Feb. 20	Wed.	Ujung Pandang	Interim compilation. Held a joint discussion with the persons concerned of south Sulawesi.
23	Feb. 21	Thur.	Ujung Pandang	Paid a courtesy call to the Governor of South Sulawesi Province, and reported the findings.
24	Feb. 22	Fri.	Ujung Pandang	Preparation of an interim report.
25	Feb. 23	Sat.	Jakarta	Moved to Jakarta by GA783.
26	Feb. 24	Sun.	Jakarta	Preparation of an interim report.
27	Feb. 25	Mon.	Jakarta	Reported the findings to the Embassy of Japan.

No.	Date	Day	Stay in	Activities
28	Feb. 26, '74	Tues.	Jakarta	Reported the findings to the Director General of Water Resources Development, DPUTL.
29	Feb. 27	Wed.	Jakarta	Collected supplementary data. Made preparations for returning home.
30	Feb. 28	Thur.		Left Jakarta for Tokyo by JAL 712.

5. Acknowledgment and List of Persons Concerned

While in Indonesia, the survey team was given cooperation by many persons concerned. The team here expresses its sincere gratitude to them. The principal persons concerned are as listed below.

1) Counterparts

Ir.	Kuncoro Jakti	Directorate of Planning and Programming, DGWRD
Mr.	Haryanto	Directorate of Rivers & Swamps
Mr.	Suharto	Institute of Hydraulic Engineering, DGWRD, Bandung
Ir.	Rusbini	Directorate of Irrigation, DGWRD (Bandung)
Ir.	Parapat	Directorate of Irrigation, DGWRD (Bundung)

Ir. Sudiyanto	Directorate of Planning & Programming, DGWRD
Ir. Abdul Thalib	Provincial Public Works Service, South Sulawesi
Mr. Haeruddin	Provincial Agricultural Service, South Sulawesi
Ir. Abdul Kadir Hamid	Hasanuddin University (Ujung Pandang)
Ir. Masud Sikong	Hasanuddin University (Ujung Pandang)
Mr. Arifin	Provincial Fishery Service, South Sulawesi

2) Japanese Experts

Toshio FUJIZAKI	Directorate of Rivers & Swamps DGWRD
Kazumi UEDA	Directorate of Irrigation, DGWRD (Bundung),
Tetsuichi SHINOZAWA	Food Production Promotion Team (Bogor)

(The above are the members who joined the team in Indonesia).

Ryutaro KAMIYA	Directorate of Rivers & Swamps, DGWRD
Katsumi KIMURA	Directorate of Irrigation, DGWRD
Kazuma SUGAO	Head, Food Production Promotion Team (Bogor)
Yoshito IWATA	Research Cooperation Team (Bogor)
Toshikazu HOZUMI	Fishery Advisery Team, The Ministry of Agriculture

3) Central Government

Ir.	Suyono Sosrodarsono	Director General of Water Resources Development, DPUTL
Ir.	Boesono Boedidarmo	Director of Planning & Programming
Ir.	Oesman Djojoadinoto	Director of Irrigation
Ir.	Sudaryoko	Director of Rivers and Swamps
Ir.	Mardjono Notodihardjo	Chief of River Basin Planning Division
Ir.	Kusdarjono	Chief of River Development Service, Directorate of Rivers and Swamps
Ir.	Sadeli Wiramihardja	Chief of Design Division, Directorate of Irrigation (Bandung)
Drs.	Attamimi	Chief of Foreign Aid Administration, Directorate of Planning & Programming
Mr.	W.M. Clark	Water Resources Planning Consultancy
Ir.	Mashudi Purmadirdja	Directorate of Irrigation, (Bandung)
Ir.	L. Taulu	Institute of Hydraulic Engineering (LPMA)
Ir.	Badruddin	- ditto -
Ir.	Istianto	- ditto -
Ir.	Moh. Memed	- ditto -
Dr.	Ir. Sugandar	Institute of Technology Bandung
Dr.	R. Roestami	Director of Inland Fishery Research Institute
Ir.	Sujadi	Institute of Meteorology and Geophysics, (Jakarta)
Ir.	Henk L. Uktolseya	Oceanographer, Indonesian Naval Hydrographic Office, (Jakarta)

4) Local Government

Mr.	Achmad Lamo	Governor of South Sulawesi Province
Ir.	Lateko Tjambolang	Chief of Provincial Public Works Service (PU), South Sulawesi
Ir.	Zainuddin	Chief of Provincial Agriculture Service, South Sulawesi
Mr.	Suratman, B. I. E.	Chief of Irrigation Section, P. U. South Sulawesi
Drs.	Junus Bandie	Chief of Provincial Fishery Service, South Sulawesi
Ir.	Joesri Zakaria	Chief of Provincial Forestry Service, South Sulawesi
Mr.	H. A. Unru	Bupati Wajo
Mr.	Asape	Public Works Office, Kabupaten Wajo
Mr.	Taif B. I. E.	- ditto -
Mr.	Jafar Husein	Agriculture Office, Kabupaten Wajo
Mr.	Andi Lahang	Chief of Agriculture Office, Kab. Wajo
Mr.	A. Salahuddin	Chief of Fishery Office, Kab. Wajo
Drs.	Burhanuddin	Deputy Bupati, Bone
Mr.	Tosu	Chief of Public Works, Kabupaten Bone
Mr.	Dajat	Chief of Water Resources Section, PU, Kabupaten Bone
Drs.	Salemo	Chief of Planning Section, PU Kab. Bone
Ir.	Moh. Badawi	Chief of Agriculture Office, Kab. Bone

Mr.	Andi	Bupati Soppeng
Mr.	Abdul Rachman	Chief of Agriculture Office, Kab. Soppeng
Mr.	S. M. Pakilaran	Chief of Irrigation Section, Kab Soppeng
Mr.	A. Singke	Chief of Fishery Office, Kab Soppeng
Mr.	Umar Saleh	Kepala Desa Wilimpong, Kab. Soppeng
Mrs.	Nurhaidah	Camat Liliriaja, Kab. Soppeng
Mr.	Andi Pabean	Camat Takkalala, Kab. Soppeng

II. Summary

1. Summary

1.1 General

The recently dispatched survey team (Jan. 30, 1974 - Feb. 28, 1974) carried out an extensive survey on the area around Lake Tempe, as already reported in the memorandum. Of the basin (7,700 km^2) of River Walanae, River Bila and other rivers flowing into Lake Tempe and River Cenranae flowing from the lake to the Bone Bay, the team covered Wajo and Soppeng related to Lake Tempe, River Walanae, River Bila, River Cenranae and parts of the adjacent Sidrap and Bone.

The attention was directed to the confirmation of agricultural water for the paddy fields and the other agricultural land along these rivers, the stable development of agriculture by extension, the directions of agricultural management and cultivation including dry field farming, the recovery and increase of fishery products from Lake Tempe, the improvement of water resources based on long range view, the problem of river improvement for preventing floods. These problems were studied both respectively and integratedly.

The results of the investigation are reported in details in the subsequent chapters. They are summarized as mentioned below.

(1) To recover and increase the fishery products from Lake Tempe, sufficient water level and water area shall be secured for ensuring enough resources in a dry season.
The water level shall be maintained at about +4.0m - +4.5m and the water area shall be maintained at about 6,000ha - 7,000ha. However, it is significantly related to an integrated river development plan, which is to be drawn on the basis of improved meteorologic and hydrologic data in the basins of 7,700 km^2 in consideration of flood control and irrigation. Therefore, it is difficult to find the concrete solutions immediately.
Under the current conditions, the lake surface area changes between 35,000ha in a wet season, and 1,000 ha in a dry season.

Therefore, considerable products can be secured by stocking fry in a wet season without special feeding.

If the object is not limited to the recovery and improvement of fishery products from Lake Tempe, fish, mainly carp can be easily raised in paddy fields where rice plants can be cultured by the stable supply of irrigation water.

The fish will be a good source of protein for local people. The technique for this operation has been used locally in this region and Java Island with satisfactory results.

(2) With regard to the works for improving agricultural foundations, the whole basin cannot be regarded identically from the meteorological view point. This is because meteorological conditions differ locally in the basin. A dry season and a wet season can exist at the same time in the basin.

Paddy field zones more than several thousand hectares are found in the basin. They can be classified into the following three categories.

1 The irrigation facilities constructed during the Dutch regime have been partly destroyed or buried due to inadequate maintenance after the World War II.
(Example: Boya)

2 Although water can be drawn from a near-by river, no work has been done yet. Agriculture depends solely on the rain in a wet season and in a dry season. Most of the paddy fields are deserted. (Example: Bila)

3 Irrigation water is drawn locally by the construction of a weir in a primitive way, such as using stones, gravel or wood.
(Example: Lawo)

The following conclusions can be drawn from the above results.

i) If the currently available facilities are restored and improved, irrigation water can be supplied to much larger area.

ii) If intake facilities and simple water channels are constructed under a primary development plan, irrigation water can be supplied to considerably large area in both the dry season and the wet season.

This will actualize stable paddy field culture even with native varieties. This area will make a rapid development as the base for transporting rice to the other areas of the country. This is one of the policies of the Indonesian government. This will also contribute to the social development of this area. This is extremely significant to the future development of Indonesia. To actualize this development steadily in steps and to solve the current problems gradually with the understanding of local people, an extension center shall be constructed and a demonstration farm shall also be constructed in each Kabupathn.
These farms should be used effectively for communication with people, for improving agricultural management, cultivation and introducing new varieties.
In these farms, engineers shall be trained and agricultural technique shall be taught widely to farmers so as to improve their morale.

(3) To realize these targets stably in an integrated manner in the basin of 7,700 km^2, an integrated and long-range development plan shall be established with the major importance attached to flood control. Since the basic data necessary for this work are not sufficient, various observation networks shall be established to obtain more data within the next three years.
The following discoveries were made as the result of this investigation.

i) Most of the rivers flow into Lake Tempe, which is located almost at the center of the basin and in low elevation. It makes an unexpectedly large contribution to floor control.

ii) For this reason, the river cross section and the gradient of Cenranae River flowing from Lake Tempe into Bone Bay have stayed to the current extent.

iii) The sediment from the basin have been accumulated at the mouth of River Cenranae. They form a delta and disperse tractive energy. This partly accounts for the closure of the river mouth.

iv) The rivers flowing into Lake Tempe mander in a zigzag way. Especially in a wet season, they flow and erode the meandering parts.
Their velocity of flow is decreased and sedimentation occurs by the temporary stagnation of flowing water in Lake Tempe. However, its historical change shall be studied in details furthermore.

v) With regard to Mong Dam upstream of River Walanae, the dam height of 50 - 60 m and the water storage of about 700,000,000 m^3 seem possible. However, the geologic factors, etc. shall be studied in more details.

1.2 Rivers

1.2.1 Current Conditions

The current conditions and problems of the rivers in this basin are described below.

(1) River Cenranae is a natural river, having the length of 70 km, the width of about 100 m and the elevation of 5 - 6 m near Lake Tempe, and the gradient of about 1/10,000. Houses are located on both the banks. The river floods slightly on both the banks during the flood season. The locally stretched swampy areas are completely submerged during this season. The insufficient channel capacity of River Cenranae present serious problems on the flood control in the districts around Lake Tempe.

(2) Lake Tempe etc.

Lake Tempe, located in the center of the basin, has the surface area of about 10 km^2 in the dry season and about 350 km^2 in the wet season.

The water level changes within the range of 5 - 6 m. This retarding effect during the flood season plays an important role for decreasing the peak flood discharge of River Cenranae. On the other hand, the decrease in the flowing through capacity of River Cenranae and the sedimentation in Lake Tempe have caused increasingly heavy and frequent floods around Lake Tempe.

(3) River Walanae, River Bila etc.

The basin of River Walanae has the area of about 3,300 km^2, while that of River Bila has the area of about 1,700 km^2. The downstream part of the river floods on both the banks during the flood season.

They have so-called natural banks, showing local erosion. The mountains in the basin are covered with grass, but are without trees.

The direction of the future investigation is summarized below.

1) Preparation of basic materials

The data for studying flood control problems are insufficient. Therefore, a hydrologic observation network (rainfall precipitation, river water level, river discharge etc.) shall be established and the river and the surrounding districts shall be surveyed.

2) Flood control problems around Lake Tempe and along River Cenranae

An idea of shifting River Walanae has been suggested, but no large flood control effects are expected. The Mong Dam plan on River, Walanae River Cenranae, Lake Tempe, shall be studied from an integrated stand point.

3) Mong Dam (in the upper reaches of River Walanae, 140 km from the mouth of River Cenranae).

The results of the present investigation revealed that it is a promising dam site. It requires further investigations by specialists in geology etc. In addition to flood control, irrigation and power generation, the dam will partly solve the problem of sedimentation in Lake Tempe.

4) Navigation near the mouth of River Cenranae

The river branches to several distributaries at the mouth in the delta. The river mouth can be technically maintained by getting them together and installing a structure, such as a training dyke. However, the economy of this plan should be studied and compared with that of road and port construction.

5) Soil Conservation

The devastation of the mountainous area in the upper reaches of the river is remakable. The countermeasure will therefore be necessary.

1.3 Agriculture and Irrigation

1.3.1 Agriculture

(1) Present Condition

The plains and mild slopes in this region are used mostly for paddy fields. Dry fields are found in the mountainous area. Most of (more than 70%) the residents are farmer.
A considerable number of farmers seem to possess no land. Each household manages the land of 1 - 2 ha. They seem not to be in a good condition and their houses are simple.

1) Rice crop

No irrigation facility is used in this region, except locally in the basin of River Lawo and River Langkemme which are the tributaries of River Walanae in Soppeng, locally in the basin along the main stream and the tributaries of River Bila in Sidrap and Wajo, and locally in the basin along a tributary of River Cenranae. In the region without irrigation facility, one cropping system fed by rain in the wet season is adopted. The cropping varieties consist solely of local ones. No improved variety has been introduced except in Bimas plan (food production increase plan) area. Fields are prepared either by animals (using a simple plough and leveling log or board) or by manpower.

The nursery duration is usually long since the transplanting time is determined on the basis of rainfall conditions. Square planting method is mostly used for transplanting. The spacing of 25cm x 25cm is adopted in Bimas area, but the spacing of 35cm x 35cm in the other areas. Urea (150kg/ha) and calsium superphosphate (50kg/ha) are used as fertilizers in Bimas area. No potassium fertilizer is used. No fertilizer is usually used except in Bimas plan area. Although rice plants grow well at the beginning, the ratio of effective tillers is small and ripening is unsatisfactory due to poor nutrition during the last period. Therefore, the yield is extremely at the low stage.

The largest damages to rice plants are given by rice stem borers, Tungro and leaf blight in order. Damages are also caused by floods in river basins and near Lake Tempe. Damages are often caused also by drought in rain-fed paddy fields. Damages by wild rats are also extremely serious since the maturation period differs among the areas (due to locally different planting period).

Management, harvesting and preparation works are carried out entirely by manpower. An extremely primitive method using wooden hand mills is used for husking and milling.

2) Dry field farming

Dry field farming is carried out in mountainous areas, slopes, inconvenient for water utilization paddy fields not allowing rice planting in the wet season, near Lake Tempe (lake field) and around houses.

The major crops include maize, cassava, peanut, upland rice, soybean, green been.
Their cash crops include tobacco, coconut, coffee, kapok Sesame is also cultured widely. Recently, the cultivation of sugar-cane has also been studied. Pepper is also cultivated for export and domestic consumption.

Maize is the typical crop of dry field farming. It accounts for an overwhelming position in terms of the cultivation area as well.

Maize is cultivated as the complement crop of rice both for domestic consumption and export. The major varieties are Gading and Baku-Baku. They are white flint corns. Compost is used only in some areas.
No fertilizer is used in the other areas. They have about 140 - 160 cm in height, about 10 cm in ear length and 12 - 14 rows of grains. The harvest is extremely low, (300

600 kg/ha). The native variety of sweet potatoes are kept in a high ridge formation 80 - 100 cm in row width and have very low yield.

Broadcast sowing method is used for peanuts cultivation. Mixed cropping with maize is found locally. The variety introduced from Jawa and the local variety are cultivated. Their growth is very poor since no fertilizer is given and the harvest is at low stage.

Generally, no fertilizer has been used for dry field farming, burnt-over fields can be formed in the mountains and no cropping pattern and no cultivation have been established. The harvest is extremely small and many problems exist.

Some fertilizers are used for cash crops, but their planted area is small. They cannot be the main crop of dry field farming.

Damages to maize are given first by corn borers, second by army worms. It is not affected by virus diseases. Largest damages to dry field farming is caused by drought. Damages are also caused by floods along river basing and near Lake Tempe.

Farming is done entirely by manpower. Animal power is locally used only for tilling.

3) Domestic animal husbandary

The livestock raised by farmers include hens, ducks, cows, buffalos, goats and, sheep. Hens and ducks are especially popular. These animals are kept free. They eat freely at post-harvest paddy fields, uncultivated land etc. They are not given concentrated feed-stuff.

4) Farm machinery and tools

No power machine is owned by the farmers within this region. The tools used by them include ploughs, leveling boards, spades, sickles, napsack type sprays and powder sprays.

(2) Current Problems

The current problems in rice farming and dry field farming are listed below.

1) Paddy field farming

The major problem in this region is stable water supply. If irrigation facilities are provided to actualize stable water supply, two crops can be obtained each year. This will increase the income of farmers and directly contributes to the improvement of the food supply in Indonesia. The second problem consists of improving cultural techniques, that is local variety selection, good variety introduction, rationalization of fertilizer supply, adoption of adequate planting density shall be needed. The third problem consists of establishing a soil maintenance and promotion system. It is possible that the physical and chemical properties of soil deteriorate gradually under the current conditions. Soil must be maintained and promoted by giving organic matters (introduction of compost and green manure).

The fourth problem consists of exalting farmers' volition to production. If farmers themselves become eager to increase production, cultivation technique will be widely spread and a soil maintenance system will be established. Farmers will eventually have a chance to grow out of proverty.

2) Dry field farming

As pointed out in the previous section, the current dry field farming involves all kinds of problems. The major problems only are listed here. First of all, soil fertility shall be actively promoted. The present dry field farming is called plundering one and organic matters are easily decomposed and dissolved due to high atmospheric temperature and heavy rainfall. This results in large soil consumption. If the present condition continues, dry fields will become waste land. Dry fields require the advantageous use of crop residues, the introduction of green manure crops and chemical fertilizer supply adapting to economic effects.

Secondly, cultivation techniques for various plants shall be improved. It is important to study plant varieties, seeding season, planting density, damage prevention of diseases and harmful insects etc.

Currently, almost no dry field cultivation technique is available and these problems shall therefore be studied.

Thirdly, a mix planting system or a rational rotation system shall be establised. Namely, a rational rotation system and a mix planting system between Legumen and true grasses, shall be confirmed.

3) Domestic animals etc.

It is difficult to shift the current pasturing system of domestic animals to the intensive raising system. It seems desirable to take gradual steps in accordance with the long-term agricultural improvements. Studies shall be made so as to draw a plan for increasing domestic animals through the soil improvement of the waste land left after burnt-over field cultivation and the introduction of pasture.

With regard to mechanization, agricultural machinery shall be introduced gradually, to begin with manually operated binders and threshers. Steps should be taken gradually in accordance with the state of agricultural developments on the basis of the relation between population problems and total labor demand. To maintain and improve soil quality, a courageous step shall be taken to introduce large machinery.

1.3.2 Agricultural Economy

(1) Agriculture is an importand industry in Indonesia in all the aspects, including its employment structure and production structure. In other words, more than 70% of the total population is engaged in agriculture and the agricultural production occupys more than one half of the gross national product.

(2) Although agriculture is an important industry, its structure is not modern and involves various problems.

(3) The most important basic facilities have not yet been developed. Although 70% of all the paddy fields are said to have irrigation facilities, only 25% of all the paddy fields have fully technical irrigation facilities.
This means that only about 30% of the paddy fields with irrigation facilities, namely, only about 20% of all the paddy fields allow two rice crops a year.

(4) The poor condition of irrigation and other facilities result in large dependence on weather and unstable agricultural production. Crops are directly influenced by drought and flood and change shaply each year. The records of the recent 10 years show that large damages were given in 1963, 1967, 1972, namely, once every 3 - 4 years.

(5) In addition to the improvement of irrigation facilities, Bimas and Inmas plans have been vigorously promoted since 1965 for increasing rice crop. Its effects have steadily appeared in the recent years.
However, both the labor productivity and land productivity are still low in Indonesia. This is attributable to the small farming area of 1.0 ha per household on an average, manual labor system and cultivation without fertilizer.

(6) The domestic production of rice has increased sharply since 1970. It reached to about 110 kg in terms of cleaned rice per person. However, it is not sufficient since rice is the staple food. Additional rice should be imported from foreign countries, but this becomes a burden to the foreign currency.

(7) Therefore, the Indonesian government is ready to promote the production of rice under the second five year plan beginning in 1974. Concretely speaking, various basic facilities (for irrigation water) are to be constructed and Bimas, and Inmas plan are to be actively promoted.

(8) The Central-South Sulawesi water resource development plan is among the series of this plan. Therefore, the current conditions in Indonesia shall be fully understood and its needs shall be studied carefully before carrying out investigations as a preparation for drawing a master plan and drawing an integrated regional development plan.

(9) The regions related to the mid South Sulawesi Province water resource development plan are distributed in Wajo, Soppeng and Bone of the 23 Kabupaten.
Considerable differences in agricultural conditions and characteristics are found among these three Kabupaten.

(10) Agricultural conditions are relatively good and stable agricultural production is obtained in Soppeng. More than 70% in area of all the paddy fields have irrigation facilities. The agricultural production remains quite stable every year partly because of the large amount of rainfall. It is one of those Kabupaten which were least affected by the drought in 1972. The Bimas and Inmas plan have been executed most actively in this regency. Cash crops, such as tobacco, mulberry tree, coconut, have been introduced to the upland, which occupies about 60% of the agricultural land. Soppeng seems to have the most advanced structure for agricultural production among the three Kabupaten.

(11) In Wajo, many farm lands are found in the fertile alluvial soil zone around Lake Tempe. However, their irrigation facilities are very poor because of no suitable water source and technical problems. For the reasons, most of them are rain-fed paddy fields. The agricultural production is therefore extremely unstable. Among the three Kabupaten, Wajo received the most serious damages from the drought in 1972. They had almost no harvest after the drought. Paddy fields occupy about 60% of the agricultural land. However, only a small portion of the paddy fields allow rice cultivation, due to unstable irrigation conditions in a dry season. (due to floods in the region around Lake Tempe in a wet season). Fields of about 30,000 ha around Lake Tempe are used only for quick corn cultivation.

(12) Agriculturally, Bone seems to be between Soppeng and Wajo. Rain-fed paddy fields occupy about 80% of all the paddy fields. Among the three Kabupaten, Bone has the largest agricultural land, which is widely distributed agricultural land from the low flat land in the basin of River Cenranae to the mountainous region.
The paddy fields around Watampone in the basin of River Cenranae have irrigation facilities constructed in Dutch time as well as small recently constructed intake facilities. However, most of the paddy fields in the mountainous area are fed by rain.

(13) In view of the poor irrigation facilities and unstable agricultural production in this region, irrigation water shall be secured urgently for increasing the food production in Indonesia and for developing regional agriculture.

1.3.3 Irrigation

This region has extremely large possibilities for agricultural development. The results of the preliminary investigation showed that nine irrigation projects by regarding the intake source as the unit were found in the designated benefited area (in Kabupaten Sidrap, Wajo, Soppeng, Bone). It is urgently necessary to draw a master plan comprising nine individual irrigation projects and river and inland fishery etc. Since it will take considerable time to complete it, feasibility studies shall be carried out immediately, starting with the River Bila area and the River Boya area with highest priority. The River Lawo area, the River Langkemme area and the River Sanrego area which are the basins of the tributaries of River Walanae, respectively seem to be have the next highest priority.

Each of these areas is briefly described below.

(1) River Bila area

The plan consists of providing irrigation water by constructing a head works on the Bila River 100 m wide for fields of 15,000 ha in the wet season and 4,500 ha in the dry season, except for the fields of about 4,000 ha already irrigated from River Larumpu which is one of the tributaries. At present this area has rain-fed paddy fields with extremely gentle undulations. It seems easy to supply irrigation water to these paddy fields. The site for new head works is also under good condition.

(2) River Boya area

River Boya is one of the tributaries of River Bila. Since it has a larger catchment area than the main river, it has relatively large discharge. Like the River Bila area, this area consists of rain-fed paddy fields with gentle and uniform slope. This area seems to be developed easily.

At present, a part of the fields, about 3,600 ha on the right bank are irrigated by the Bulucenrana Weir, 110 m wide. Since it has been ruined heavily, it is to be improved and extended for irrigating 15,000 ha in the wet season and 6,000 ha in the dry season including the area benefited by the current facilities.

(3) River Gilirang area

This river has relatively small catchment area and the wet season in this area continues only three months. Therefore, taking water from this river is limited. Although this area has vast rain-fed paddy fields and dry fields with gentle undulations, River Gilirang can irrigate 5,000 ha in the wet season and 2,000 ha in the dry season. Since this river is at the stage of progressing meandering due to bank erosion, the state of meandering near the proposed site of head works (40 m in width) shall be studied carefully.

(4) River Cenranae area

This river has a gentle gradient and flows from Lake Tempe, which naturally controls the discharge of rivers flowing into the Lake. Although the previous report suggested to construct a all movable weir for irrigation, it was found impossible to irrigate by gravity. This report recommends the idea of pumping water supply 9 - 10 m up from Lake Tempe. The area of 15,000 ha is assumed for the plan in both the wet and the dry season. The uses of Lake Tempe shall be determined by examining comprehensively the relation among flood control, inland fishery and irrigation. The basic data shall therefore be obtained immediately for this purpose.

(5) River Lawo area

Currently, fields of about 300 ha are irrigated by the water taken by a masonry heap. Fields of about 200 ha are also irrigated by a free intake in the upper reaches. The current plan consists of constructing a 40 m wide weir with a permanent structure instead of the existing weir for irrigation for 6,000 ha in a wet season and 2,500 ha in a dry season. The rainfed paddy field and dry-field zone with gentle slope in the higher part of the terrace along River Walanae is to be benefited by this project. The intake site is at the concave of the river curve, where rocks outcrop and the flow in stable.

(6) River Langkemme area

The comparatively flat rain-fed paddy field zone located at the middle of the terrace along River Walanae, is to be benefited. The river width is about 50 m and the rocks are made of agglomerate at the site proposed as the head works. The head works are to provide irrigation water for 15,000 ha in the wet season and 5,000 ha in the dry season.

A cliff is found on the right bank as the intake site. Traces of landslide are found on the left bank on the intake side. Therefore, some problems of intake facilities control may remain to some extent. An approximately 1 km long driving tunnel is necessary by the topographical reasons.

(7) River Sanrego area

The Indonesian government has already carried out investigations and made plans for this area. According to the plan, the irrigation service is to cover 5,000 ha in the wet season and 2,000 ha in the dry season. However, it seems possible to irrigate 20,000 ha in the wet season and 8,000ha in the dry season since the discharge in the dry season is large because of the spring at the water source.

The river width is about 40 m at the proposed intake site. Outcropping rocks are found on the river-bed. In the area to be benefited, the upper reaches is undulating much, whereas the lower reaches has generally uniform mild slope. Therefore, the upper reaches will require considerable many channel structures.

(8) River Walanae area (from Ludunge)

The site proposed as head works is located downstream of the Mong Dam, namely, on the main stream of River Walanae. There is no problem with regard to the water quantity to be taken. The river width is about 80 m at the proposed weir site. Outcropping rocks are found on both the banks. Some difficult construction problems are anticipated because of large flood discharge, and an all-movable weir shall be adopted.

Benefits will be brought about to the rain fed paddy fields with mild slope located at the lower part of the terraces on both the banks along the river. The irrigation services can cover 15, 000 ha in both the wet season and the dry season.

(9) River Walanae area (from Mong Dam)

Irrigation services are to cover 35, 000 ha, a part of the entire irrigable area of 54, 000 ha in Bone, in both the wet season and the dry season.

A dam of 50 m in height, 300 m in dam creset length and 700×10^6 m^3 in storage capacity seem adequate. There is no problem on taking water. However, various hydraulic problems related to the dam shall be studied by experiments.

Since a mountainous zone exists between the Mong Dam and the area to be benefited, the head race channel will require the structures, such as a tunnel and an adueduct.

The channel length will amount to be quite long.

These nine areas are so-called major irrigation project areas. There are many suitable places to apply quick yielding technique on small-scale, where water is taken from tributaries. It is desirable to carry out these projects quickly.

1.4 Inland Fishery

Lake Tempe is an extremely shallow plate-like lake with the maximum water depth of 2.70 m (5.40 m in elevation). The fishery productivity of the lake is regulated by the surface area and water volume in the dry season dropping to 1/10 - 1/30 about 1000 ha - 3000 ha in area of those in the wet season. The lake probably has large potential for fishery production in the wet season. To recover the fishery production of Lake Tempe, its water level shall be kept at water level of 4.0 - 4.5 m, about 6000 ha - 7000 ha in water area in the dry season.

However, the installation of water level regulating facilities require the studies on technical problems and economic effects. It requires meteorological and hydrological investigations etc. of the basin of 7,700 km^2 so that the studies on flood control and irrigation effects might be made.

Therefore, in the future it shall be studies in relation to all the projects in the master plan. It is difficult to find concrete solutions immediately. Considerable catch, however, can be expected by stocking artifically produced fry in large quantity by regarding Lake Tempe as a large scale fishpond to utilize the large fishery productivity in the wet season. In this case, the reduction of the surface area and water volume in the dry season will facilitate the fish catch. In view of the fry production techniques, market price, growing speed, edibility and residents' taste, Ikan Mas (carp) seems to be the best fish.
One of the major industries around Lake Tempe is salting and drying of Tawes and Sepat Siam. On the other hand, no established technique of processing and preservation for Ikan Mas is available at present. Therefore, the possibilities of stocking fry other than Ikan Mas shall also be studied sufficiently. The studies on the developments of the Swampy areas, rivers and Lake Sidenreng must be delayed until sufficient data are obtained by future investigations.

It is significant to take notes that fish is the most important source of animal protein for the residents around Lake Tempe and the other parts in this region. As far as the people have a large demand for fish, paddy field fish breeding will also be possible with sufficient technical irrigation. Therefore, possibilities of fish breeding in the existing and proposed paddy fields with technical irrigation shall also be studied. In Central and East Java, Ikan Mas have been bred in paddy fields since the ancient time. The yield of 150 kg per ha during one rice cropping period is reported. Soppeng and Sidrap have the production of 90 t from paddy fields of 400 ha.

Fry production presents problems to paddy field fish culture. There are five hatcheries in Soppeng and Sidrap. However, their fry production is extremely small even for the existing technically irrigated paddy fields. Very crude way is used and eventually their productivity is low.

Hatcheries shall be increased and expanded urgently. Along with the training of engineers, the hatchery problem shall be studied immediately in Wajo, where fry is necessary to be bred in Lake Tempe, and in Bone with large technically irrigated paddy fields.

The demonstration in pilot farm is necessary for popularizing paddy field fish culture like agricultural farming. Possibilities for paddy field fish culture shall be studied from an integrated view point before planning agricultural developments through improvements of irrigation facilities. Paddy field fish culture may present problems along with the development of agricultural techniques, in relation to the use of agricultural chemicals and the breeding of domestic animals. However, paddy field fish breeding shall be spread widely and developed for the time being as the source of animal protein.

2. Conclusions

The following conclusions were drawn from the preliminary survey on Central-South Sulawesi water resource development.

(1) This region has extremely large potentiality for agricultural development and for the promotion of inland fishery, and wide range character for social development.

(2) This region is still at a low stage of economic development. However, the sharp increase of agricultural production and developments of agricultural structure are expected by securing irrigation water, by improving road, harbour, and sea communication, and by organizing farmers, etc. This will promise large development of the regional economy.

(3) Targets for stages shall be established for the agricultural developments. Rice farming shall be strengthned at the first stage. The production from both paddy field and dry field farming shall be increased at the second stage. Technical improvements, including the techniques for breeding domestic animals, shall be made at the third stage.

(4) Since this region has abundant land, water and large population, it will be developed rapidly by improving flood controlling and irrigation facilities.

(5) The following methods, are principal for minimizing flood damages in the region around Lake Tempe and for improving the function of water utilization.

1) Increase of channel capacity of River Cenranae
2) Construction of multi-purpose dam
3) Improvement of Lake Tempe
4) Erosion prevention measures

(6) With regard to the irrigation problem, considerably long time will be required before the completion of a master plan. Feasibility studies for individual projects shall be started immediately in the order of their priority.

The river Bila area and the River Boya area are considered to have the highest priority. They are followed by the River Lawo River Langkemme and River Sanrego areas where the water is taken from one of the tributaries of River Walanae, respectively.

(7) Inland water fishery

The water level of Lake Tempe shall be maintained sufficiently high even in the dry season in order to recover fishery resources in Lake Tempe. However, sufficient studies shall be made in the future. Some resources can be obtained by stocking fry for the immediate future.

Possibilities for fish culture in technically irrigated paddy fields shall be studied for obtaining protein to be supplied to entire region concerned. This can be actualized concretely and easily.

3. Recommendations

The following recommendations are made on basis of the conclusions drawn in II-2.

(1) Agricultural foundation arrangement project, most importantly including irrigation, for this region should be started as immediately as possible in the order of their priority in consideration of their economic and social effects as well as the opinion of the Indonesian government. Various data necessary for river planning etc. should be collected.
Concurrently, a master plan comprising the projects subsequent to secondary developments should be made. It is believed that this will meet the requests of the Indonesian government, provincial government, the related regencies and local residents.

(2) If the site office is built, the engineers should work for obtaining various data necessary for the river planning etc. and to making a master plan comprising the secondary and subsequent developments within three years. The field conditions should be considered sufficiently for the procedure, the sequence and the necessary time for development.

(3) Various circulation measures should be planned and actualized in view of the fact that the market price of rice and other major products tends to be determined by external factors even though it offers considerably large supply to other districts.

(4) There is no need to emphasize again detailed investigation on agriculture. In view of the fact that the water resources development in Central-South Sulawesi Province has the significance of regional development, investigation on arrangements should cover not only agriculture, but also roads, harbours, sea communication, power, living environment, namely, the entire regional society.

(5) Feasibility studies on River Bila and River Boya irrigation projects should be started immediately. Among the basic materials for the development planning, the data collection and the investigation on the following items are required as quickly as possible.

1) Topographical map
2) Hydrological observation
3) Checking of bench-marks
4) Geological investigation of proposed sites for major structures
5) River survey at intake sites

(6) The investigations of irrigation projects for making master plan should be carried out comprehensively in consideration of other aspects, that is, flood control, inland fishery etc.

(7) River planning plays the central role in the water resources development project and requires long-range works. First of all, basic materials should be collected and a master plan for the entire river system should be made.

Basic investigations for a master plan should desirably be started immediately along with the investigations for irrigation projects for the upstream region which can be started before the completion of a master plan. River investigations must cover the following items and will take approximately three years.

1) Collection and analysis of hydrological data
2) Topographical map and longitudinal and cross sectional surveys of rivers
3) Geological investigation of the site proposed for dam construction
4) Hydrological calculation
5) Other investigations
6) Summary and making a master plan

(8) To attain the targets of the agricultural development plan in steps, an extension center should be constructed in each Kapupaten in the area concerned and one or two demonstration farms should also be constructed in each Kecamatan for improving cultivation technique.

(9) Basic investigations on the fish in the lake and the environment should be carried out for recovering fishery resources from Lake Tempe. Adequate sites for hatcheries should be looked for and engineers shall be trained for producing fry for paddy field fish culture and stocking into the lake.

(10) The overall development projects with the main emphasis on water resources should be promoted smoothly and intensively with the understanding and the cooperation of developed countries. Human communication, especially through the training of middle-ranking engineers, is important in order to carry out this project for the future prosperity of the whole country.

III. Details

1. River System

1.1 Current River Conditions

1.1.1 The River Basin and the Channel Conditions

The object region that falls under the Central South Sulawesi Water Resources Development Plan is located in lat. 4° - 5° South and Long. 125° east, and occupies the middle part of South Sulawesi.

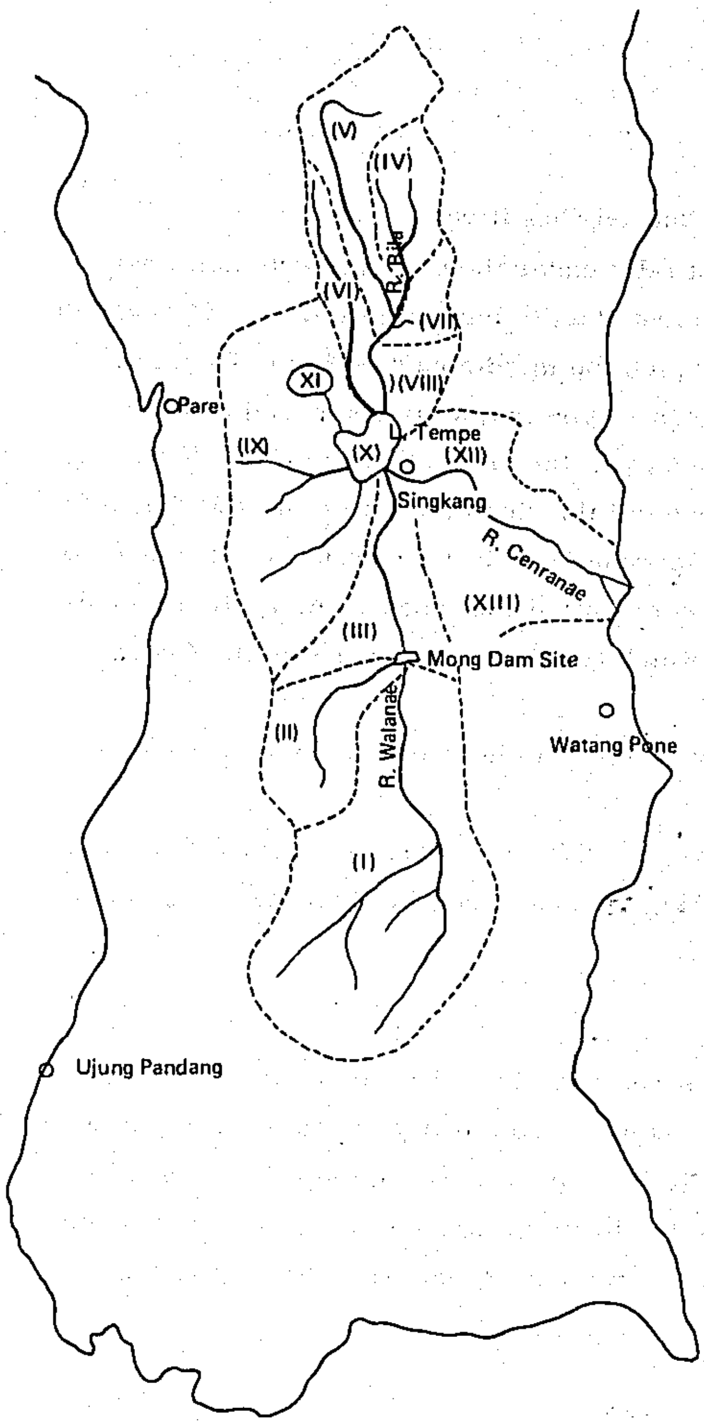
The river system in this region is mainly composed of Lake Tempe at the center of the basin, the river Walanae which flows into this lake from the south, the river Bila which also flows into this lake from the north, and the River Cenranae which flows from this lake and reaches the Bay of Bone. This may be called Cenranae river system including all river basins from which the flows come through the Cenranae to the sea.

The region covered by the plan, either belongs to or is related to the Cenranae river system.

The total catchment area of Cenranae basin is about 7,690 km^2. The length of the river along Walanae from the Cenranae river mouth is about 250 km (Fig. 1-1).

(1) The River Cenranae

Cenranae river is the only river that comes out from the Lake Tempe flowing south east to the Bay of Bone. The length of the channel is about 70 km from the river mouth to Singkang beside the lake where the local government office of Wajo is located. Wide and lower swampy areas are found on both sides of the channel.



	No.	(km²)
Walanae	I	2,180
	II	530
(at Mongdam)		(2,710)
	III	640
(Total)		(3,350)
Bila	IV	440
	V	620
	VI	180
	VII	170
	VIII	280
(Total)		(1,690)
Others	IX	1,220
Tempe	X	100
Sidenreng	XI	40
Cenranae	XII	440
	XIII	850
(Total)		(1,290)
(All total)		7,690

Fig. 1-1 River Basin Area
(Walanae, Bila, Tempe, Cenranae)

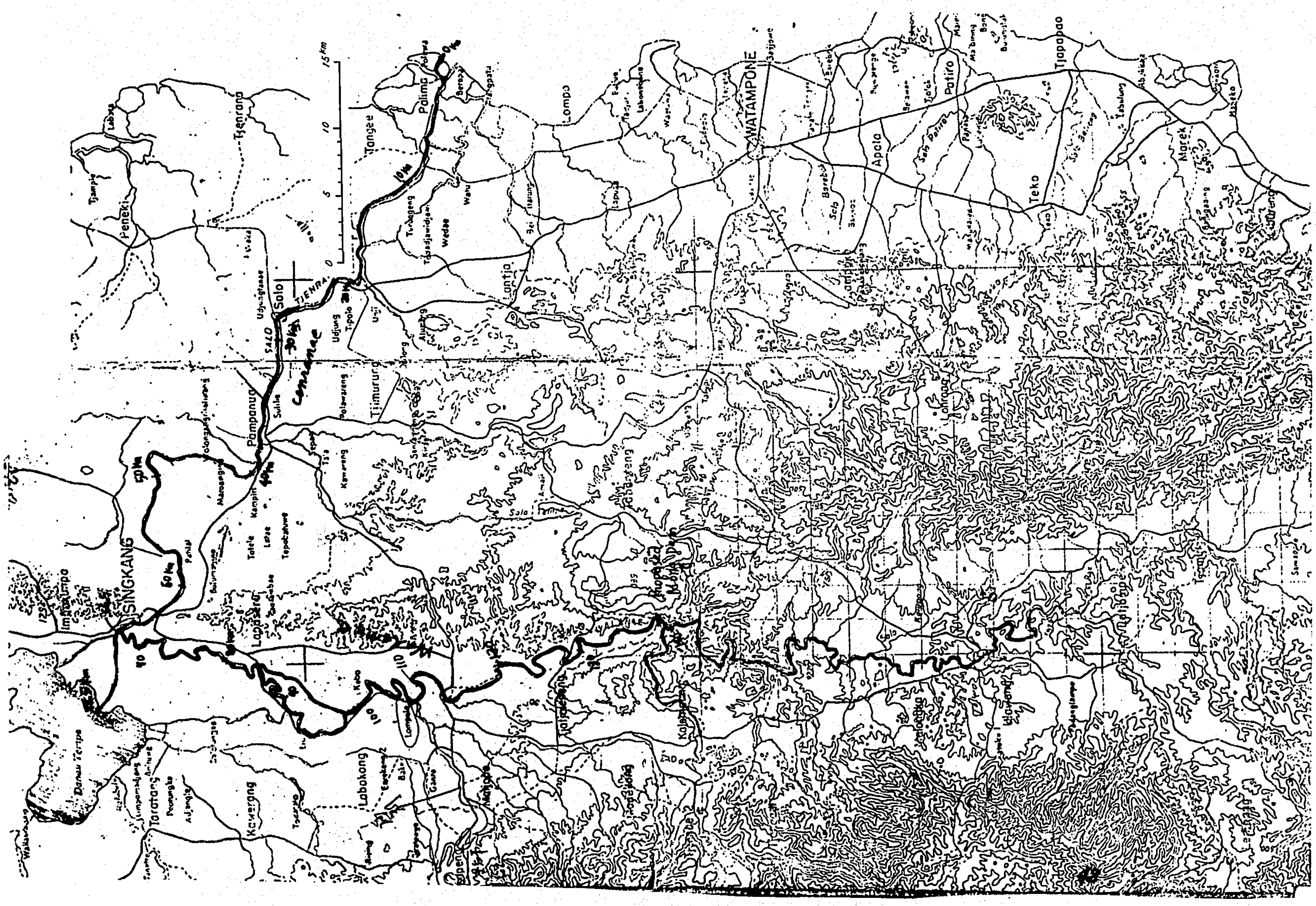


Fig. 1-2 Walanae and Cenranae

The catchment areas that are to be added from Sengkang to the river mouth are 850 km^2 on the right bank side and 440 km^2 on the left bank side.

The course of Cenranae is just like a natural non-antificial channel single section. The width of the channel is about 100m at Sengkang Bridge, 63 km from the river mouth and about 110m near the river mouth. A 70 - 80m wide channel seems most dominant, judged by the sight in the inspected upstream reaches of the 15 km point.

The gradient of the channel is extremely mild. Though exact figures are not known since neither the data on the longit udinal and cross sectional survey of the river nor the data on the mean sea-level are available, but estimates are made from the altitude near Sengkang. It must be checked whether the altitudes indicated sea-level heights. According to the estimate made by the irrigation team on the basis of this bench mark, the water level of the Lake Tempe was 5.40m on Feb. 10, 1974. The droughty water level of the lake seems about 2m lower than this, judged from the minimum water depth in the center part of the lake. Therefore, the droughty water level is estimated to be around 3.5m. The yearly flood level and the water level that occurs once every ten years are estimated to be about 9m and 9.60m, respectively. This is based on the information that the highest water level are as high as the knees at the plaza in front of the Sengkang local government office. This leads to an estimate that the average gradient is 1/20,000 at the time of drought, 1/15,000 at normal water-level and 1/11,000 at the time of a flood.

The ordinary part of the River Cenranae flows through an alluvial channel of lower flat land, but it does not show sufficient meandering, and bank erosions are only locally found. Small groyns were found to be working in bends at some rapid flow parts adjacent to roads. However, no other river improvement works have been made, to remain the channel at it naturally were. Almost no water conservancy and intake facilities are found.

The river banks consist of clay soil. The sand for aggregate used in Pampanua Village at 37 km from the river mouth was visually estimated to have the average grain diameter of 0.4 - 0.5 mm of angular sand. However, no certain information was obtained as to the origin of the sand. It is suspected that the stream bed consists of considerably fine silty soil.

A trunk road runs along the Cenranae river at right hand side connecting Sengkang and Watampone, the capital of Bone. And its river conditions can be observed at several parts along the road. Houses are naturally found more on the right bank side, as the road exists. These houses are almost continuously built along the road in forest of palm, banana and other trees. But during wet season, these high-floor type houses are flooded up to 1 - 2m up on the land level.

According to the available information to our ears, the flooded area seems to be not very large, only to the limited areas along the both sides of the river and the swampy areas, and not to become like a sea. The land seems to have considerably high altitude, especially on the left bank side. This fact may be one of the important reasons for relatively stable meandering state of the channel. According to the information obtained on Feb. 11, 1974, at Solo, 27 km from the river mouth, the maximum water level was 50 cm above the road (April & May, 1973). This means the water level rise of about 3m judged from the water level on Feb. 11. On the other hand, the lowest water level is said to drop as much as 1.20m during the most droughty season. It should be noted that this area is within the tidal portion. (See Fig. 1-3). However, the water level at the most droughty season may be assumed to be a straight line as shown in Fig. 1-14, since the channel feature remains longitudinally almost unchanged. If the water level fluctuation range at the 72.5km point is 6.10m and that at the 27 km point is 4.2m, the water level curve for floods shows sharply decreasing backwater curve near the estuary. This seems to show that the channel capacity

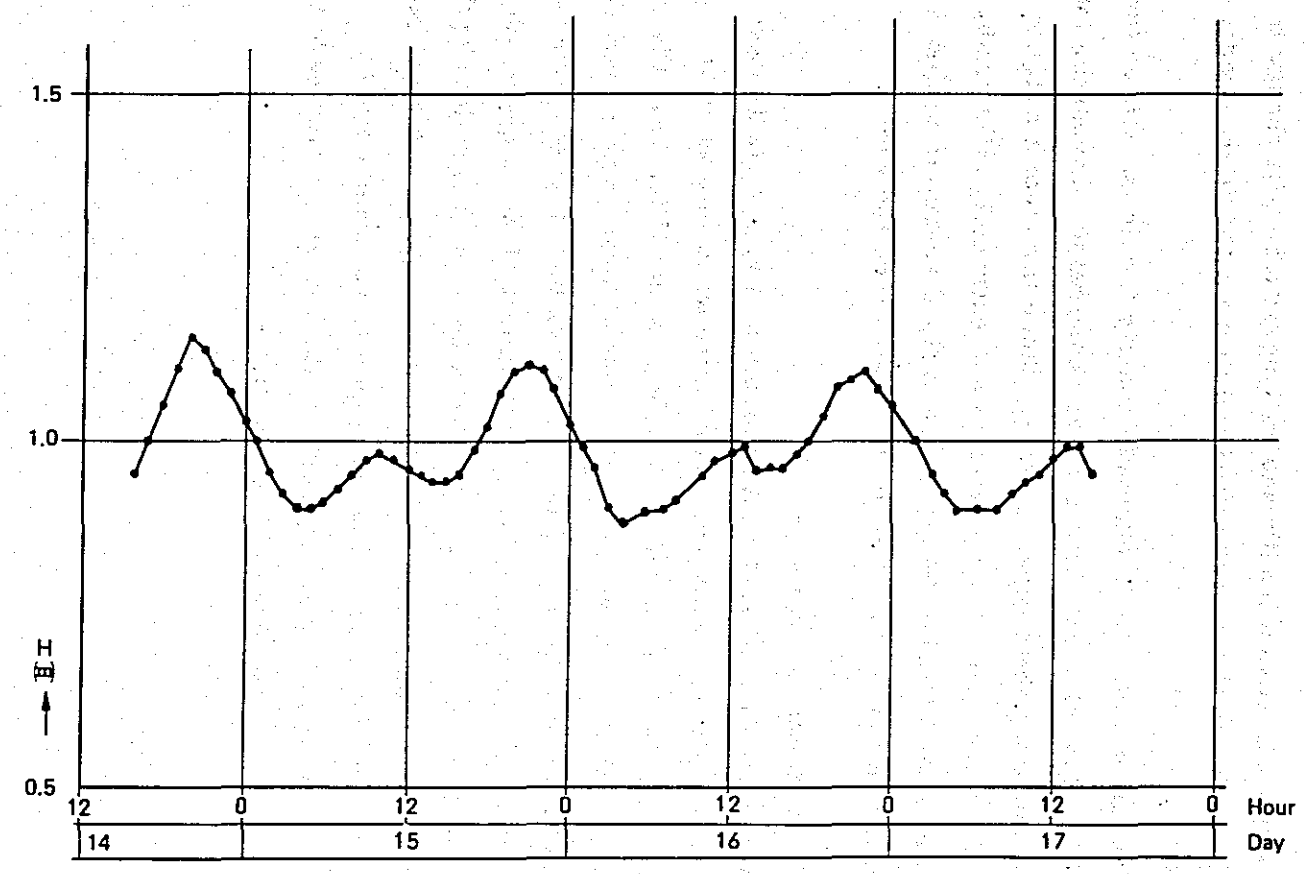


Fig. 1-3 Water Level Fluctuation at Solo
(27.5 km from the river mouth) Feb. 1974

near the estuary is relatively insufficient.

It is agreeably said that salt water intrudes up to Ulawe, 20km from the river mouth. However, the mixing and seasonal fluctuation conditions are unknown. Saline water intrusion state, for example, intrusion length and mixing pattern will change if tributaries in the delta are unified and brought together, dredged and widened.

The River Cenranae's channel capacity for floods will be the most important element for the water conservancy around the lake Tempe and along the Cenranae river. Since the river Cenranae currently has narrow channel section and extremely mild gradient, the water level of Lake Tempe during a flood season is probably determined by the back water level of the river Cenranae.

(2) The River Mouth of Cenranae

A delta is formed at the river mouth by the sediments carried down by the river. Cenranae river is branched into several channels for the Bone bay near the river mouth (Fig. 1-4, Fig. 1-5). The sea depth near the river mouth is considered to be extremely shallow to a great distance from the shore, based on the observation at the Bay of Bajoe, which is the outport of Watampone, about 20 km south of the river mouth. The reason that the water depth near the river mouth is small and makes navigation difficult, seems to be attributable to the heavy sedimentation carried down by the river and the channel branching at the estuary, which results to decrease the tractive force of the flows.

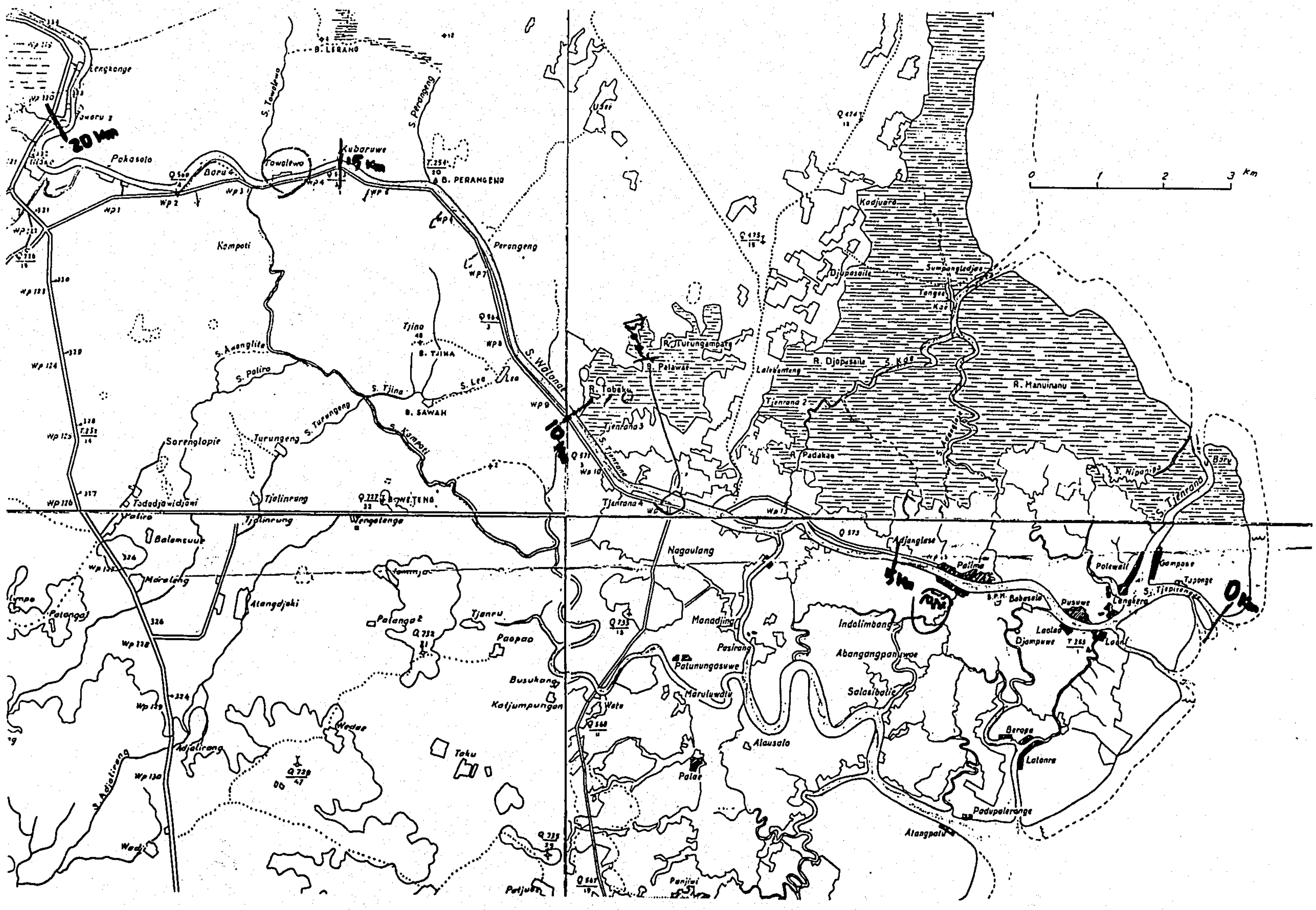


Fig. 1-4 Cenranae

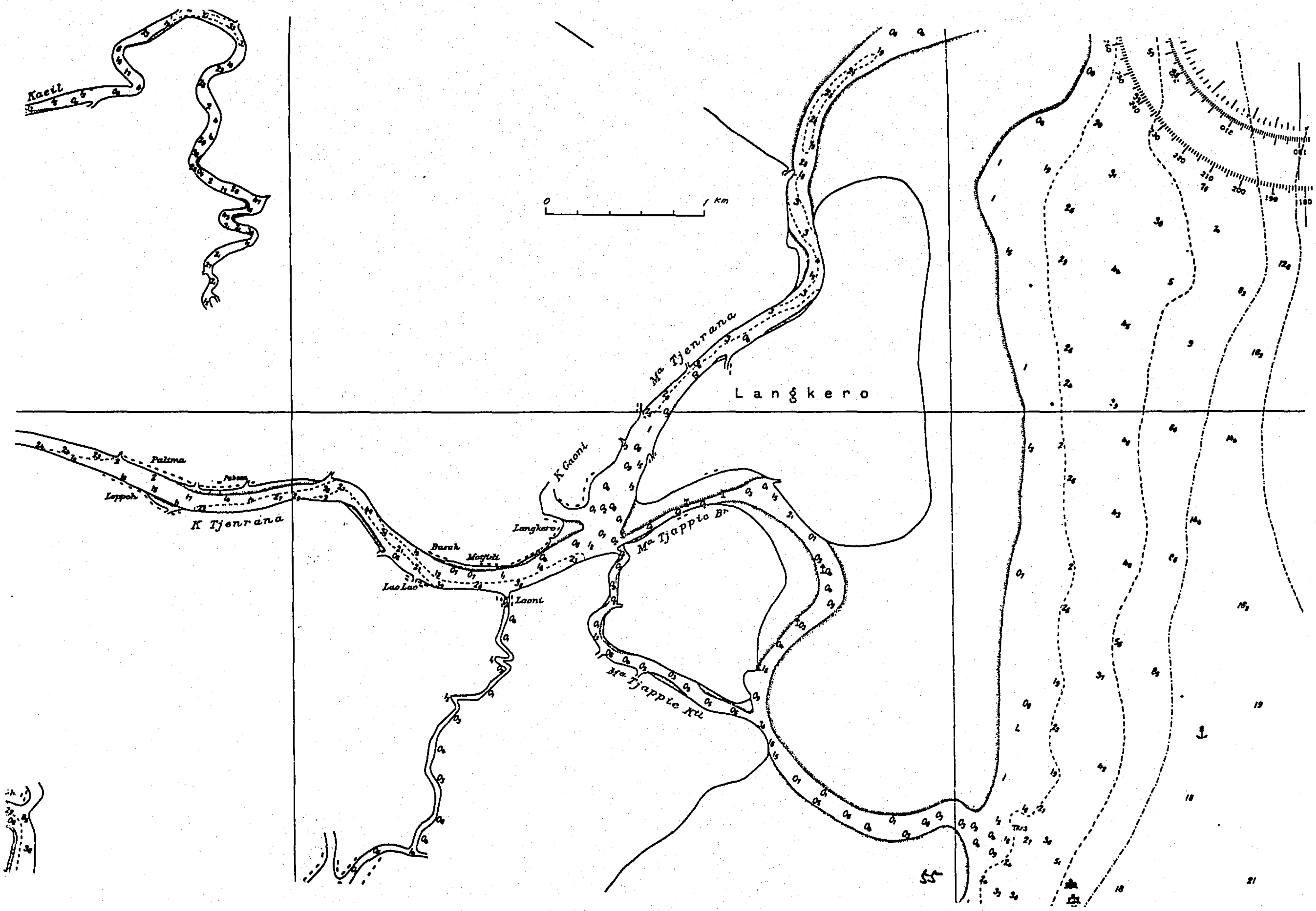


Fig. 1-5 Estuary of Cenranae

As pointed out before, the problem of the river mouth improvement is extremely important just as the problem of enlargement of the river Cenranae's width. However, the Cenranae estuary could not be reached during this investigation since no road leads to the river mouth, and it was not easy to reach there in a limited time. The conclusions drawn from the available data are listed below.

The following information was given by Drs. Burhanuddin, who is the Secretary of Bone Area of the Public Works Section in Watampone, and Abdul muis Ridwan, who is the chief of the Harbour Section.

1) There is no tidal level gage around there.

2) Zero point measurements have never been taken. The mean sea level height is unknown.

3) No data on wind direction and wind velocity are avilable. However, west wind prevails from November through January and east wind prevails from February through November. (Measurements will be needed since some doubt arises from the rainfall record.) The maximum wind velocity is about 50 - 75 knots. Sometime, north wind or south wind blows about twice a month. The wet season begins in March and ends in August near Bone. No cyclone has occurred.

4) Wave observations for wave height, wave direction, cycle etc. have never been carried out. The sea is quite calm. Waves arrive in June - August, only when strong east wind blows. In reference, the Bay of Bone is faced to the south. The distance to the other end is about 300 km. The distance from the river mouth to the east shore is 115 km. The water depth is unknown.

5) The condition of the development of delta at the river mouth will be able to be estimated by comparing maps. The valiable maps include the sea chart (1904, scale 1:20,000, already

obtained) at the Navy Hydrographic office in Jakarta, a map of 1/50,000 drawing in around 1920, and a map of 1/25,000 drawn in 1971. It is said that the sediment condition at the Cenranae estuary has changed sharply after the 2nd world war. There was a port at Palima, 4 km from the river mouth, before the war. Boats about 30t of 2m in draught and 14m in length travelled between this port and the Bay of Bone. Small boats were also able to travel to Pampanua, 37 km from the river mouth, before the war. However, Palima Port moved to Bajo Port, located at 6 km in the east of Watampone because of the shallowing at the estuary and also clogging at the river mouth, after the war. Ferry boat services are currently available for the 140 km route between Port Bajoe of Kolaka.

6) River team visited the Port Bajoe. There is a landing pier of 535m in length, stretching out perpendicular to the coasted line. It is heavily damaged at some parts, but the damages may not be due to wave actions. This pier is to be extended as much as 2 km more according to the plan. Then, water depth of 5 m will be obtained at the edge of the pier even at ebb tide. The sea has a shaling beach. Almost no wave was seen on the day of the visit. Probably, large waves rarely come to the shore. The bottom was muddy sludge and the water was slightly turbid. The low and high tide difference is said to be 2m at the max. However, this is not the result of the measurement by gage stuff. The shore line is said to move as much as 1 km at such a time.

The additional helpful information supplemented to the above is listed below.

1) There is a shrimp yard belonging to Kyoei Seiko (Director: Mr. Yaichiro Tsuda) at Ujungpatiro, 20 km south east of Watampone. A private stuff gage is installed there.

The records are said to show the average annual tidal level difference of 1.5m and the difference of 1.80m at high tide, though the zero point height is unknown.

2) According to the information obtained at the Navy in Jakarta, depth measurements were taken at the Bay of Bone and there are three tidal level gage stations working at the Bay of Bone. Therefore, the tidal level change near the river mouth of Cenranae will be able to be estimated from these records.

3) An annual extension of 150m of estuary delta is observed at the Jeneberang river, located in the south of Makasar. (according to Mr. Yaichiro Tsuda)

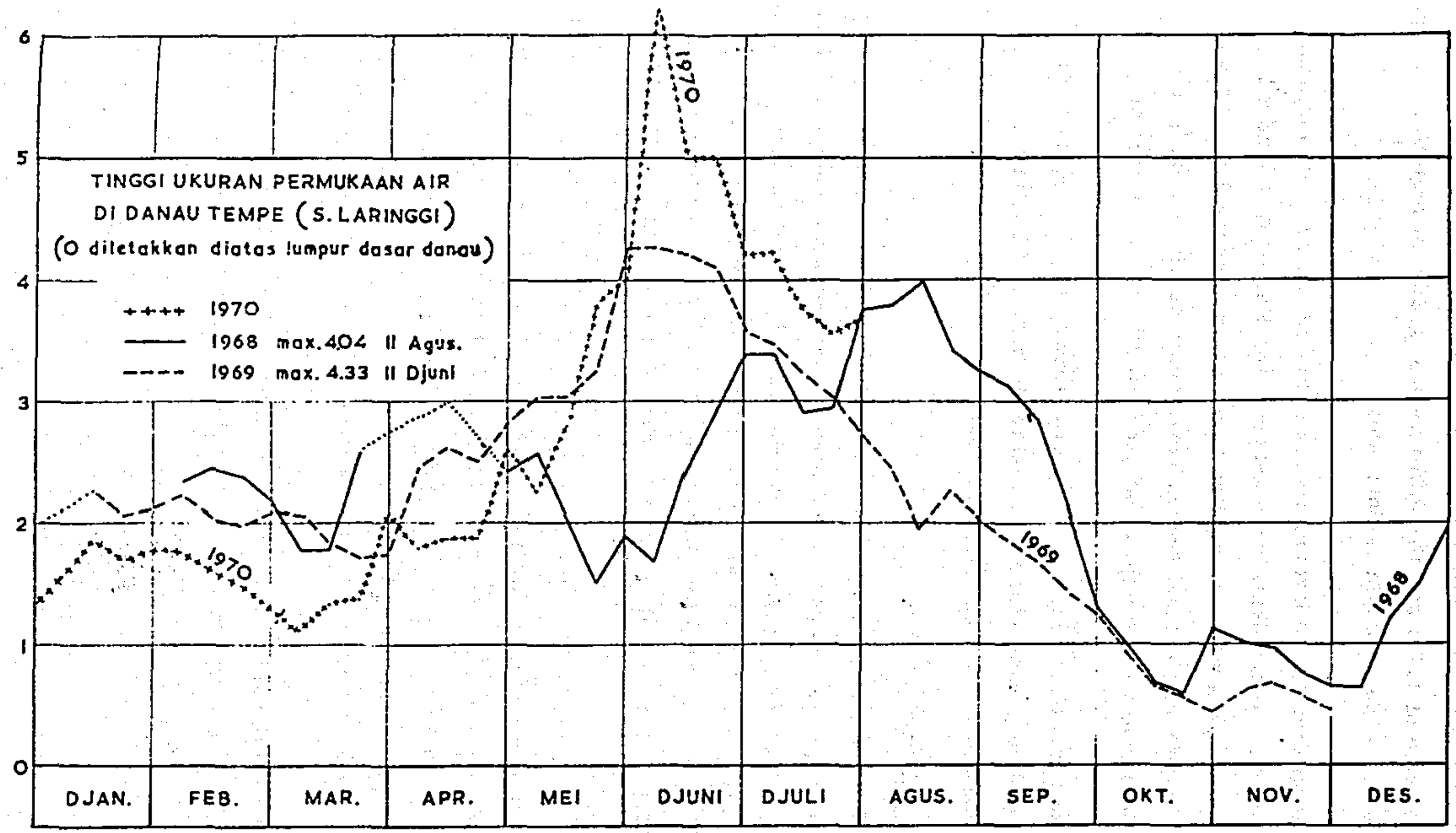
(3) The Lake Tempe

The lake Tempe, located at the center of the basin, forms one lake during a flood season, but forms three separate lakes (the Lake Tempe, the Lake Sidenreng, and the Lake Buaya) during a dry season. They are connected with the Lake Tempe by water channels.

The area around this lake is an alluvial zone formed by Walanae River and other rivers, flowing into the lake with mild slope.

The water level of the lake changes within the range of 5 - 6m between dry and flood season. (See Fig. 1-6 and Fig. 1-7.) The surface area of the lake is said to be about 10 km^2 during a dry season and about 350 km^2 during a flood season. Daily water depth was measured at deepest point by Holland between 1939 and 1954. Daily water depth data between 1964 and 1973 are available too.

The both banks of the River Walanae and the River Bila are flooded at the downstream reaches to form as if one lake together with the Lake Tempe.



Notes: 1. See Fig. 3.3 in detail
2. From the report by Waskita Karaya)

Fig. 1-6 Max. Depth of Lake Tempe

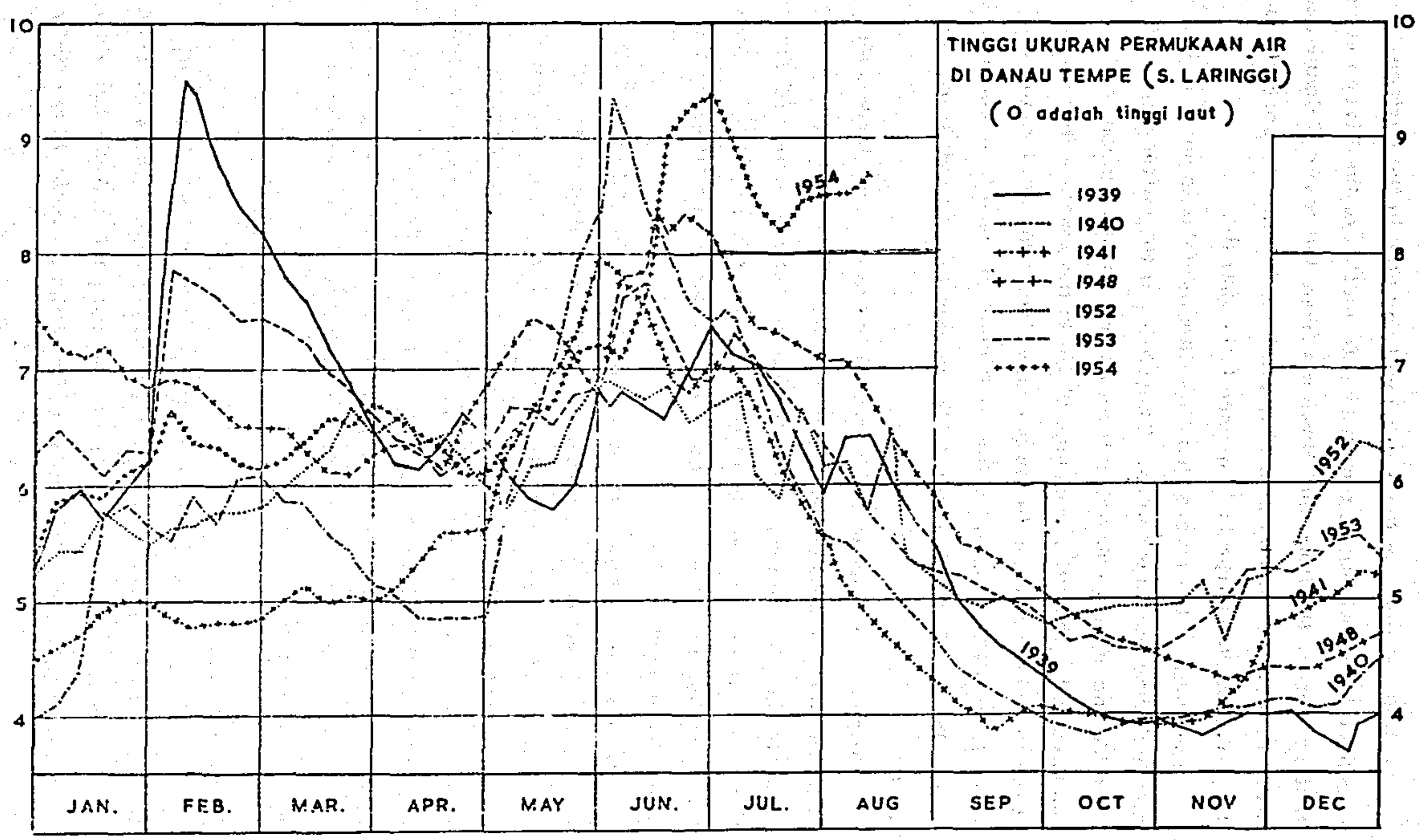


Fig. 1-7 Water Surface Fluctuation at Lake Tempe

Such big changes in the water level and also in the surface area have large effects on the channel formation of the River Cenranae. In other words, the flood that flows out from the River Walanae and the River Bila etc. is mostly stored in the Lake Tempe temporarily and the peak flow discharge in Cenranae falls sharply.

The basin of the rivers that flow into the lake is about 6,400 km^2 including the lake's area. Therefore, if the surface area of Lake Tempe at the peak water level during a flood season is assumed to be 350 km^2, a change of 1m in the lake's water level at the flood corresponds to the average flood run-off of 55mm of water from all the basin. If the coefficient of run-off is assumed to be 50%, rainfall of 110 mm as basin average is to be stored in the lake.

However, at Singkang, the capital of Wajo, many houses and huge fields exist around the Lake Tempe, and suffer large damages from floods. Therefore, the water conservancy problem of the Lake Tempe is extremely significant for the development of this region. This problem must be solved under the master plan covering the whole basin system.

During a dry season, the water level and the water surface area of the Lake Tempe decrease sharply, resulting in small catch of fish from the lake. The sediment run off that are carried down continuously by Walane and also by Bila have formed fertile plantation around the lake, but, it has also yearly decreased the water depth and the water surface area in dry season. Therefore, the measures for lake sedimentation and the maintenance of water depth and water surface area in dry season have become important themes.

(4) The River Walanae

Among the rivers that flow into the Lake Tempe, the river Walanae has the largest basin area of 3,350 km^2. (See Fig. 1-2).

The Walanae flows through the central part of South Sulawesi from south to north. The shape of the Walanae basin is narrowly

110 km long for north mountain zone on the east, a 1000m mountain zone in the west and a 3,000m mountain zone in the south.

The river Walanae joins with the river Cenranae at Singkang. However, it reverses its flow and flows into the Lake Tempe at the time of high water. At the downstream reaches, flood flow overflows on both banks at the water depth of around 1m, and the flooded area becomes a part of the Lake Tempe.

Walanae river has a slightly larger channel section at the downstream part than the Cenranae, and 130m width of a natural channel with a single section. Some advanced meandering and bank erosion are found, but it differs from the meandering found in so-called floodplain. Its channel changes do not seem so violent or unreasonable. Its meandering seems relatively stable, though advanced. Since this river flows through a volcanic ash zone, it has the turbidity of about 1000 - 2000 P.P.M. (visual estimate) even at the discharge of 200 - 300 m^3/s. Its slope increases at the upstream from around 130 km from the river mouth, and bars of sand and gravel are seen in upstream from there.

A trunk road runs from the capital of South Sulawesi, Ujung Pandang to Sengkang via Watansoppeng along the left bank side of Walanae river. Many houses and plantations are found along this road.

The both banks are flooded during floods. The water level difference between a dry season and a flood season is said to be 5 - 6m at downstream and 10m at upstream reaches. According to the information obtained at 135 km, floods usually last for about three days. The water depth drops to about 50cm to make it possible to across the river on foot during a dry season.

There is a site suitable for dam construction at Mong, 70km from the confluence with Cenranae (at about 140 km from the river mouth). This Mong dam plan will probably play an important role for the water conservancy, water power and irrigation for the basin.

The areas without tree, which seem to be the results of burnt crop fields, are found in the mountain zone of the basin. Although such areas are covered with grass, it will also become one of the important projects to afforest the ruined areas for preventing erosion.

(5) The River Bila

The river Bila comes down from the mountain zone in the north of the Lake Tempe and flows into the Lake Tempe. It branches into Lawanra, Bila, Kalempang (Boya) and Lancirang rivers. They run in parallel and join at the downstream reaches. The total catchment area is 1,690 km^2.

It has a natural channel with single section, and both banks at downstream reaches of each river are flooded during a flood season. The downstream part of Bila river forms one lake with the Lake Tempe. Bank erosions are found at big bends in the downstream reaches. The mountain regions in the basin require such treatment as afforestation for soil conservation.

The sites for a multi-purpose dam cannot be determined yet since no field investigation has been carried out. Studies of a geological map reveal a promosing spot along Kalempang river (Boya river). The basin of Bila could not be investigated since no sufficient road is available.

1.1.2 Hydrology of the Basin

The precipitation characteristics in this region seem to be attributable to neither cyclones nor complicated frontal. Rainfall may be usually characterized by a small rain zone and a short duration. In simple terms, rain falls where rain cloud arrives. Precipitation seems to be quite influenced by geology. The major precipitation characteristics can be probly inferred from the length of sea surface that is a source of water steam, and mountain conditions. Therefore, the east wind prevailing season and the west wind prevailing season have different precipitation characteristics. When west wind prevails, water steam is supplied from the Java sea and the west part of South Sulawesi has heavy rainfall and the Walanae basin has also considerable rainfall, though there is a mountain range of some 1000m height. At this time, the amount of rainfall in the Bila basin, the north of Lake Tempe may not be large since it is shielded by Kalimantan. On the other hand, when the east wind prevails, the amount of rainfall becomes generally smaller since the whole region is shielded by South East Sulawesi.

In other words, the east shore and the west shore have a mutually opposite season, because of the mountain chains that runs in north and south of the southern Sulawesi. And the Bila basin has somewhat different unique characteristics of precipitation.

Generally speaking, the wet season begins in November and ends in April, while the dry season begins in May and ends in October on the west shore. On the east shore, the wet season beings in March and ends in July, while the dry season begins in August and ends in February. The both shores have the dry season between August and October. The difference between wet and dry seasons is very clear in the west coast and the south coast.

The rainfall during the wet season depends heavily on geological conditions. The time and the amount of rainfall within the basin change according to each district in a complicated manner since Bila basin is shielded by the northern mountains and Walanae basin is shielded by two mountain chains that run in north and south, both on the east and the west sides of the basin.

The extremely useful data on the rainfall in Indonesia have been published by the Department of Communication, Meteorological and Geophysical Institute, Republic of Indonesia. The average annual rainfall and the average monthly rainfall are discussed below on the basis of the published data. (See Fig. 1-8 and Fig. 1-9.)

1) The average annual rainfall in the basin is around 2,000 mm. A 3,000 mm region is found at the upstream basin of Walanae. The rainfall is slightly lower, about 1,500 -2,000 mm in the region around the Lake Tempe.

2) The dry season stays in August - October in the whole basin. The monthly rainfall during this season is around 50 mm except that in the upstream part of Bila.

3) Supplemented to the above item mentioned in 2) the area around the Lake Tempe has a small dry season from December through January. The monthly rainfall during this season is around 100 mm.

4) The basins of Bila and Walanae rivers have relatively small monthly changes in rainfall except the dry season in August - October since they are under the influences of the wet seasons both in the east and the west shores.

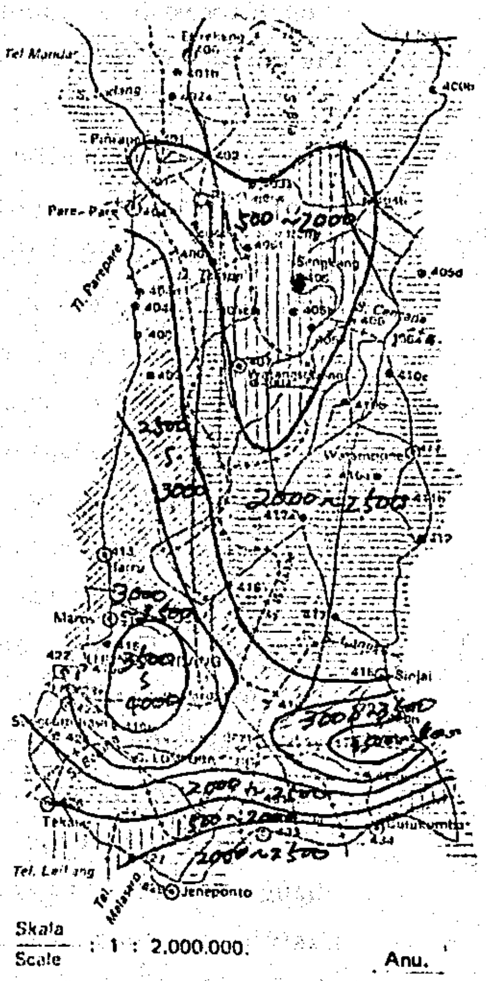


Fig. 1-8 Annual Rain Fall (mm)
(1911 - 1955)

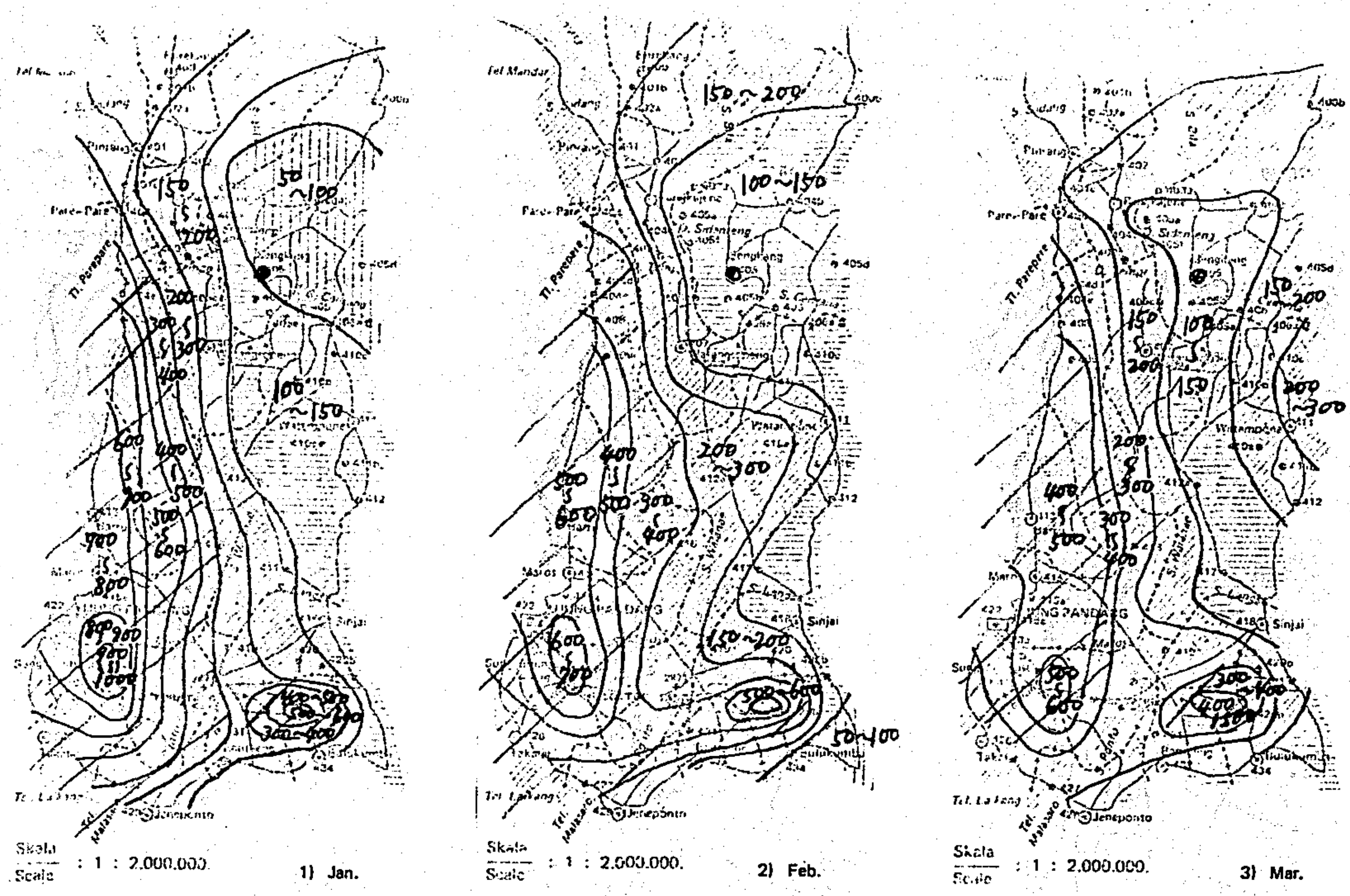
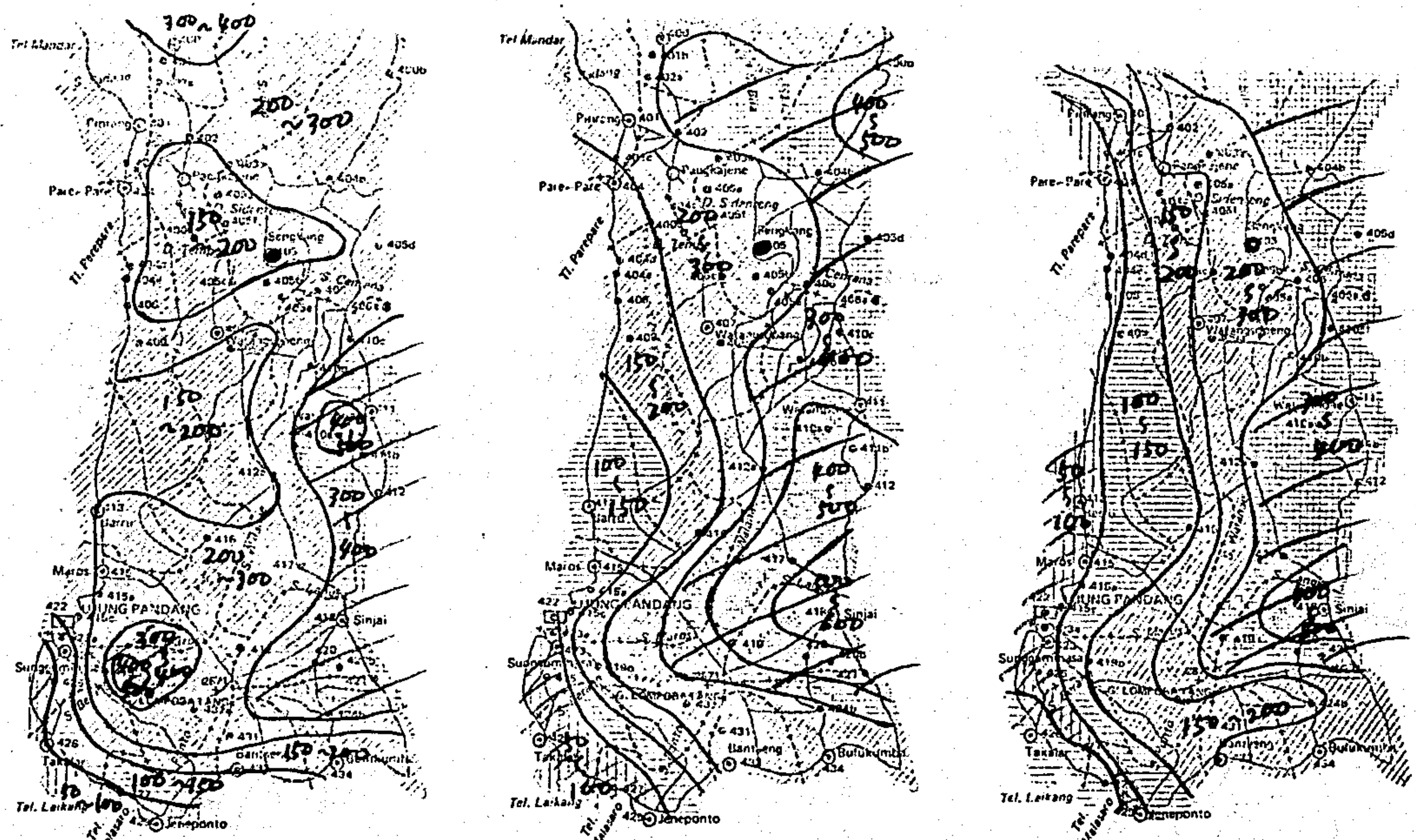


Fig. 1-9 Monthly Rain Fall (mm)

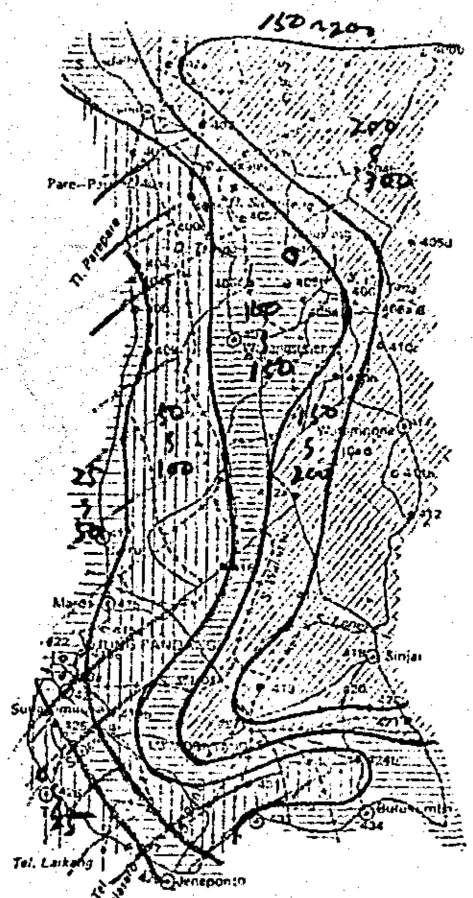


Skala / Scale : 1 : 2.000.000. 4) Apr.

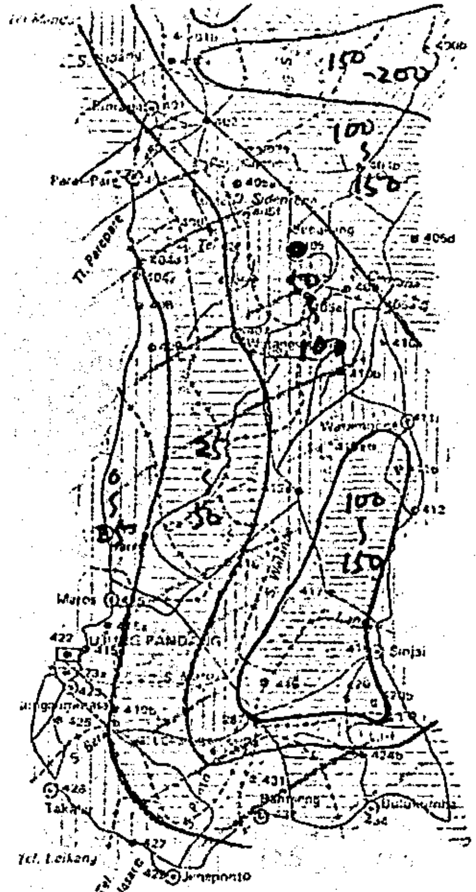
Skala / Scale : 1 : 2.000.000. 5) May

Skala / Scale : 1 : 2.000.000. 6) Jun.

Fig. 1-9 (Cont'd)



Skala / Scale : 1 : 2.000.000.   7) Jul.



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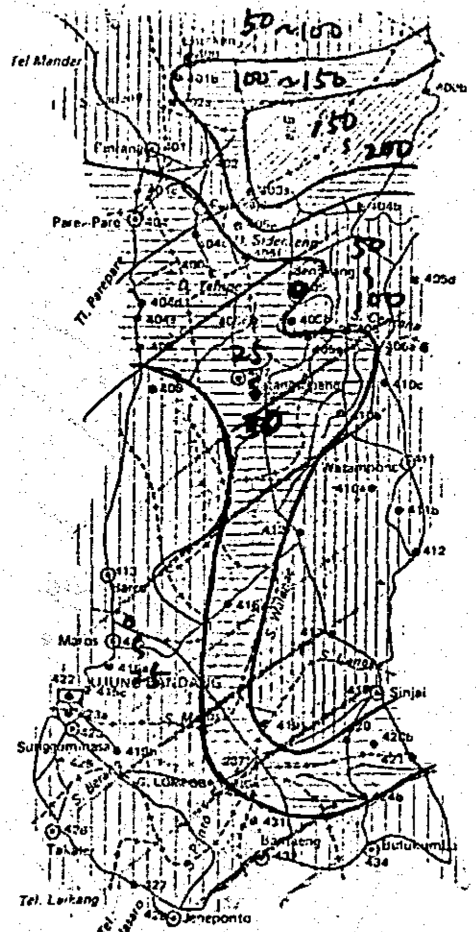

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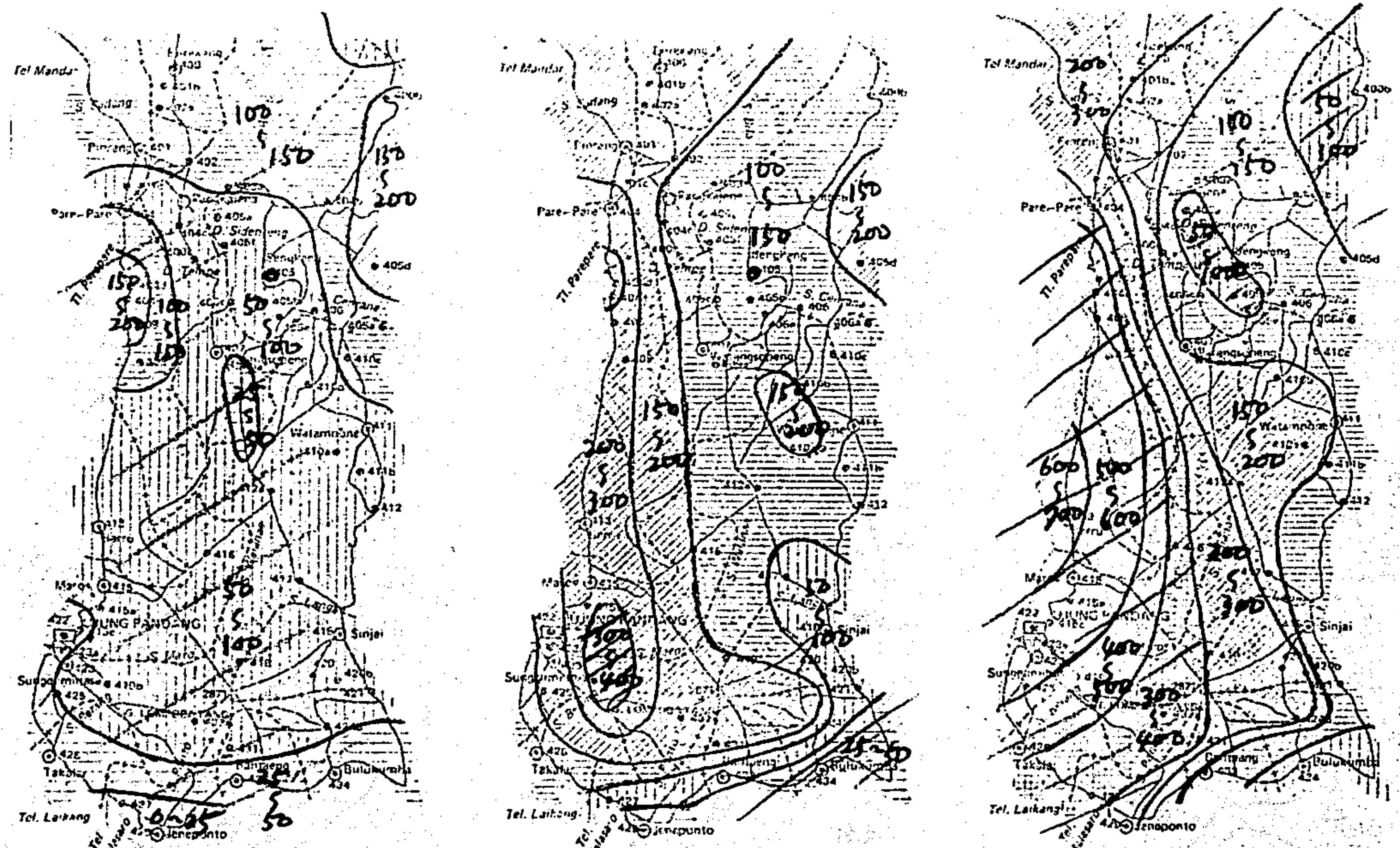
Fig. 1-9 (Cont'd)



Skala / Scale : 1 : 2.000.000. 10) Oct.

Skala / Scale : 1 : 2.000.000. 11) Nov.

Skala / Scale : 1 : 2.000.000. 12) Dec.

Fig. 1-9 (Cont'd)

However, the amount of rainfall reaches the peak in January - February when the max. amount of rainfall is recorded in the west coast and in May - June when the max. amount of rainfall is recorded in the east coast. The monthly amount of rainfall during these periods is about 300 mm. This is clearly indicated by the water level change at the Lake Tempe. (See Fig. 1-7)

5) The water level change at the Lake Tempe indicates that the amount of rainfall changes sharply every year. There are two cases that heavy rainfall occurs in May - June due to the wet season on the east coast in some years, and on the other hand, in January - February due to the influence from the west coast in other years.

The general characteristics of rainfall in this whole basin have been described. Yearly changes are especially important for drawing a water resource development plan. The rainfall data, especially, daily rainfall data in and near the basins are necessary to be collected, analyzed and studied.

1.1.3 Flood System of the Basin

The general flood system of Cenranae may be described as below that the floods from Walanae, Bila and the residual basins of the Lake Tempe are stored in the Lake Tempe, and discharged from the Lake Tempe into the Bay of Bone by the River Cenranae.

In order to study the channel capacity for flood flow of each river, the discharges of each river were observed at one location at each river. Fig. 1-10 - Fig. 1-12 show the results of the flow velocity measurements in Walanae, Bila and Cenranae. The mean velocity was obtained by measuring the velocity at two points i.e. 20% water depth and 80% water depth, and taking their simple mean.

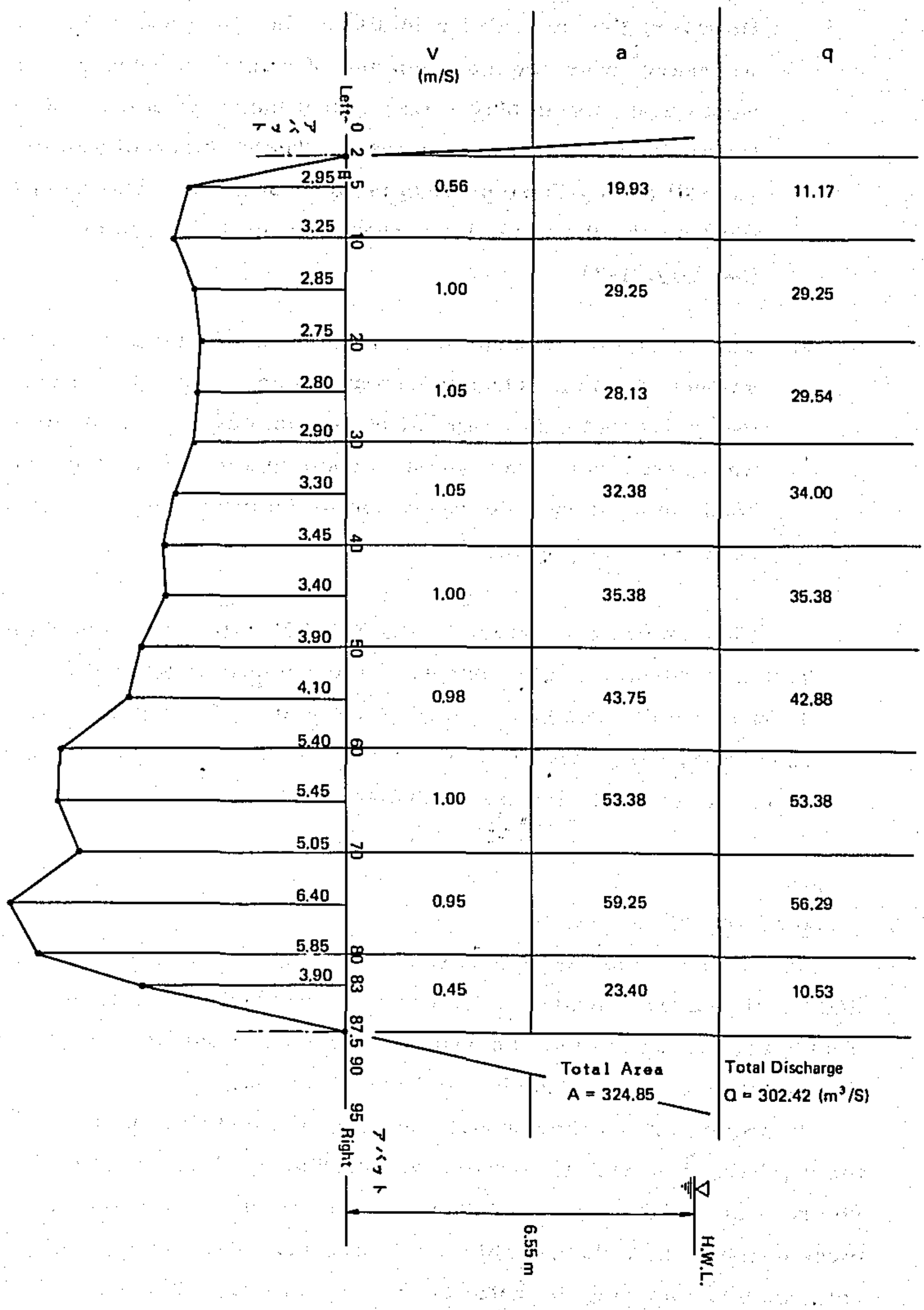


Fig. 1-10 Discharge Measurement at Walanae Bridge (114 km), Feb. 16, 1974

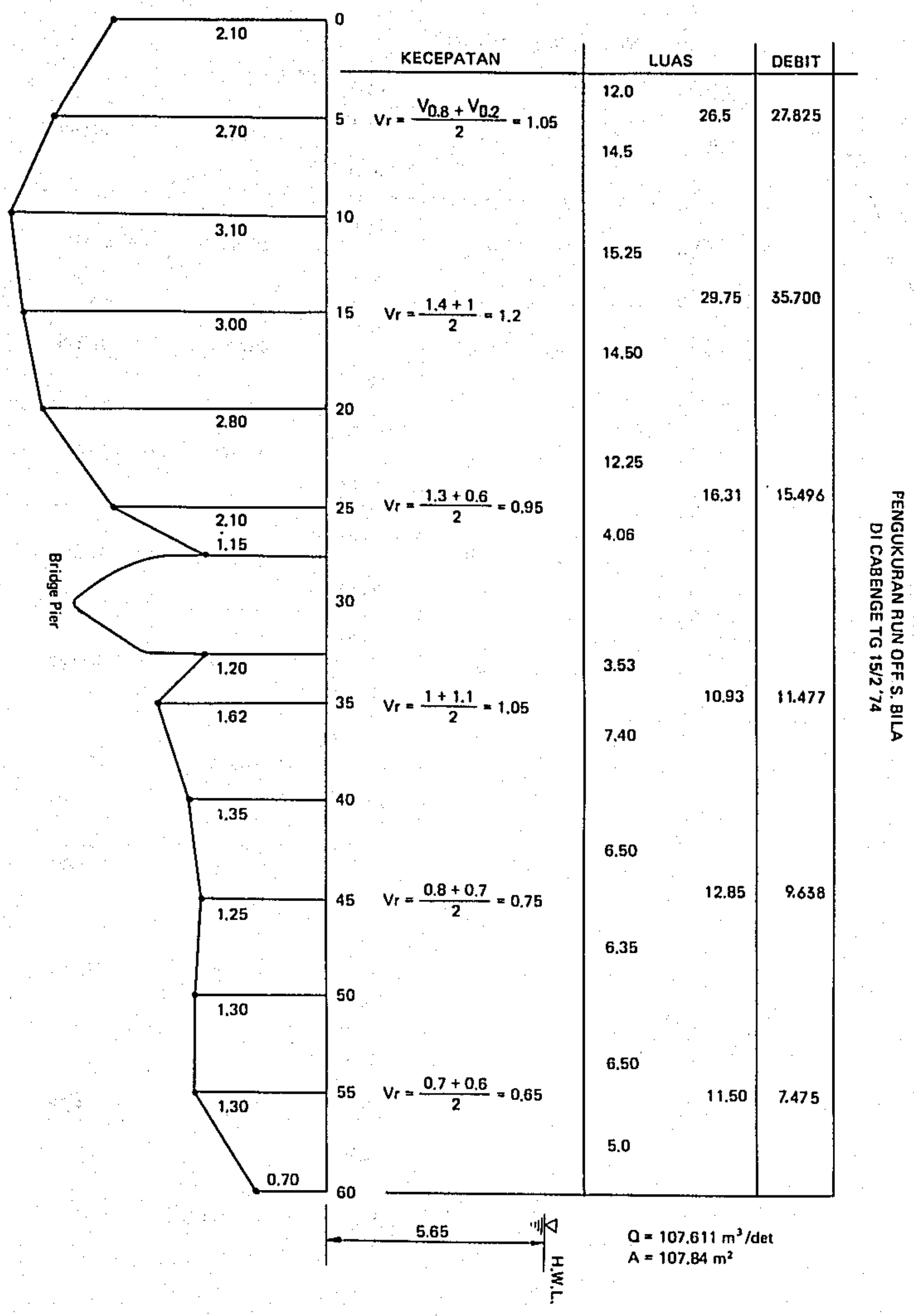
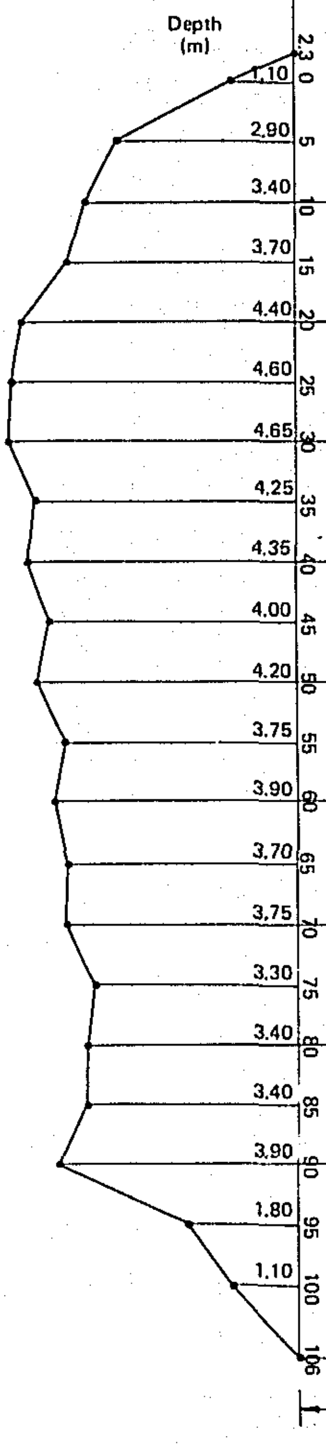


Fig. 1-11 Discharge Measurement at Bila
Feb. 15, 1974



$V_{0.8}$ (m/S)	$V_{0.2}$ (m/S)	V mean (m/S)		a (m^2)	q (m^3/S)
0.7	0.5	0.6	1.265 10.00 15.75	27.015	16.209
0.7	0.7	0.7	17.75 20.25	38.000	26.60
0.8	0.6	0.7	22.50 23.125	45.625	31.938
0.8	0.4	0.6	22.25 21.50	43.750	26.25
0.9	0.6	0.75	20.875 20.50	41.375	31.031
0.8	0.5	0.65	19.875 19.125	39.000	25.350
0.8	0.4	0.6	19.00 18.625	37.625	22.575
0.8	0.6	0.7	17.625 16.750	34.375	24.063
0.8	0.5	0.65	17.00 18.25	35.250	22.913
0.25	0.1	0.175	14.25 7.25 3.300	24.800	4.340

3.10 H.W.L

Q = 231.269 ≒ 231.3 m^3/S

Fig. 1-12 Measurement of Discharge R. Cenranae at Sengkang Br.
Feb. 14, 1974

Table 1-1 Discharge Data

Name of River	Date	Lateral Area	Dis-charge	Mean velocity	n (assumed)	R	I
Walanae	Feb. 16, 1974	325 m^2	302 m^3/s	0.93m/s	0.023	3.80 m	$7.74x10^{-5}$
Bila	Feb. 15, 1974	108	108	1.00	0.023	1.80	$2.41x10^{-4}$
Cenranae	Feb. 14, 1974	367	231	0.63	0.023 0.020	3.39	$4.13x10^{-5}$ $3.12x10^{-5}$

Table 1-1 shows the discharges that were observed at each river. The measurements were taken during a small flood, but not undertaken on the same day. We assume that the discharge remained almost unchanged during these three days. If the flood from the residual basin of the Lake Tempe can be ignored (The rainfall in this basin was very small.) and the water surface area of the lake is assumed to be 120 km^2, the water that is stored in the Lake Tempe will be obtained as below in terms of the water level.

$$(302 + 108) - 231 \ m^3/s \ \times 86400 \ sec = 15.5 \times 10^6 \ m^3/day$$

$$\therefore \ 15.5 \times 10^6 \div 120 \times 10^6 = 0.13 m/day$$

As shown in Fig. 1-13, the daily increase of water level elevation at the Lake Tempe during Feb. 14 - 16 is about 10 cm. These discharge measurement are seen quantitatively quite accurate in consideration of the fact that the discharge of Cenranae increased on the 15th and the 16th from that on the 14th when the measurement was done.

The water surface gradient at the time of the measurement is calculated from the result of the discharge observation by applying Manning's formula. According to the formula, mean velocity v is

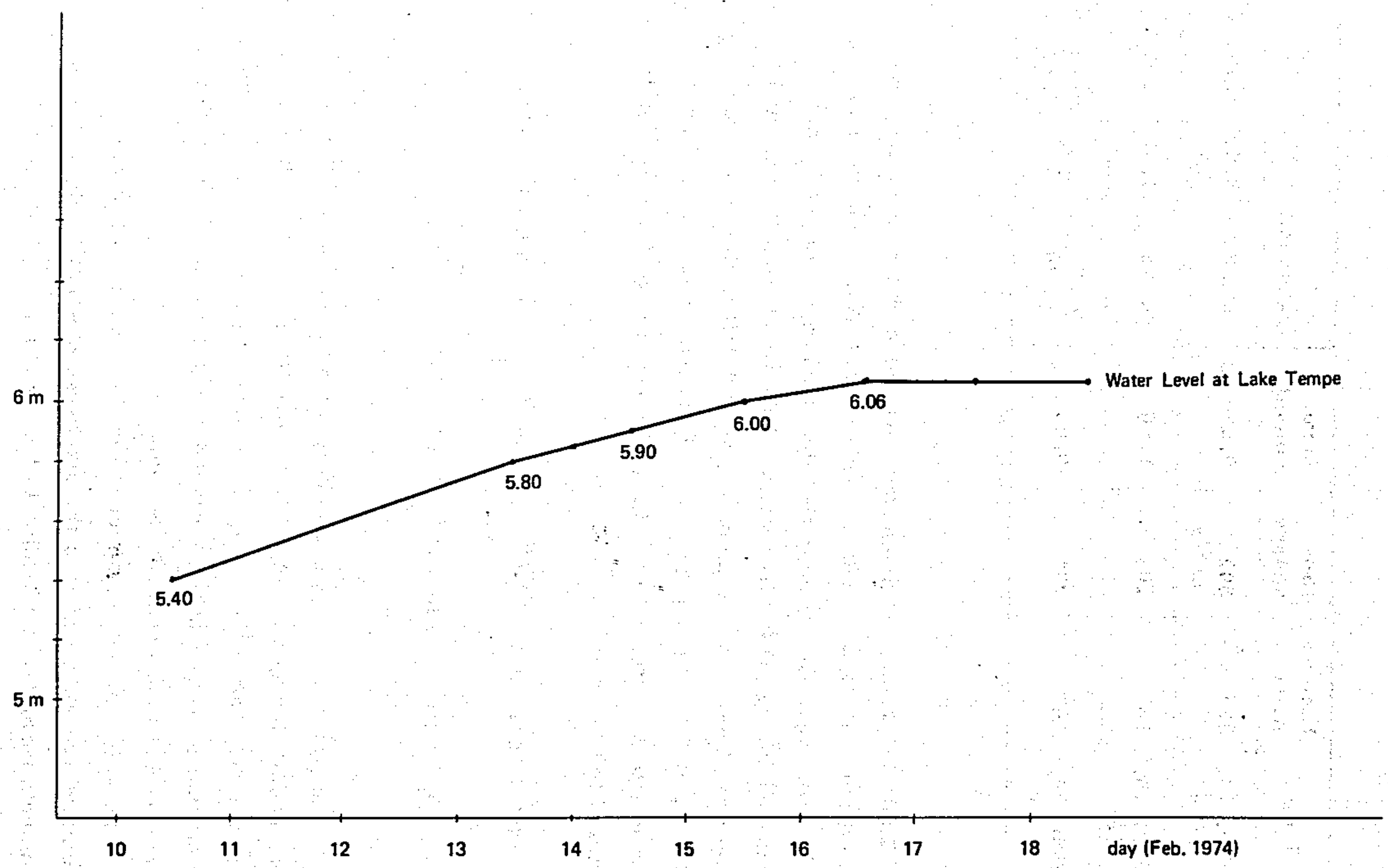


Fig. 1-13 Water Surface Elevation at Lake Tempe

obtained by the following equation.

$$v = \frac{1}{n} R^{2/3} I^{1/2}$$

where, n: Roughness coefficient
R: Hydraulic radius
I: Gradient

The roughness coefficient of each river is assumed to be n=0. 023 on the basis of the inspection. The calculated water surface gradients are shown in Table 1-1. In this case, an assumption of uniform flow is made. The results of the inspections show that almost no difference in the channel pattern is found between the upstream and the downstream of each river, and uniform river width, uniform gradient and uniform river bed grain size seem to be applicable respectively in each river. Therefore the results are probably close to the results of non-uniform flow calculation. The maximum water level of each river during maximum flood was estimated on the basis of the locally obtained information. This estimate seems to be quite accurate since it was calculated from the maximum water level points of such a structure as bridge pier. The maximum water elevation of each structure is shown in Fig. 1-10 - Fig. 1-12 as the distance from the river water level in the day of measurement. Although, during a big flood, the gradient will be slightly larger and the roughness coefficient will be slightly smaller at all of these locations, these figures may be used without modification for estimating extremely rough maximum flood discharge, because sufficient data are not available in this case.

Non-uniform flow calculation should really be carried out, but in this case, for rough estimation, the maximum discharge was also calculated under uniform flow conditions. The results are shown in Table 1-2. On the other hand, Fig. 1-7 indicates that the maximum water level elevation in the Lake Tempe was about 35 cm/day in June, when both floods in Walanae and in Bila coincided. If the lake's water surface area was assumed to be 350 km^2, at that time, the rate of water storage in the Lake Tempe is as calculated below.

Table 1-2 Estimated Max. Discharge

Name of River	n	R	A	I	Q_{max}	v	Catchment area a km^2	$Q_{max/a}$
Walanae	0.023	10.0m	$950m^2$	$7.74x10^{-5}$	$1690m^3/s$	1.77m/s	3350	0.50
Bila	0.023	7.45	430	$2.41x10^{-4}$	1100	2.56	1690	0.65
Other rivers to Tempe					(272)		1360	(0.20)
Cenranae	0.023	6.49	703	$4.13x10^{-5}$ $9.01x10^{-5}$	682 1009	0.97 1.43	(1290)	-

$$350 \times 10^6 \times 0.35 = 1225 \times 10^5 \ m^3/day$$

The inflow to the Lake Tempe from the remaining basin would be about 272 m^3/s if the assumption of $Q_{max/a} = 0.2$ is made.

Based on the above consideration, the run-off into the River Cenranae is calculated as,

$$\left[(1690 + 1100 + 272) - x\right] m^3/s \times 86400 \ s/day = 1225 \times 10^5 \ m^3/day$$

$$\therefore \quad x = 1640 \ m^3/s$$

In other words, the calculated water level elevation of the Lake Tempe does not agree with the measurement results unless the run-off into the River Cenranae is 1640 m^3/s. Actually, however, the flow capacity of the River Cenranae is below 1640 m^3/s since that the maximum discharge in the past of Walanae river probably did not coincide with that of Bila river. If River Walanae had a flood of 1690 m^3/s and the River Cenranae had a flood of about 500 m^3/s at the same time, a flood of about 1000 m^3/s was to be assumed in the River Cenranae. Moreover, it will give another proof to the maximum discharge in Cenranae river below 1640 m^3/s, that the duration of peak discharge in such a big flood must have had some effects on decreasing the maximum discharge in Cenranae. Therefore, it may be assumed that the maximum discharge of each river was quite accurately estimated by such simple calculations.

The Fig. 14 shows the estimated maximum water level at a flood and the average minimum water level during a dry season in the River Cenranae. The estimates are based on the following assumptions.

1) The minimum water level and the maximum water level data at the Lake Tempe are rather reliable.

2) It must be checked whether or not the bench mark shows the altitude from the mean sea-level, but it is assumed to indicate the altitude above the mean-sea level, here.

3) The data on the average tidal level change in the sea of 1.5m seem to be reliable.

4) The maximum and the minimum water level at Solo, 27 km from the river mouth, was estimated on the basis of the verbally obtained information and the water level observed on the day of the investigation.

5) A normal minimum water level curve shows smaller gradient toward the downstream. The gradient will become even smaller if such unsteady flow elements as tidal level fluctuation etc. are added. Since the river channel geometry does not seem to change sharply in the reaches, straight line was assumed here. The real gradient will probably not differ much, only if the alitutude of the

zero point is correct. Actually, however, the gradient will be slightly more sharp at the upstream and slightly more mild at the downstream.

6) The influence from the tidal level change of about 20 cm was observed at Solo (27 km) during the investigation. The fact that the sea water comes up to about 20 km point indicates that the estimated results are quite close to the actual phenomena.

7) It may be possible that the altitude of the minimum water level at Solo is even lower, but the maximum water level curve on the basis of such low water level would be nearly the same maximum high water level curve as shown in Fig. 1-14.

The water surface gradient of the River Cenranae during a big flood is obtained on the basis of Fig. 1-14, to be $I = 9.01 \times 10^{-5}$ as given in Table 1-2. The gradient at the minimum water level can also be estimated to be 4.83×10^{-5}, which is slightly larger than the calculated result. The calculation result seems to be more correct in this case as discussed before.

The above consideration leads to the conclusion that the channel capacity for flood flow of Cenranae would be around 1000 m^3/s. This is based on the assumption that the water level of the Lake Tempe is 9.6 m. It must be noted that the channel capacity will drop further if the water level at Tempe is lowered. In consideration of the current flood scale at Walanae and Bila, the capacity of Cenranae should desirably be increased according to the water level to be schemed at Tempe in order to lower the flood water level at the Lake Tempe and also to solve the sediment problem with the Lake Tempe. If the storage of the Lake Tempe could not be considered in the extreme example, the River Cenranae would have to be expanded to the channel capacity of 3000 m^3/s at the water level of 6 - 7 m at Sengkang.

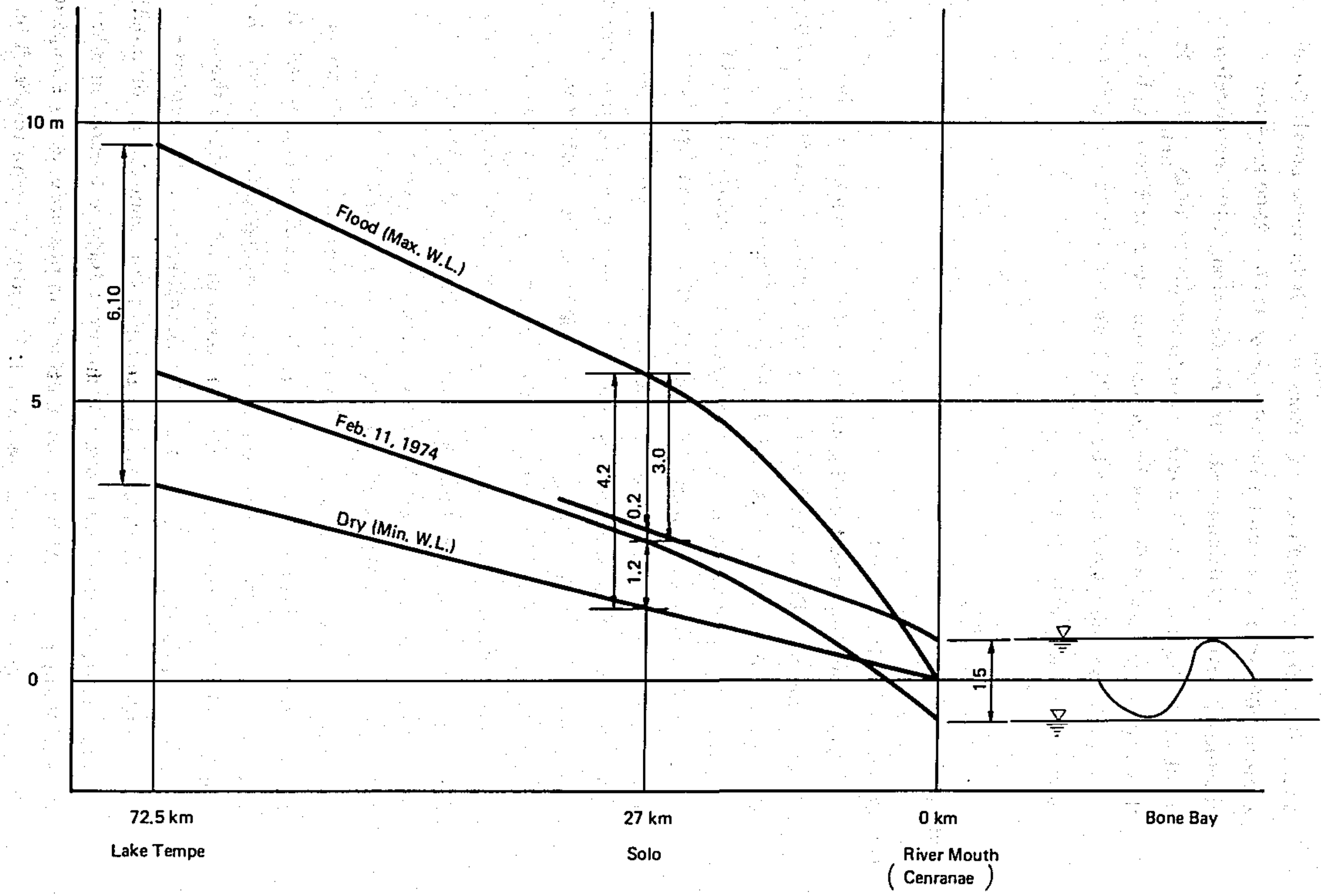


Fig. 1-14 Supposed Water Level Curve at Cenranae

However, the specific discharge (Q_{max}/a) of Walanae and Bila under the current conditions is about 0.5. It is quite small for a zone of 2000 mm of annual rainfall and of 1500 - 3500 km^2 for catchment area. This naturally increases along with the development of the basin. It will easily rise to about 1.5 of Q_{max}/a. In this case, the maximum discharge of each river will be trippled. A careful consideration must be made before drawing a long-term plan under the master plan.

1.1.4 Sedimentation

(1) Run-off of Volcanic Ash

The most important sediment problems are deposit of the sedimentation in the Lake Tempe of which bottom is said to be rising at the rate of 10 - 20 cm/year and the silting at the Cenranae estuary. Sedimentation in swampy areas is desirable for plantation. However, sedimentation in the Lake Tempe and Estuary has raised the flood level, decreased the catch and inhibited navigation. It is said that such heavy run-off of sediment has begun after the 2nd world war. It may be partly attributable to tree felling in forests and field burning method. According to an aged man in Sengkang, a flood occurred once every three years before the war, but three floods occurred during each wet season after the war. This old man seems to call it a flood when water covers the ground near his house. Although his figures may not be highly reliable, the water level around the Lake Tempe seems to become higher after the war even when an equally heavy flood comes out. It is said that the catch in 1973 from the Lake Tempe dropped from about 16,000 ton/year to 5,000 tons/year after 10 years in 1973, though these figures of amount and the method of estimation are not completely reliable. The Port Palima, located in 4 km from the river mouth, became unusable and was moved to the Port Bajowe located in 6 km east of Watanpone. Although navigation was possible up to Pampanua, 37 km in upstream, before the war, it has also become impossible.

It seems to be true that the conditions of the lake and the estuary have deteriorated at least quantitatively, especially after the war, due to the sediment deposition in the Lake Tempe and Estuary. It is suspected that Walanae and Bila are mainly responsible for the sediments to the Lake Tempe and that the sediment brought by the River Walanae accounts for the burying of Estuary. According to Mr. Istiatno, a geologist in Bandung, this basin has considerable sedimentation of volcanic ash. It is said to be more thick in the Bila basin. Considerable amount of limestone is found in the mountains in the west part of the Walanae basin. The volcanic ash has been scoured and sedimentary rocks of sand stone and others that are containing shell are locally exposed. Generally speaking, in the Walanae basin, any forests can not be found except the place quite far into the upstream district, and gentle hills of most of the basin are planatations or covered with bushes. Slight erosion of the surface layer has spread out quite widely in this region and partly caused the turbidity of the river water.

The hilly districts in the basin of Bila are similar to those in the Walanae basin. It is said that more forests are in the upstream region of Bila. This basin could not be investigated sufficiently due to the poor road conditions, but it is sure not to have developed just as in the middle and upstream reaches of Walanae basin. The river water shows only slight muddiness at a low water level and also during the dry season also.

According to Mr. Istiatno geologist in Bandung, some earthquake districts exist both in the upstream of Bila and in the upstream of Walanae. No volcanic disturbance has occurred recently. However, uniform 1m - 0.3m thick volcanic ash strata and 20 cm thick jem and stone strata are found alternately in 3 - 4 strata on the bank near the 135 km point of Walanae downstream of the proposed Mong dam site. This observation was made during the boat trip. It should be studied further whether the result is by the volcanic ash desimentation or floods. Any way the problem consists in this fine volcanic ash, which runs off even with slight rainfall. The run-off of large grain gravels (gravels, jem stones etc.) need not be considered for sand prevention etc. except for the far upstream reaches.

The basin of Walanae is locally afforested. The problem of burnt crop fields must be studied, too. Habitations and plantations are found even in considerable upstream region. Even small tributaries are normally quite muddy in such an area.

Then, the run-off of sediments due to bank erosion is also necessary to be studied. Since such bank stabilization works as revetment works have rarely been carried out, considerable erosion is expected. However, it is not as serious as in delta waste land where the watercourse changes every year. Unexpectedly, some stable conditions are suspected from the fact that houses have been built quite close to the river bank. One of such stable conditions maintained probably because the river is lower than the ground and because the bank is 3 - 4m above the normal water level except the River Cenranae.

The characteristics of meandering fluctuations will be clarified to certain extent through aerial photographs to be taken probably in 1974. The states of bank and mountain erosions are necessary to be quantitatively grasped by investigating sediment deposit, river bed fluctuation and also measuring the rate of longitudinal sediment transport. In Mid Java, sediment run-off is said to be closely related to volcanic disturbances. The mean sediment run-off of 6 - 7 mm in the whole basin is reported, though with some fluctuation. However, such heavy run-off would not be expected in view of the degree of water muddiness in this basin. In any event, it will be significant to estimate the rate of total sedimentation by measuring the amount of sediments and studying geologic changes. In this case, the place and the rate of sediment deposit will be important to be studied. Attention should also be directed to normal sediment run-off since silting at normal water level presents problems at the estuary. Afforestation and dam construction are possible measures.

(2) Bank erosion (at 84 - 98 km of Walanae from the Cenranae river mouth)

General river bed descent and fluctuation except local ones would not bring big problems in near future in these rather stable channels since the effects of sediment balance are large. No conclusion can be drawn without data on time-sequential changes. Therefore, bank erosion is treated here.

The concave side of a curve in the meandering reaches, a diversion point, a confluence and the upstream and the downstream reaches of a structure are important for bank erosion. The study can be restricted to alluvial reaches alone. No special attention may be directed to alternate bars and shoal developments. Some spots were found where river flow approaches such a structure as road especially in a bend, but extremely heavy bank erosion seems to be limited. An example of a diversion channel in the downstream reach of Walanae is given here.

A diversion channel exists in the downstream reach of the River Walanae between 84 - 98 km from the Cenranae river mouth. This branch river is found in the 1/50,000 map (drawn in around 1920 ?) as an extremely small branch river called Manyilong. While the main stream is 14 km long, this branch river is only 9 km long. Although the river gradient is extremely small in this district, that of the branch river is larger due to its smaller length. This results in large flow velocity and quick bank erosion. According to the inspection, diversion channel has grown to be almost equal to the main river. The branch river is said to receive rather much discharge than the main river during a flood. This tendency will continue in the future and their superiority relation will be reversed. The branch river will become the main stream and the current main channel will lose its superiority further. Since sediments seem to flow down almost in the form of suspension near the branching reach, its shape probably has little effect on the change of diversion geometry. If a large bed load exists, the shape near the branching point must be studied for predicting future changes.

(3) On Confluence at Sengkang

The confluence of Walanae and Cenranae at Sengkang is characterized by considerably sharp angle. It seems to be above 90° currently. Generally speaking, vertical axis vortex is formed at a confluence, causing sedimentation in the downstream of the confluence side and deep excavation in the downstream of the opposite side. For this reason, a confluence angle becomes sharp gradually and it moves toward the upstream side if it leaves to the natural action.

The flow is divided into two at this confluence if the water level of the Lake Tempe is not sufficiently high during a flood of Walanae. In other words, one flow goes to the Lake Tempe and the other to the River Cenranae. At the last stage of a flood, the run-off from the Lake Tempe and the flow of Walanae get together and flow into the River Cenranae. Thus, the flow changes at various stages of a flood. However, a normal confluence change seems to be taking place since the River Walanae has large effects. According to the information obtained from residents, the confluence point has moved as much as about 300 m (estimate) toward the upstream during the past ten years and this tendency seems to have been still continuing. In other words, confluence conditions are gradually deteriorating.

A large vortex is found on the right side of the River Cenranae and serious erosion at the water hammering part of the left side. It is said to be 5 - 6m deeper than the mean river-bed. Simple protection works made of bamboo trees are found at the water-hammering part on the left bank side.

However, the bank erosion is at the advanced stage and houses are exposed to the dangers.

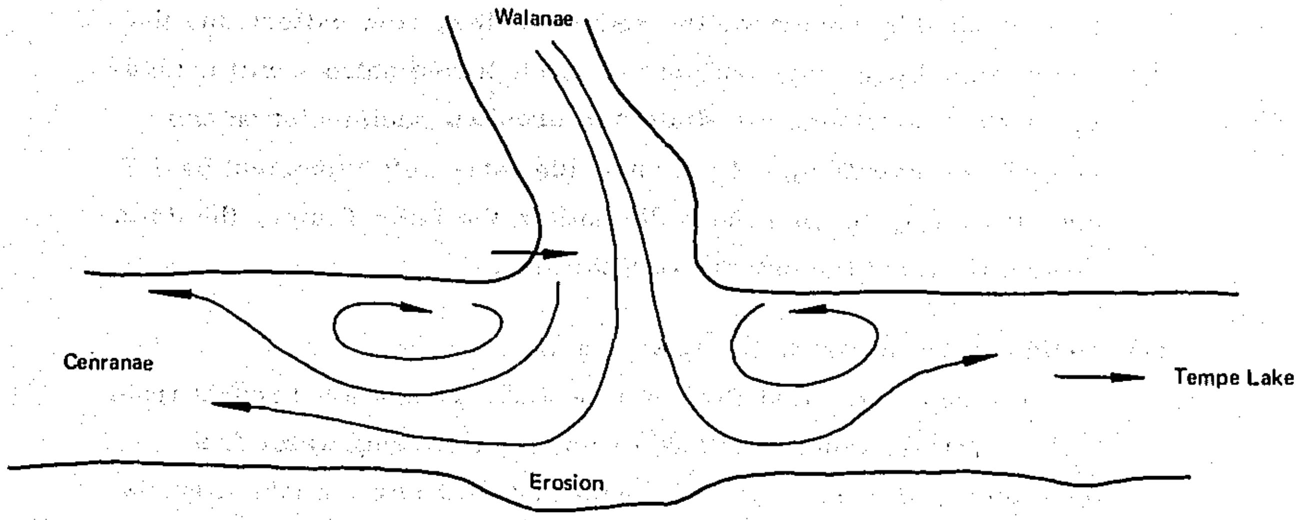


Fig. 1-15 Confluence Flow Pattern at the Flooding Stage of Walanae

The sediment distribution at a confluence presents problems. The bed load consists of large grain sand and the relation of $Q_B \propto U_k{}^3$ is found for the rate of bed load transport Q_B. Here, U_k is friction velocity. The bed load concentration is large near the river bed and its sediment movement is dominated by the flow direction near the river bed. In other words, the direction of bed load whether to the Lake Tempe or to the River Cenranae is determined by the local flow. Generally speaking, more bed load will flow toward the River Cenranae as the confluence has a sharper angle and flows toward the upstream direction. Although suspended load is almost in proportion to the sequare of discharge, sediment distribution is not simple due to the effects of the flow pattern. It may be assumed that wash load not determined by hydraulic quantity is in proportion to discharge ratio. Thus, the ratio of sediment distribution is so complicated depending on grain diameter, sediment flow pattern and flow pattern, that it will be necessary to be studied by observing the sediment flow, flow pattern and the bed material near the confluence. Such investigations will not only prove the importance for studies of erosion, sedimentation and river bed fluctuation, but also provide extremely important basic conditions for studying the sediments in the Lake Tempe, the downstream part and the estuary of Cenranae.

(4) Sediment Transport to the Lake Tempe

The sediments that flow into the Lake Tempe are brought from Walanae, Bila, other small rivers and overflowing water from them during floods. The sediments that flow into the lake directly from rivers are those of all grain sizes. However, the sediments that flow into the lake from overflown water are uniformly fine since coarse ones settle in the low swampty area. The water overflowing from the left bank at 70 - 100 km from Cenranae river mouth at Walanae seemed to present problems. The old map of 1/50,000 shows a few small channels in this district. If such water channels exist really, sediments will be carried into the Lake Tempe directly without settling in the low swampy area. However, no such channels were found during the field investigation. River water seems to rise gradually and overflow very slowly and uniformly at the time of a flood. Overflowing water does not seem to gather to form a stream being reaching the Lake Tempe. Therefore, there is no need to assume that the sediments of the River Walanae are directly carried to the Lake Tempe due to overflowing.

Of the rivers that are connected to the Lake Tempe, the River Walanae (the River Cenranae) shows an extended shoal into the lake, but the River Bila does not show any clear shoal extension. The extending shoal of the River Walanae had the rather deep water depth of 3 - 4 m on Feb. 10, 1974. However, the exit for the lake was around 1m deep and quite shallow locally. The river bed material around here consists sludge of about 0.03 - 0.07 mm, but has no offensive odor and contains little organic matters.

The native was able to walk in the water in this area without sinking so much probably because the bed was dry and firm during the dry season.

The shape of the Lake Tempe is just like an extremely shallow plate. Although Fig. 1-7 is said to give the maximum water depth, its difference from the mean water depth is small. It seems that fine sediments are uniformly carried and uniformly settled in the entire lake. The water was quite muddy above 500 p.p.m. from the center of the lake toward the southern part when the investigation was made. Considerable muddiness was also found near the exit of the River Bila. However, clear water and water plants were found in a limited range in the northern part. The north east part did not show much muddiness.

The flatness and the muddiness of the Lake Tempe seem to be attributable to the lake flow, the wind current, wave action by wind and water plants for traveling sediments. Wind flows quite strong over the Lake Tempe and causes 50 cm or higher waves. The waves can stir up the bottom material. It is conceivable that the wind forms wind current and waves, which uniformly distribute fine river sediments in the lake. The material distribution of the bottom was not investigated that time. Deep channels in the lake and local deep parts for fish can be buried again very soon unless constructed well enough.

1.2 Direction of Development

This region has rich land with water resources and a large population. However, the nature's gifts are not fully used at present due to insufficient development of water resources facilities for water conservancy and water use. Especially, damages from floods have restricted the development in this region.

Water resources development works must be promoted for the future progresses in this region. However, these works take a long time before completion and must be carried out along with the development of the basin. For these reasons, a long-term master plan must be drawn.

The following main four methods are recommended for minimizing flood damages in the region around the Lake Tempe and for increasing water use functions.

1) Increase of the channel capacity of Cenranae
2) Construction of multi-purpose dam
3) Improvement of the Lake Tempe
4) Erosion preventing measures

These methods are discussed below.

1.2.1 Increase of the Channel Capacity of Cenranae

The purpose of increasing the channel capacity of Cenranae consists complete discharging harmful flow into the sea safely and as quickly as possible.

This purpose can be achieved either by dredging and excavation or by embankment. The dredging and excavating method seems to be the most effective since the river water level especially and the water level of the Lake Tempe cannot be lowered by embankment during a flood. In this case, embankment is somewhat effective as an auxiliary method for protecting a specific district.

If the channel of the River Cenranae is extended by dredging and excavation etc., the water level of the river and the lake during floods will be lowered, will shorten flood duration, will minimize the flood damaged area around the Lake Tempe and along the River Cenranae and will increase possible plantations. The dredged sediments will be discharged to the low swampy area along the River Cenranae and form some new plantations. It will also facilitate the navigation at the estuary since it increases tides and promotes river mouth maintenance.

Generally speaking, insufficient channel capacity for flood and poor navigation conditions at estuaries are attributable to insufficient water depth and the movement of the opening. The effects of waves do not seem to reach the mouth of the River Cenranae due to the shallowness of the sea. (This requires confirmation). Therefore, an attention should be directed to the silting of sediments from the river. Ocean currents, tidal flow and sand drift would better be studied, but the effects from the river side seem to supersede. Therefore, the netting-like branch rivers in the delta must be gathered into one channel in order to increase the tractive force at the estuary. It will be desirable to carry sediments sufficiently far from the shore before settling. In this case, flow velocity distribution and salt water distribution must be studied. In some cases, structures such as a training dyke would be studied. However, considerable sediment run-off is expected even if sediment transportation is inhibited by soil conservation works in the upstream. Therefore, the river-mouth will be extended yearly. Measures for extension must be considered from the beginning.

Tidal flow occurs in the downstream reaches of the River Cenranae due to tidal level fluctuations of 1.5m as mean value. The river-mouth section will be able to be maintained by ebb and flood flows.

M.P. O'Brien* proposed the following equation.

$$A = 2 \times 10^{-5} p$$

in which A: Minimum cross-sectional area of stream under mean sea-level (ft^3)

P: Tidal prism

This equation is applicable to a river-mouth without jetty. Although this equation is based on actual measurement, neither the effects of waves, nor sea current, nor sediment quantity, nor grain size, nor salt concentration, nor plane shape of river mouth, nor flow velocity distribution of tidal flows, and nor tidal-level wave shape is considered. Therefore, the actual application of this equation present some problems. However, it may be used either for rough estimate

* M.P. O'Brien: Equalibrium flow areas of tidal inlets on sandy coasts, Proc. of Tenth Conf. on Coastal Eng. 1966

or for qualitative judgements. For example, this equation shows that the maintained water depth will be doubled without any extension of the tidal portion by doubling the width of the River Cenranae at the down-stream reaches. The water depth will be tripled if the tidal portion becomes 1.5 times longer. Thus, sufficiently large section at the estuary has the effect to increase the channel capacity of the River Cenranae, to lower the flood water level around the Lake Tempe and to facilitate navigation.

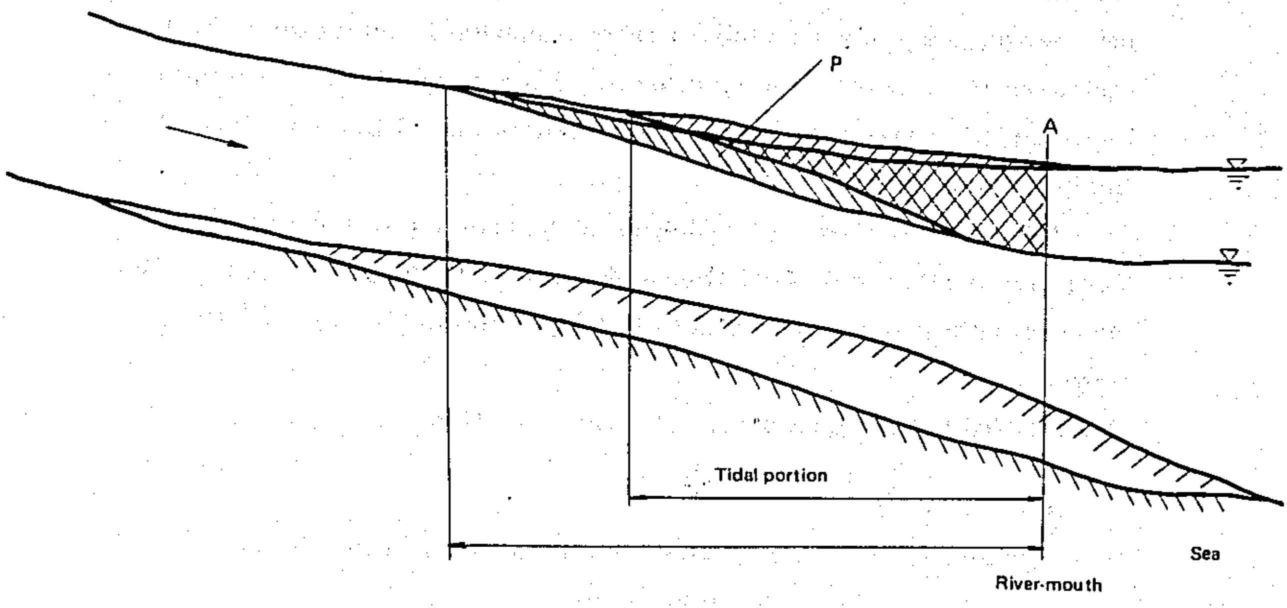


Fig. 1-16 Tidal Prism (P)

To widen actually the river Cenranae is not the work that could be operated easily and a great quantity of work becomes necessary for it. The Fig. 1-17 show the rough relation of the increase of widening quantity and the drainage capability. They indicate two cases for ease that the river was made twice of width in condition of the present water-depth and that the river-bed was scoured with 1 m in condition of the present river-width. In case of decreasing the water-level of the

Lake Tempe to 6.5 m or the harmless level, the present drainage capability will not be obtained unless the river channel is kept itself under the conditions of scouring of 2.5m or the width of 2.5 times. In that case, the sand quantity of about 18 x 10^6 m^3 is necessary to be scoured for the scouring of 2.5 m, and the quantity of 100 x 10^6 m^3 for the width of 2.5 times. This means that a great quantity is needed for carring out that work.

If we consider from the point of sand quantity, the way of scouring is more effective than that of widening. Any way, from the point of the condition of the river-mouth and sand deposition (maintenance of river channel for river-bed), the ratio of these two matters has to be considered carefully. In other words, the both matters are necessary more or less, and it is not enough to carry out the only one of these. The ratio of scouring and widening that is reasonable hydraulically will be determined according to seasonal discharge change, planed flood discharge and sand outflow discharge. Some consideration will become necessary including about the Lake Tempe while the sand caused by scouring will be used effectively for reclaiming the swampy area and roads.

1.2.2 Construction of Multi-purpose Dam

A suitable site for dam construction is found at Mong in the River Walanae about 140 km up along the River Cenranae. The present investigation was limited to the right bank alone due to the time restrictions. It is topographically suitable for dam construction. With exposed sandstone and shale of enough hardness on the right bank, it seems to be an extremely promising dam site. However, it must be studied the geology of the saddle part near the confluence with the River Mario on the left bank and the rock quality just like the limerock made from coral reef around there. Water storage of about 700 million m^3 will become possible by constructing a gravity concrete dam or a rock fill dam of 50 - 60 m in height at this spot according to the estimate

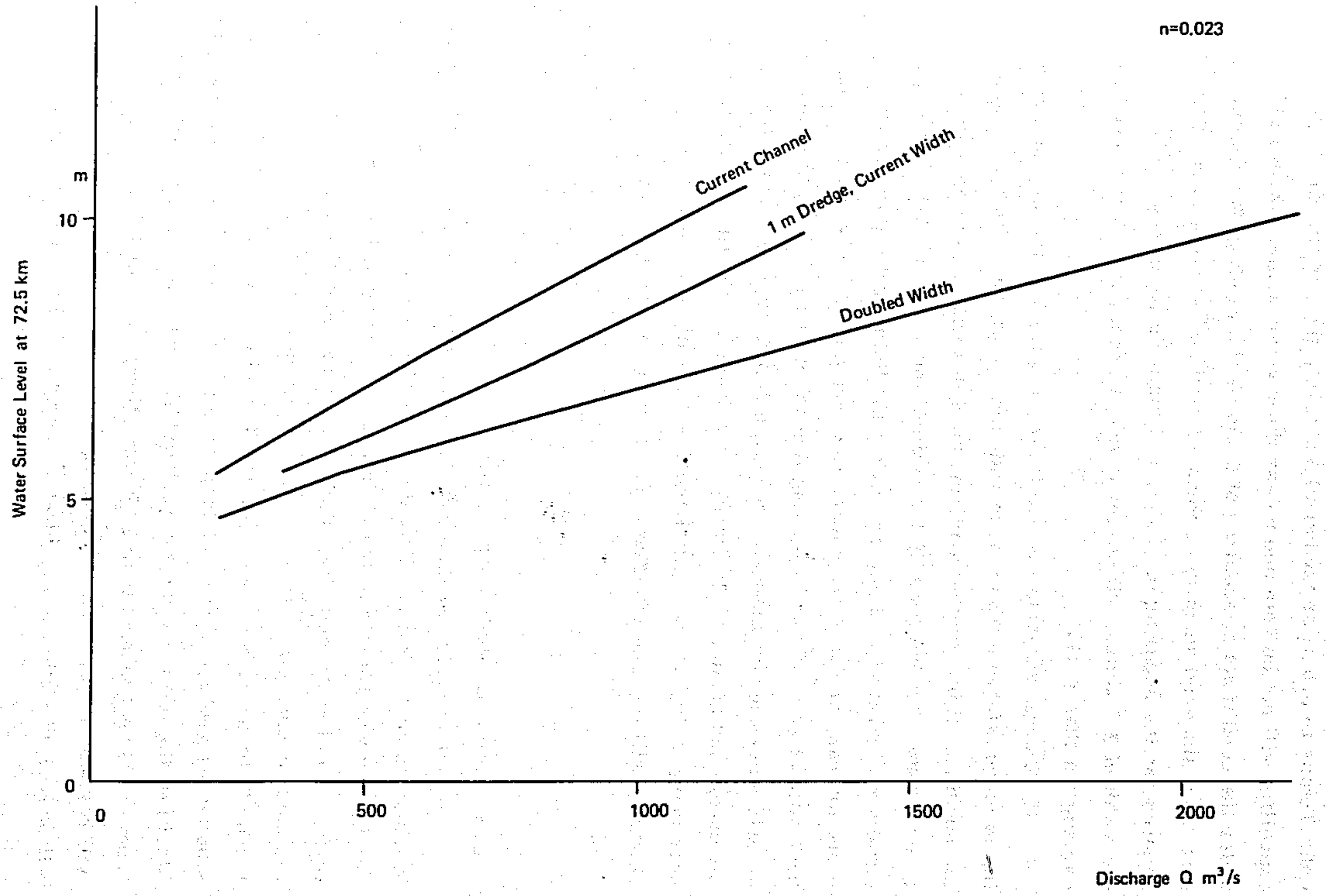


Fig. 1 - 17 Channel Capacity of Cenranae River

made from the topographic map of 1/50,000. (Fig. 1-18).
The catchment area at the dam site is about 2,700 km^2. Since the capacity of a dam is desirable to be large as much as possible, the consideration about the matter of a dam is necessary in the stage of farming a Master Plan.

Dam construction will realize flood control, irrigation and power generation etc. It will play a central role in the future water resource development plan. Furthermore, a dam will promote sedimentation in the reservoir, control floods and thus will decrease the flood inflow to the Lake Tempe, giving satisfactory effects on the sedimentation problem of the Lake Tempe as a secondary benefit.

The possibility for dam construction at Bila river would be better to be studied, too. The topographic map shows a suitable site for a dam construction with the catchment area of 400 - 500 km^2 in the River Kalempang (the River Boya). The possibility from the view points of geology and topography of this spot would be confirmed by field investigation. Additionally, other possible dam sites in the reaches upstream of Mong dam and upstream of the River Bila would become to be necessary to be investigated, too.

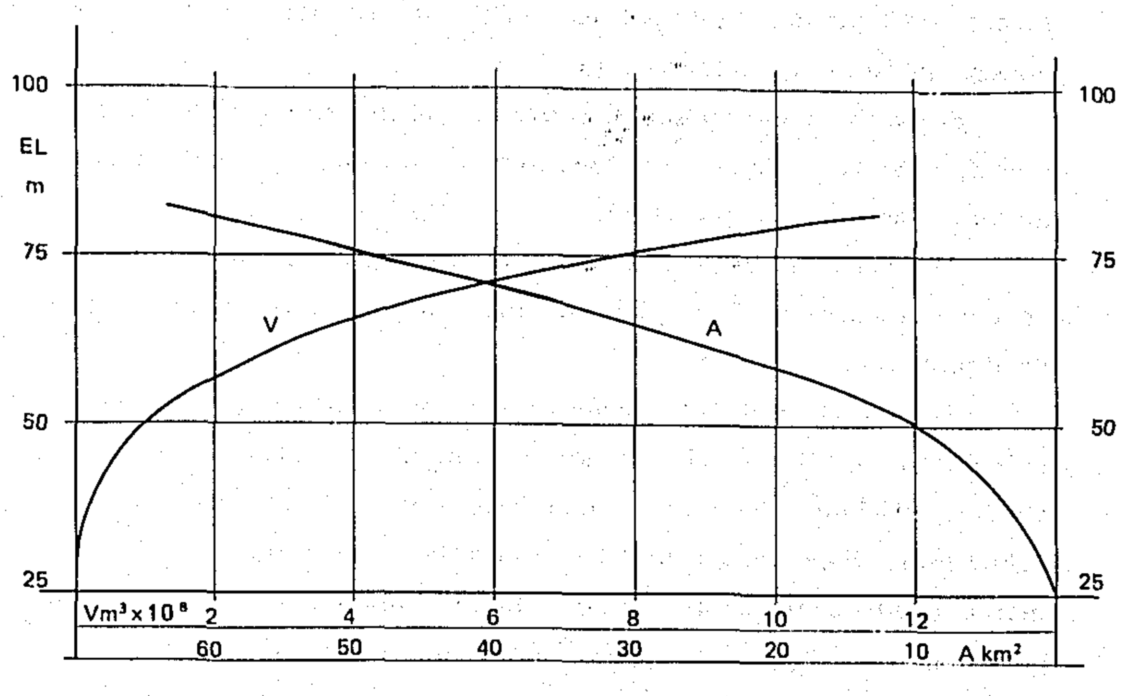
Since these dam plans are closely related to the flood control plan for the Lake Tempe and the River Cenranae, its position within the master plan must be clarified.

The retarded basin plan using the swampy area would also deserve of studies. This plan should be desirably studied in relation to road planning.

The output of hydro-power generation at the Mong Dam can be calculated as follows. The upper catchment area of the Mong Dam is about 2,700 km^2. The mean annual rainfall at the basin is about 2,500 mm. Supposing runoff ratio into the reservoir should be estimated at 50% of the total rainfall, the average annual discharge would be 105 m^3/s. Supposing approximately one fourth of discharge in average could be used for power generating purposes, eliminating the flood discharge and irrigation water, discharge of $Q = 25\ m^3/s$ would be available for power generating purposes. Supposing the dam is 55 m in height and the effective water head is he = 50 m, approximate 10,000 kW of output could be generated as shown in the equation below.

$$\rho g Q he \ \eta_1 \eta_2 = 9.8 \times 25 \times 50 \times 0.85 \times 0.95 = 10,000 \text{ kW}$$

where, η_1 is the turbine efficiency, η_2 is the power generating efficiency. If the demand for irrigation water diminishes, the average power generating potentiality increases, and subsequently the peak power generation can be further increased, say, to around 30,000 kW. At that time, power generation of about 30,000 kW in potentiality was reported, and this is considered to be reasonable. In any case, estimation of the maximum and mean power generating potentiality will require considerable studies of hydrologic data, and further studies are to be considered at the stage of drafting the master plan. Also, the power generating potentiality under practical planning should be taken into account according to the future development of the basin.



By. 1 : 50,000 map.

Fig. 1-18 Walanae River Reservoir Storage Capacity Curve (Mong Dam)

1.2.3 Improvements of the Lake Tempe

The improvements of the Lake Tempe is consisted of constructing a gate near its outlet and shifting the River Walanae to the downstream in order to decrease the reversed flow from the River Walanae into Lake Tempe during the flood season and to prevent water level dropping in the Lake Tempe during the dry season.

The benefit of this plan would be not only to lower the water level of the Lake Tempe during the flood season and decrease flood damages, but also to increase planation area and decrease sedimentation in the Lake Tempe from Walanae. Moreover, the closure of the gate during the dry season will keep the lake's water level high and recover inland water fishery.

However, large water conservancy effects can not be expected from by carrying out this plan independently. In other words, it will not effectively prevent the flow from reversing into the Lake Tempe in view of the current channel conditions of limited capacity of the River Cenranae and overflowing of the River Walanae from the both banks becoming a flooded area connecting to the Lake Tempe, at the downstream reaches during floods.

If embankment is adopted for preventing the reversing of the flow from the downstream reaches of the River Walanae into the Lake Tempe, floods in the River Walanae and also in the River Cenranae can be intensified. At the same time, the water level elevation in the Lake Tempe due to the River Bila and other rivers that directly flow into the Lake Tempe would not be neglected. Water level drop in the Walanae river due to the short-cut by constructing a diversion channel is considered to be extremely small.

This plan will prove extremely effective if carried out in relation with the expansion of the River Cenranae's channel capacity and the construction of a multi-purpose dam. Therefore, a master plan must be drawn and its position within the master plan must be clarified, first.

This plan should obviously be carried out since it has such various advantages as dry construction of structures and simultaneous confluence improvements. Therefore, this plan can be started soon after the completion of a master plan, having the objects for maintaining the water depth and the surface area of the Lake Tempe for inland fishery and irrigation water.

With regard to the plan for this diversion channel, the large angle of the water supply channel to the Lake Tempe will present no problem, except local river-bed fluctuation. The type and the rate of sediment transport and its size in the River Walanae during flood and normal flow conditions must be studied sufficiently. Gate operation is considered to have some difficulties with water level difference between up and down stream of the gate. Therefore, the problems of the channel maintenance around the gate and its control should also be considered at the same time.

It will not be so easy to expand the channel of Cenranae at once that the flood control ability of the Lake Tempe would be necessary to be maintained and used in the immediate future. The water level of the Lake Tempe during a wet season is very important to be kept at some high elevation in order not to decrease the surface water slope of flood flow in Cenranae and to increase the channel capacity for a flood. In other words, channel capacity for a flood is studied to be determined from the view point of combination of slope, enlargement of width and dredging. Therefore, the upper and the lower limit of the water level of the lake is not so easy to be determined. In this case, the inland fishery, the irrigation capacity, flood hydrograph and also the channel capacity of Cenranae must be considered at the same time. The construction of a lake embankment might also be studied in the future in the relation to the above matters.

1.2.4 Soil Conservation

With regard to the surface erosion in the basin, studies from the view points of erosion control engineering and afforestation etc. are desirable to be carried out next time by the specialists, since the prevent investigation could not cover this field sufficiently.

Bank erosion control works may be limited to large curves and confluences where erosion presents some special problems. Improvement works of two large scales will give some bad effects on the upstream and the downstream. Therefore, light structure such as rubble-mound, wood piles or similar short groyne works is recommended.

Navigation in the Cenranae estuary will be automatically facilitated by the estuary improvement works. The dredging works the unification of branch channels in the delta, enlargement of width, and also installation of auxiliary structures such as a training dyke, which are proved to be necessary for controlling floods in Cenranae, will increase and maintain the water depth and tidal flow even in the dry season. Therefore, navigation will become possible in all seasons.

The problem of the sedimentation in the Lake Tempe will also be solved. In other words, the water level of the Lake Tempe during floods will be lowered by expanding the channel section of the River Cenranae and constructing a multi-purpose dam. Consequently, flood inflow into the Lake Tempe will decrease and sedimentation in the lake will also decrease.

The previous sedimentation in the lake will also be partly replaced by the sedimentation that is promoted in the reservoir to be constructed in the upstream.

In sum, soil conservation problems would be investigated both qualitatively and quantitatively and adequate measures must be studied in consideration of the balance in the entire basin.

1.3 Investigations for Drawing Master Plan

The necessary basic investigations for drawing master plan must be started immediately along with the investigation of the irrigation plan etc. On the upstream area of which master plan is not needed, it is possible to start the actual investigation. The following is the necessary basic data for drawing master plan.

1) Collection of the hydrologic data
   Data on water level, discharge, amount of rainfall and evaporation.

2) Topographic map, longitudinal and cross-sectional survey map of rivers

3) Geological data on the possible dam construction sites

4) Hydraulic calculation

5) Other data

1.3.1 Collection of the Hydrologic Data

(1) Data on Water Level and Discharge

1) Current Conditions

The efforts have just been begun to improve the water level observation facilities in the river district of the basin. There are five automatic recording water level observation stations including the one currently under construction. However, sufficient data are not obtained at the current stage.

As for the data on water level of the river mouth, according to the information by the Indonesian Naval Hydrographic Office, there are three gage stations in Bone bay, i.e. Take Bone Rate, Kadjang, and Kolaka.

However, the observation results at these stations are unknown yet.

With regard to the water level of the Lake Tempe, it is quoted in the report by Waskita Karya there are the data measured by the Fishery Service. These data are very useful while they do not give a clear relation with Bench Mark.

No discharge datum is currently available except that on a few small tributaries.

2) Consolidation Plan

The basic data are not able to be obtained enough under the observatory measurements of the basin shape and its size. From this investigation I propose the consolidation plan as Fig. 1-18 shows. Since their location depends on the map, it must be adjusted well enough after studying various conditions of channel, necessary traffic routes for observation, employment of field staff etc. in the future field investigations.

Nine automatic recording water-level gauge stations including one tidal level gauge station and eight staff gauge stations should be established in addition to five existing stations.

Discharge data is also necessary to be obtained at these gauge stations in order to know H-Q relation except the lake water-level and the tidal level observation spots. At the same time, the observation of the flooded area is also recommended.

It is considerable to install the staff gauges for two regular observations in morning and evening until a recording water-level gauge station is established if the construction takes long time. These staff gauges are to be left even after installation of the automatic gauges because it keeps to work correcting records or complementing some missing data.

(2) Rainfall Data

1) Current Condition

There are about one hundred rainfall gauge stations in South Sulawesi, and thirteen stations in the basin. The older ones among them were constructed at the beginning of this century.

Daily rainfall gauges of 100 cm^2 in the opening mouth are used for observation. The records are first arranged by the local government, and then gathered by the Institute of Meteorology and Geophysics. The records are published yearly as monthly rainfall records.

We can get the daily rainfall records either at the above-mentioned Institute of Meteorology and Geophysics service or at the local government who keeps the original copy. Data are partly collected also at the Institute of Hydraulic Engineering in Bandung.

The river team could not investigate about the period of available daily rainfall data, any missing data and conditions at the stations because of time limit.

2) Consolidation Plan

In view of the rainfall distribution in the basin and the basin scale etc., only the existing stations are insufficient for drawing a master plan. The Fig. 1-19 shows the proposed improvement plan. In this case as the location depends only on the map too, it must be adjusted after studying various conditions by field investigation.

This plan proposes the construction of eighteen new recording rainfall gauge stations for the purpose of collecting hourly rainfall data for flood analysis. Even if the proposed location of a station overlaps with the position of the existing station, observation must be continued under this condition at least until the completion of the master plan because that it would be a help in case of

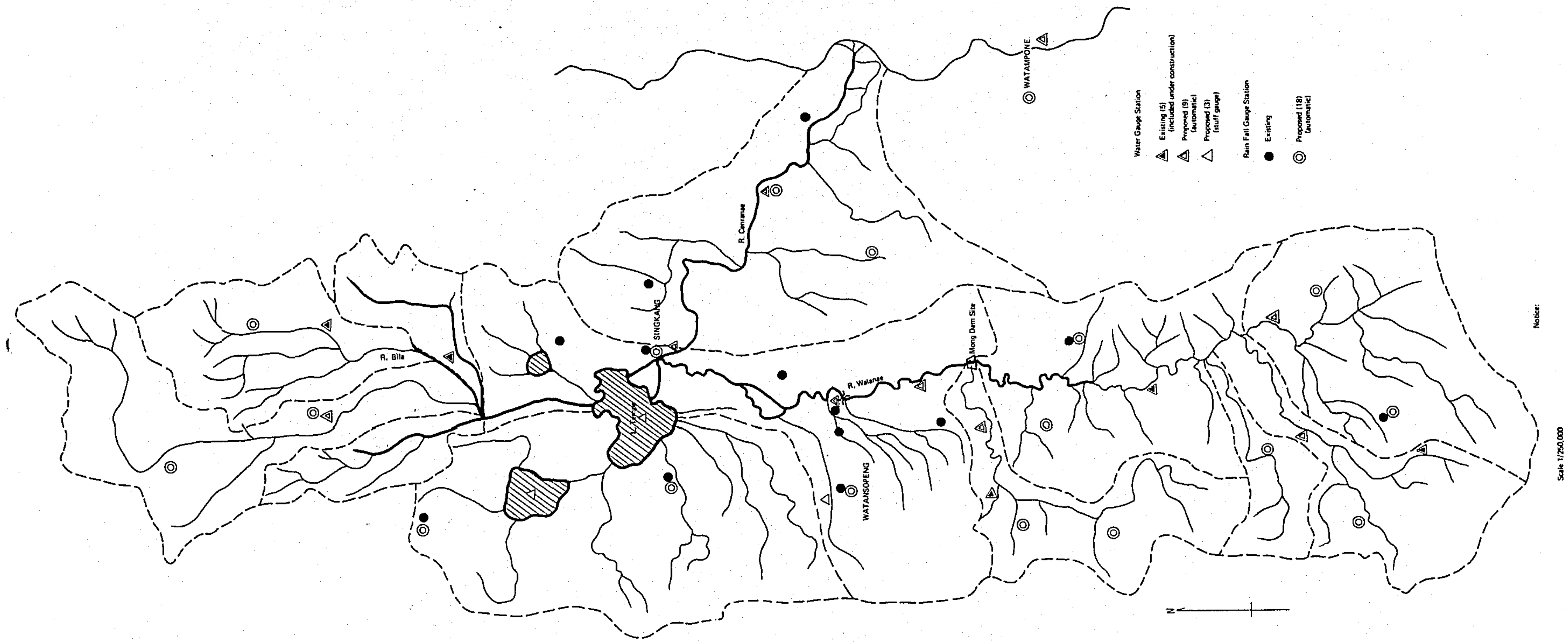


Fig. 1-19 Proposed Location of Water Level Gauge Stations and Rainfall Gauge Stations

missing observation . Also as the daily rainfall records that accumulated for many years are necessary for calculating flood occurrence probability and for determining designed high-water discharge, the all existing data must be collected and ready for use if an occasion arises. The hourly rainfall data obtained at the newly established stations are to be used for analyzing the relation between rainfall and run-off.

(3) General Meteorological Observation Stations

Since three capitals of Sengkang, Watampone and and Watansopeng are geographically favored, it is necessary to establish a general meteorological observation station that can make observation of all possible regional meteorologic conditions including the above-mentioned recording rainfall gauge station for rainfall, atmospheric temperature, humidity, insolation, evaporation, wind direction, wind speed, etc.

These data will also give a great advantage in investigation of the regional agriculture and each industry besides the river planning.

(4) Observation of Marine Meteorology at the River-mouth

Those observations of the sea-bottom topography and quality near the river-mouth and wave phenomena such as wave height and wave direction are inevitable for the study of river mouth treatment works.

1.3.2 Topographic Map and Longitudinal and Cross Sectional Survey Map of Rivers

(1) Topographic Map

1) Current Conditions

As existing and available topographic maps of this area, there are those reduced of 1/50,000, 1/125,000 and 1/250,000 etc.

When we use those maps, the important parts must be modified by actual field investigation as there are some different parts from the current conditions and also there are some parts missing.

The aerial photographs of 1/20,000 will be carried out probably by FAO. Although they were impossible to use for practical during the present investigation, they will provide some important informations for the master plan.

The marine chart is available for information of the area near the river-mouth. Although this chart is old (surveyed in 1904), it will give some valuable informations on the river-mouth sedimentation, the river channel change etc. compared with the current conditions.

As stated in the item on the irrigation plan, the tophographic map of 1/5,000 is restricted to a certain district only.

2) Improvement Plan

Some sufficient basic data for a master plan can be obtained by using the existing topographic maps and adding supplementary information by field investigation and aerial photographs. However, the topographic maps of 1/5,000 - 1/10,000 are necessary for the area around the Lake Tempe and for the dam construction sites. (Photo maps with contour lines could be substituted).

The contour lines for the Lake Tempe and the surrounding area must be based on an accurate levelling related to the bench mark since their unevenness difference is small.

With regard to the possible dam construction sites, the maps around a dam site and a reservoir are necessary and they are also used for geological investigation, drawing the H-V curve of the reservoir and submerged district study.

(2) Longitudinal and Cross Sectional Survey Map of Rivers

1) Current Conditions

Longitudinal and cross-sectional survey map of rivers must be drawn by future investigations. But the cross sectional shape of the upstream reaches of theRiver Cenranae is partly described in the Waskita Karya.Report. Some old bench-marks still remain.

2) Improvement Plan

Longitudinal and cross-sectional surveys covering the entire Cenranae and the downstream part up to Mong dam site of the River Walanae are necessary for drawing a master plan.

Cross-sectional survey is to be carried out at intervals of about 1 km and it should desirably include sounding in the river channel and also surveying of the land as much as the river channel width on the both banks.

In the cross sectional survey spot, the concrete or stone distance marks should be installed at one bank of the river channel, because it works as the position of cross sectional survey and its height basis. Furthermore, their altitudes are to be measured correctly as the heights from the mean sea level.

These distance marks are to be used for drawing a river profile and as the bench marks in various basin investigations from now on.

Although it should be necessary to explain about the height basis of these distance marks in connection with the existing bench marks, for the immediate future, it is recommended to install a basic bench-mark for a master plan near Watam-pone and to relate its height basis with the tidal level observation station to have been newly contructed near the Port Bojoe.

1.3.3 Geological Investigation of Dam Construction Sites

Possibility for dam construction is an extremely important question for drawing a master plan. Therefore, geological investigations would be better to be started on as early as possible by specialists with knowledge and experiences in dam construction survey.

The geological map of South Sulawesi drawn by the Directorate of Geology in Bandung will prove helpful.

A geological map of 1/5,000 - 1/10,000 is necessary to be prepared before the field investigation by geologists. If no geological map is available, an enlarged aerial photograph can be used as a substitute. In this case, some geological measurement will be necessary.

It is reported that the earthquake zone of the River Walanae is restricted to the upstream part. It should desirably be checked to get general information, if necessary.

1.3.4 In the Hydraulic Calculations

In investigation of the rivers and its basin this time, a few methods of hydraulic calculations are adopted. But as these are only just the approximate calculations, the precise calculations are necessary for drawing a master plan as follows.
As for computer IBM 360 (16K, 3 punchers) at the Ministry of Public Works and Electric Power can be used.

1) Flood Run-off Calculation for Verification

The storage function method based on rainfall and flood observation may be applicable for run-off calculation to determine the constants. The data of a few large floods are required for verification. The storage function method seems to be applied to this basin. There seems no use for applying any other method such as the unit-hydrograph method.

2) Reverse Calculation of Roughness Coefficients

Toughness coefficient is calculated reversely by non-uniform flow calculation based on flood observation of discharge and longitudinal water level.

3) Setting of designed rainfall

4) Designed discharge hydrograph is obtained by run-off calculation.

5) Statistical analysis of flood occurrence including the analysis of designed rainfall.

6) Several designed channels for the River Cenranae are set for non-uniform flow calculation.

7) Unsteady flow calculation

Unsteady flow calculation for the downstream reaches of the River Cenranae at normal time and unsteady flow analysis of the entire water system including the Lake Tempe shall be carried out. This will provide the data for studying designed maximum water level of the Lake Tempe.

8) Sediment run-off calculation

Measurements of river-bed materials, sediment size, pattern and rate of sediment transport are necessary to study the sediment formula, which will be applied for practical computation.

9) River-bed fluctuation calculation.

10) Estimation of graded stable river channel

1.3.5 Other Investigations

Additionally, the following investigations must be carried out concurrently with preparation of the master plan.

1) Inundation data during the flood season of flooded area, water depth, inundation period, and damages.

2) The condition of land uses in the basin.

3) Investigation of sediments, river-bed materials and rate of sediment transport at several stages during a flood and ordinary flow period.

4) Investigation of the total sediment run-off and sediment settling in river-channel, swampy area, the Lake Tempe, and of estuary.

5) Investigation of meandering and historical changes of the meandering characteristics

6) Soil conservation works (saboh works) and afforestation plan

7) Flood forecasting system

8) Operation standard of structures such as gates at dam and diversion channel.

9) Prediction of run-off ratio change due to development

10) Embankment plan (probably at the last stage, except some local plans)

11) It will be sufficient to consider model test experiments just before making a work plan.

12) Investigation of the techniques and materials for works.

13) Training of river engineers

1.3.6 Period and Staff Required for Preparing a Master Plan

The period that is required for drawing a master plan mainly depends on the availability of various data. A rough estimate is given below.

The First Year

(1) Construction and improvement of hydrological observation stations

(2) Collection of existing hydrological data and their analysis

(3) Collection of topographical maps, comparison with field observation, longitudinal and cross sectional survey of rivers

(4) Other investigations

The Second Year

(1) Continuation of the first year's investigations

(2) Study of the basic problems related to a master plan

(3) Geological investigation of the dam site

(4) Others

The Third Year

(1) Continuation of the first year's investigation

(2) Completion of a master plan

For these investigations, it will be required two well trained river engineers (3 years), one senior river engineer (3 months), one dam geology engineer (3 months), one soil conservation engineer (3 months), one afforestation engineer (3 months), one boring engineer (3 months) and three survey engineers (6 months). It is desired that Indonesia should provide similar staff (at least the same number and period.) Some boring workers and survey workers should also be employed.

1.4 Conclusion

The Cenranae water system consists of the Lake Tempe located at the center, the River Walanae and the River Bila which flow into the lake and the River Cenranae which flows out into the Bay of Bone.

It is considered that each river in the upstream from the Lake Tempe has a flood for three to seven days. The channel capacity of the River Cenranae is so small that the entire water system depends on the flood control capacity of the Lake Tempe. While the fertile land was forming in the low swampy land around the Lake Tempe, flood condition in the Lake Tempe was much suffered hydraulically from the rising during a long period of one to three months. Furthermore, the post-war deforestation in the upstream area especially of the River Walanae promoted the destruction of the river basin and caused heavy sediment run-off. This destroyed the previous sediment balance, and brought river-mouth closure and sedimentation in the Lake Tempe. Consequently, the frequency and scale of floods have increased in the low swampy land around the Lake Tempe. The residents are obliged to have the inconvenient life for a long time due to the water level elevation during the rainy season.

To improve these conditions, the partial repairing should be avoided, but the systematic way of the plan should be taken throughout a whole area. Shortsighted repairing inevitably causes some distortion in the upstream and the downstream and presents some difficulties to subsequent treatment.

Sudden change of a river often brings about undesirable results. No river planning can be perfect.
Since some unpredictable natural phenomena occur, rivers should not be changed suddenly. A large disaster would occur if the natural balance is lost. If there are not enough data of the river, a long term plan should be taken under the long term observation depending on the progress of development.

The initial determination of general direction is extremely important for river improvements. The general direction proposed of development in this report is based on above basic idea. These works are of an extremely large scale. So profound study should be taken in progress of works. And the basis for them is a vision and data.

Since a river planning constitutes the basis for the water resource development plan, much efforts must be started as soon as possible to obtain basic materials.

2. Agriculture and Irrigation

2.1 Current State of Agriculture

2.1.1 Agriculture

(1) Natural Conditions

The region under the investigation is in lat. 4° - 5°S and long. 125°E. Located at the middle of South Sulawesi State, it is in a tropical zone and is under the influence of monsoons. A vast plain is formed around Lake Tempe. It is the agricultural center of South Sulawesi State.

1) Site Conditions

Lake Tempe is located almost at the center of the region under the investigation. Lake Sidenreng and Lake Buaya are located in the north west and in the north of Lake Tempe, respectively. These three lakes join to form one lake with large surface area during the high water season. The surface area of the lake decreases sharply during the dry season, when so-called lake field appears around the lake.

Lake Tempe is surrounded by mountains on the north, the west and the south. They form gentle hills and slopes toward the lake. A vast plain is found toward the Bay of Bone in the south east.

The following rivers flow into Lake Tempe. In other words, River Bila from the northern mountain flows into Lake Tempe, River Walanae from the southern mountain goes up north, while gathering many tributaries is used for agricultural purposes.

Since the gradient of River Cenranae is extremely small, it overflows on the both banks in the mid-stream during the high water season. As a result, a vast swampy zone is found along the river. The slopes of the mountains are used as burned field but left alone subsequently. Some of these districts show desolation by Alang-alang and soil erosion.

2) Meteorological Conditions

As stated in the item on Site Conditions, the region under the investigation does not have uniform meteorological conditions. Meteorological conditions differ among the mountains, the hills, the plain. They also differ between the north and south. Therefore, the meteorological conditions are quite complicated in this region. Generally speaking, it has a wet season and a dry season due to the effects of monsoons. It has a tropical weather characterized by relatively high temperature throughout a year and small diurnal temperature variation.

The amount of rainfall has the largest effect on agriculture in this region. In the plain area, Bone (Watam pone) has the largest amount of rainfall (2,000 - 2,500 mm). It is followed by Soppeng (Watan soppeng, 2,000 mm) and Wajo (Sengkang, 1,500 mm). The monthly rainfall also varies among districts. The plain area has a large amount of rainfall in March - July, but less in August - February. The mountain in the upstream of River Bila has a wet season in February - June, while the mountain in the upstream of River Walanae in the south has a wet season in December - February. Intensive rainfall, unique to a tropical zone, was often found during the investigation. This indicates that rainfall may be maldistributed even during a wet season. The number of rainy days and the amount of rainfall are expected to fluctuate considerably by years.

In this region, the air temperature changes little throughout a year. The maximum air temperature is 29°C - 32°C, the minimum air temperature is 22°C - 24°C, and the mean air temperature is around 26°C - 27°C. The inter-diurnal temperature change is small. The pattern of diurnal temperature variation remains almost unchanged throughout a year. The air temperature drops as much as 5°C - 6°C at rain.

The diurnal variation of humidity is large. It is between 60% and 90% (measured at 9 o'clock), though it also shows monthly changes.

The amount of evaporation is unknown since data at various places are not available. Daily evaporation is large during the dry season and small during the wet season. The agricultural production in this region is influenced by these meteorological conditions. The kinds of crops and the cropping season are also determined by meteorological conditions.

3) Soil Conditions

The soil conditions of the region under the investigation are closely related to these site conditions and meteorological conditions. The soil conditions in this region can be concluded as below according to the data at the Institute of Soil Research, Bogor and the result of the present field investigation.

In Fig. 2. 1-2, soil is classified by altitude. Soil conditions are classified into mountain type, hill type, terrace type and plain type. The Institute of Soil Research classifies the province of Sulawasi into I-VII zones by soil fertility (Fig. 2. 1-3). The I - V zones are considered good enough for crop production. The mountains and the hills in the upstream of River Bila and River Walanae have low soil fertility, while the hills along Lake Tempe and on the right and left banks of River Cenranae have slightly low soil fertility. On the other hand, the area in the downstream of River Walanae and River Bila and the basin of

River Cenranae have the highest soil fertility.

Fig. 2.1-4 and Fig. 2.1-5 show soil distributions. Viscous alluvious soil is found in the gentle slopes in the downstream of these rivers, in the plain and around the lake. Sandy soil with small clay content is found in a part of the gentle slopes in the downstream of River Bila. The alluvial soil in the plain generally has small content of organic matters. It is heavy and viscous and solidifies, when dry. It has a single grained structure and poor physical properties.

The following table shows the result of the acidity study of the plain within the region. The investigated districts had low acidity (around PH 5, 6). The clay content and the humus content were found to differ among districts. These districts require thorough investigations in the future.

The soil conditions of the hills and mountains were not investigated. Hower, they have mediteran or Latosol soil, as Fig. 2-1-6 shows. They are often inadequate for crop cultivation because of low soil fertility and low acidity attributable to base dissolution by rain.

The soil of upland fields has slightly less clay content and often is gravelly. Upland fields are generally characterized by acidic soil with small base and humus content, shallow arable soil and low productivity. Thorough investigations must be carried out in the future.

No.	Sample taken at	Paddy field or upland field	PH	Soil Color	Clay Content	Humus content
1	Wajo, Amasangang	Paddy field (dry)	6. 4	Brown	Small	Large
2	Wajo, Labuangpatu	"	5. 4	White gray	Small	Extremely small
3	Wajo, Burumatajina	"	5. 4	"	Small	Small
4	Wajo, Lamalusa	Upland field	5. 6	Black	Small	Small
5	Soppeng Tadunijulabalo	Paddy field (Wet)	5. 6	Graish black	Large	Small
6	Soppeng Langkamal Kahpiri	"	5. 4	Yellowish brown	Large	Medium
7	Sidrap Lasijotongriawa	Upland field	5. 4	Blackish brown	Small	Small
8	Sidrap Samalangiz	Paddy field (Wet)	5. 6	Graish brown	Large	Medium
9	Bone, Paodjowa	"	5. 4	Light yellowish brown	Medium	Medium
10	Bone, Adjalirang	"	5. 4	Red yellowish brown	Medium-small	Large

No.	Sample taken at	Paddy field or upland field	PH	Soil Color	Clay Content	Humus content
11	Bone, Tobeku	Paddy field (Wet)	5.4	Brown	Large	Small
12	Bone, Timurang	Paddy field (Semi-wet)	5.6	Blackish muddy color	Medium	Small
13	Soppeng Lapabelo	Paddy field (Wet)	5.6	Blackish brown	Large	Large
14	Soppeng Tjangaa	Paddy field (Wet)	6.6	Blackish brown	Large	Large
15	Wajo Sampo	Upland field	5.6	Yellowish brown	Medium	Medium
16	Wajo Tempe	Lake bank	5.8	Black	Medium - small	Large

(2) General State of Agriculture

Within the region under the present investigation, 75% and 88% of the total population are engaged in agriculture in Kabupaten Bone and Soppeng, respectively. In other words, most of the residents are engaged in agriculture. The plain area inoluding gentle slopes is mostly used as paddy fields. Although paddy rice is cultivated during two seasons (wet season and dry season), most crops are obtained during the wet season due to extremely poor irrigation. Upland fields are found in mountains and hills with poor water conditions, in the lake field and around houses. Maize is the major crop. Cash crops, such as coffee and tobacco, are also cultivated. Seri-culture is also found locally.

Each farm household manages land of 1 - 2 ha in this region. However, the yield per unit area is low because of low land productivity, primitive cultivation techniques and low morale among farmers. Farmers are not generally well off. Natural pasturage is used exclusively for livestock raising. Farmers use an extremely small number of agricultural machineries and do most works manually. The following section describes rice cultivation, upland crop cultivation, livestock raising, agricultural implements etc. in this district.

1) Paddy Rice Cropping

Rice is planted in the gentle slope land and the plain area in the basin of the main stream and the tributaries of River Bila, River Walanae and River Cenranae. Cropping season are classified into wet season cropping and dry season cropping according to planting time. Two cropping can be obtained per year. The planting time of wet season crop and dry season crop depends on regional meteorological conditions (especially, the amount of rainfall) and varieties. In Kabupaten Soppeng, March - September are used for wet season crop, while October - March for dry season crop. As Table 2-1-1 shows, crops are roughly classified into wet

Table 2-1-1 Period of Paddy Rice Cultivation
(Kabupaten Bone)

Kecamatan	Wet season cropping		Dry season cropping	
	Seeding time	Harvesting time	Seeding time	Harvesting time
T. Riattang	Mar. - May	Aug. - Oct.	Oct. - Nov.	Feb. - Apr.
Palakka	Apr. - Jun.	Aug. - Sep.	Nov. - Dec.	Mar. - Apr.
Ulaweng	Apr. - May	Aug. - Sep.	Nov. - Dec.	Feb. - Mar.

Data obtained at Agricultural Improvement and Extension Office in Bone Prefecture (Feb. 1974) season crop and dry season crop also in Kabupaten Bone but difference is found 2 - 3 months in seeding time and harvesting time are found.

Table 2-1-2 shows the planted area and harvested area, in 1973, in individual Kabupaten within this region.

The table shows that the planted area and the harvested area of wet season crop are large, while those of dry season crop are extremely small in all of the three Kabupaten. The ratio of wet season crop and dry season crop in terms of planted area is as shown below.

Kabupaten Wajo	96 : 4
Kabupaten Soppeng	59 : 41
Kabupaten Bone	85 : 15

The ratio of dry season crop is extremely small in Kabupaten Wajo and Kabupaten Bone since rice planting depend mostly on natural rain (rain fed paddy fields) in these prefectures. Irrigation with river water is rarely used.

Table 2-1-3 shows the irrigated area in these Kabupaten. The data were obtained at the Agricultural Improvement and Extension Office.

Table 2-1-2 Paddy Rice Planted Area and Harvested Area, 1973

Unit: ha

Prefecture	Wet season cropping		Dry season cropping		Total	
	Planted area	Harvested area	Planted area	Harvested area	Planted area	Harvested area
Wajo	63,269	52,966	2,303	59	65,572	53,025
Soppeng	21,242	15,261	14,582	9,000	35,842	24,261
Bone	75,521	65,092	13,803	2,969	89,324	68,061

Data obtained at Agricultural Improvement and Extension Office in Kabupaten Wajo, Soppeng and Bone.

Table 2-1-3 Irrigated Area in Individual Kabupaten
(Unit: ha)

Kabupaten	Season	Irrigation Method			Rain fed paddy field	Others	Total
		Technic	Semi technic	Villag			
Wajo	-	-	-	2,150	67,046	-	69,196
Soppeng	Wet season	2,000	3,600	7,995	6,950	1,147	21,692
	Dry season	700	650	2,010	17,185	1,147	21,692
Bone		7,474	5,150	3,634	59,179	205	75,437

Data obtained at Agricultural Improvement and Extension Office in the three Kabupaten.

The irrigated area is small in these Kabupaten. It means that most paddy fields are fed with natural rain. Although simple irrigation facilities are used in all the Kabupaten, the technically irrigated area is small. This is the major reason for unstable rice crop in this region. During the present field investigation, the members found the use of technical irrigation for dry season rice plantation only locally in the downstream of River Lawo and River Langkemme (tributaries of River Walanae), in the downstream of River Bila and a tributary of River Cenranae.

Under the food production increasing plan (Bimas plan), the Indonesian government has designated some districts and distributed paddy rice seeds, fertilizers and agricultural chemicals to promote the production of paddy rice. A similar plan (Inmas) has also been promoted by farmers themselves. The districts that come under these plans in 1973 are as shown below in terms of area.

Kabupaten Wajo	Bimas area	10, 000 ha
	Inmas area	3, 000 ha
Kabupaten Soppeng	Bimas area	6, 154 ha
	Inmas area	1, 404 ha

They are equivalent to 10 - 15% of the total paddy rice planted area. These figures as well as the figures of irrigated area indicate rather low morale for paddy rice cultivation among farmers.

The paddy rice varieties that the cultivated in this region are shown in Table 2-1-4 in terms of cultivated area and ratio (1973) in Kabupaten Bone and Kabupaten Wajo.

The ratio of improved varieties has been increasing in Kabupaten Wajo. The local variety is still cultivated in the districts other than the Bimas district. This indicates that the cultivation area of the local variety is considerable large.

Table 2-1-4 Cultivation Area by Varieties and Ratio

Variety	BONE		WAJO
	Cultivation area (ha)	Ratio in plantation (%)	Ratio in plantation (%)
Local variety	18,246	23.7	23.0
UNGGUL NAS	28,775	37.4	-
PB 5/8	26,398	34.3	64.0
PELITA I/II	3,608	4.6	3.0
C_4 - 6_3	-	-	2.0
Improved Bogor variety	-	-	8.0

Data obtained at the Agricultural Improvement and Extension Center in Kabupaten Wajo and Bone.

Among the improved varieties, PB-5, PB-8, PELITA I & II are weak to Tungro and have not be well adopted by farmers. No sufficient consideration in local adaptability, especially in diseases and injurious insects, has been made with the efforts to introduce improved varieties.

The seeding time of paddy rice is determined by local meteorological conditions, as stated before. Currently, seeds are planted over a long period. When irrigation is introduced in the future, a local water management system must be established for concurrent seeding. Manual transplanting method is exclusively used for rice cultivation. No direct seeding cultivation is found in this region. Long strip type irrigated rice nursery system is generally used. However, their width and shape lack uniformity. Generally speaking, the amount of seedling tends to be rather thick since rainfall is assumed after seeding. The adequate nursery period is between 20 days and 25 days, though it differs among various varieties. Approximately 25 cm long seedlings with 5 - 6 real leaves are said to be the best for transplantation. Currently, the nursery period is between 40 days and 50 days. About 50 cm long seedlings are often cut to transplant their tip. This practice should be corrected quickly. On the other hand, rain fed paddy fields have high balks and footpaths (45 - 50 cm) to keep rain within the fields since the water depth is large at the time of transplantation, this practice may be unavoidable under the current conditions.

Either human labor or animal power (cattle, buffalo) is used for plowing and puddling paddy fields. Small spades are used for plowing as deep as 15 cm. Fields are puddled and made quite carefully to increase their water keeping ability.

Seedlings are transplanted by manual works, alone. A square plantation system (25 cm x 25 cm) is adopted in the Bimas plan district. The other districts have the tendency for thin planting (35 cm x 35 cm, 3 - 4 seedlings per stand). The optimum planting density is determined by the amount of fertilizer, soil fertility and varieties. Planting density should be studied for each district, since yield can be effectively increased by increasing the number of stands per m^2.

Within the Bimas plan district, 100 kg - 150 kg of urea and about 50 kg of triple superphosphate are used per ha as fertilizer. No potassium fertilizer is used. One half of urea and all of triple superphosphate are fed as basal dressing, then the remaining half of urea is fed as top dressing at the young panicule formation stage. Fertilizers are extremely effective in this region, but are expensive. Therefore, either a small amount of fertilizer or no fertilizer is used for paddy fields in the districts not under the Bimas plan. In the case of continuous flowing irrigation, fertilizers are not efficiently absorbed by soil, but are washed away. Therefore, good water management is an important condition. Paddy rice grows well from the initial stage through the middle stage due to high atmospheric temperature. However, root decay occurs at the final stage because of the lack of fertilizer or the lack of oxygen due to deep water. Therefore, it is recommended to feed one third of fertilizer at the initial stage, to use the remaining three fourths at 10 - 12 days after rice transplanting and the young panicle formation stage, and then give top dressing during heading time.

Management works consist mostly of weeding by manual works. Water management and disease and insect prevention are carried out in some districts alone.

Damages on paddy rice from diseases, injurious insects, drought and floods are extremely large.

Table 2-1-5 shows the causes of damages on paddy rice and the damaged area in 1973 within the three Kabupaten. Table 2-1-6 shows the damaged area (paddy rice) in 1968 - 1972.

Rice-stem borers, field rats and Tungro give large damages every year, while flood and drought damages tend to vary. Drought seems to account for the largest damages in 1972. Therefore, stable water supply is an essential condition for avoiding damages in this region. Damages by field rats can probably be avoided by establishing a systematic cropping system for paddy rice and adopting low land-upland conversion system in the future. Damages by Tungro and bacterial leaf blight etc. can be decreased by introducing varieties with large disease resistance and by restudying local varieties.

Sickles or aniani are used for manual harvesting. Ears are thrashed by feet or by hitting against a tree. No thrashing machine is used. Natural drying method is used. Natural wind power is used for preparation. Rice hulling and grain cleaning works are usually carried out by women with a mortar and a wooden pestle.

Table 2-1-7 shows the average yield (1968 - 1972) of paddy rice per ha. The yield changes by years, seasons and regions. However, the yield in this region is generally low.

Table 2-1-5 Damaged Area (Paddy Rice) (1973)
(Unit: ha)

Cause	Wajo Prefecture	Soppeng Prefecture	Bone Prefecture	Remarks
Rice stem-borer		3,166	7,362	Wet season crop is marked with *
Field rat		5,824	6,213	1. Data of Kabupaten Soppeng are of April, 1973 - April 1974.
Bacterial leaf blight	*1,529 179	608	219	2. The figures of Kabupaten Soppeng and Bone include wet season and dry season crops.
Tungro		978	3,577	
Pink borer		-	-	
Flood	*8,474	4,553	13,610	
Drought	156	-	-	

Data obtained at Agricultural Improvement and Extension Center Office in Kabupaten Wajo, Soppeng and Bone.

Table 2-1-6 Damaged Area (Paddy Rice) 1968 - 1972
(Unit: ha)

Kabupaten	Season	1968	1969	1970	1971	1972
Bone	Wet season	3,554	2,615	1,469	2,718	45,261
	Dry season	6	124	173	5,949	273
Wajo	Wet season	3,006	12,427	8,083	4,441	25,577
	Dry season	-	262	62	4,207	3,077
Soppeng	Wet season	1,211	1,441	1,013	264	11,945
	Dry season	-	46	-	2,491	994

Data obtained at Agricultural Improvement and Extension Center Office in Province of South Sulawesi.

Table 2-1-7 Average Yield of Paddy Rice (kg/ha)

Kabupaten	Season	1968	1969	1970	1971	1972
Bone	Wet season	2,095	1,993	2,791	2,192	1,340
	Dry season	1,954	2,430	1,915	2,640	3,829
Wajo	Wet season	3,012	2,654	3,401	2,843	2,096
	Dry season	-	2,514	1,213	1,713	2,077
Soppeng	Wet season	3,144	3,271	3,406	4,053	2,733
	Dry season	3,088	2,383	3,000	3,928	2,889

Data obtained at Agricultural Improvement and Extension Center in the Province of South Sulawesi.

Note: Kering giling

The low yield rate is attributable to poor soil properties, the properties of varieties and seedlings cultivation density, fertilizing, diseases and injurious diseases, floods, drought etc. These factors are basically related to the poor irrigation system in this region. It is also important to improve the fertilizing method for preventing decay at the final stage of growth, for increasing the assimilation of blades for higher ripening ratio, and for increasing the percentage of ripened grains as a result.

2) Upland Cropping

The entire upland cropping could not be covered during the present investigation due to the time restriction and inadequate road conditions. However, a brief picture of the situation was obtained from the data available at the Agricultural Improvement and Extension Center Office in South Sulawesi Province and in the three Kabupaten, from the data available at the Institute of Soil Research, Bogor, from the information obtained from farmers, and from the field investigation. The results are summarized below.

Table 2-1-8 shows crops and planted area (1971 - 1973) in the three Kabupaten. Among the crops of upland field maize accounts for the largest cultivation area.

Maize is cultivated inburned fields in mountains, on hills, around houses, near paddy fields and Lake Tempe either as a complementary crop of paddy rice or as a cash crop. The local varieties (Baku baku, Dadi) of white flint corn (hard grain variety) alone are currently cultivated. (Dadi is called as Gading in Soppeng and Wajo Kabupaten). Although some traces of the yellow varieties remain, they are not cultivated currently. No improved variety, such as hybrid varieties, is cultivated. Since the local varieties grow in 70 days - 75 days, three croppings can be obtained yearly. The local varieties have grains arranged in 12 - 14 rows, 10 - 15 cm long ears, (See the photo). rather thick rachis and small grains.

Table 2-1-8 Planted Area of Upland Crops
(Unit: ha)

Kabupaten Year / Crop	Kabupaten Wajo			Kabupaten Soppeng			Kabupaten Bone		
	1971	1972	1973	1971	1972	1973	1971	1972	1973
Upland rice	5,784	3,750	2,042	1,333	1,232	1,355	9,824	7,042	8,627
Maize	6,604	43,635	46,790	26,750	51,844	10,316	36,722	74,610	83,884
Cassava	3,212	4,098	4,496	188	251	207	1,141	2,670	3,897
Sugar cane	1,170	772	1,036	119	40	49	795	1,011	1,291
Peanut	831	918	1,414	3,217	4,648	3,417	4,729	9,746	11,026
Soya beans	692	858	1,178	634	3,164	470	13	82	220
Green beans	818	9,945	10,105	4,139	3,466	3,462	4,325	5,138	4,400
Other beans	-	-	-	4,975	472	2,292	-	-	-
Sesame	502	3,306	3,718	22	177	14	-	-	-

Data obtained at Agricultural Improvement and Extension Center in Kabupaten of Wajo, Soppeng and Bone.

The culm length is about 140 - 160 cm. The ripening ratio varies locally, but it was good near Lake Tempe. (See the photo).

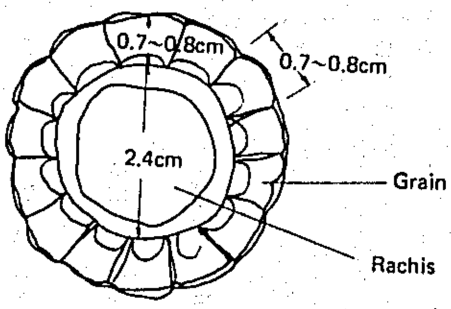


Fig. 2-1-1 Cross Section of Maize (1 : 1)

Soil is softened at the seeding positions with a tool shown in Fig. 2-1-2. Seeds are taken out from a seed pot fixed at the waist at the rate of 3 - 4 grains at each position. (See the photo).

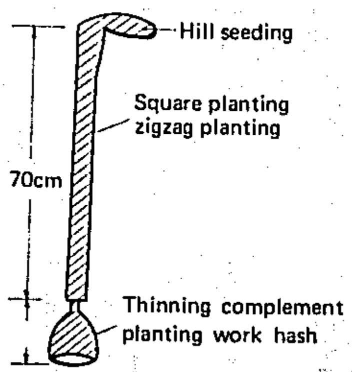


Fig. 2-1-2. Seeding Tool

The cultivation density also varies locally, ranging from square planting of 90 - 120 cm to zigzag planting of 100 cm x 40 cm.

No fertilizer is usually fed, but a small amount of manure is used in some districts.

Neither thinning work nor complement planting work is carried out. Human labor is used both for weeding and for harvesting. Ears are dried by bundling them with 4 - 5 hask left and leaving them under the floor of well ventilated houses.

Table 2-1-9 shows the yield (kg/ha) of maize.

Table 2-1-9 Yield of Maize kg/ha (1968 - 1973)

Kabupaten	1968	1969	1970	1971	1972	1973
Bone	820	727	700	750	603	705
Wajo	1,317	1,058	760	1,061	1,027	1,279
Soppeng	1,000	997	989	841	904	663

Data obtained at Agricultural Improvement and Extension Center in South Sulawesi Province, Kabupaten of Wajo, Soppeng and Bone.

The average yield is extremely low each year, and it is gradually decreasing further. Far larger yield is expected in the future through improvements in cultivation method.

Other crops of upland field include upland rice, peanuts, sugar cane, beans, cassava, sesame. Except peanuts, local varieties alone are cultivated for upland crops. The local small grain variety and two large grain varieties of peanut (Gasia and Suwarns imported from Java Island) are cultivated. Peanut is mixed cropping with maize in some districts. The yield is generally low because of the large percentage of sterile seeds.

No fertilizer is usually used for upland field cropping. Management work consists solely of weeding. They have practice of neither thinning, nor complementary planting, nor intermediate tilling. No standard cultivation method is established.

Since the atmospheric temperature and the day length hardly change in this region, no fixed cultivation period is found. In other words, cultivation is possible at any time. As an example, the cultivation period in Kabupaten Bone and Soppeng is shown in Table 2-1-10 and Fig. 2-1-3.

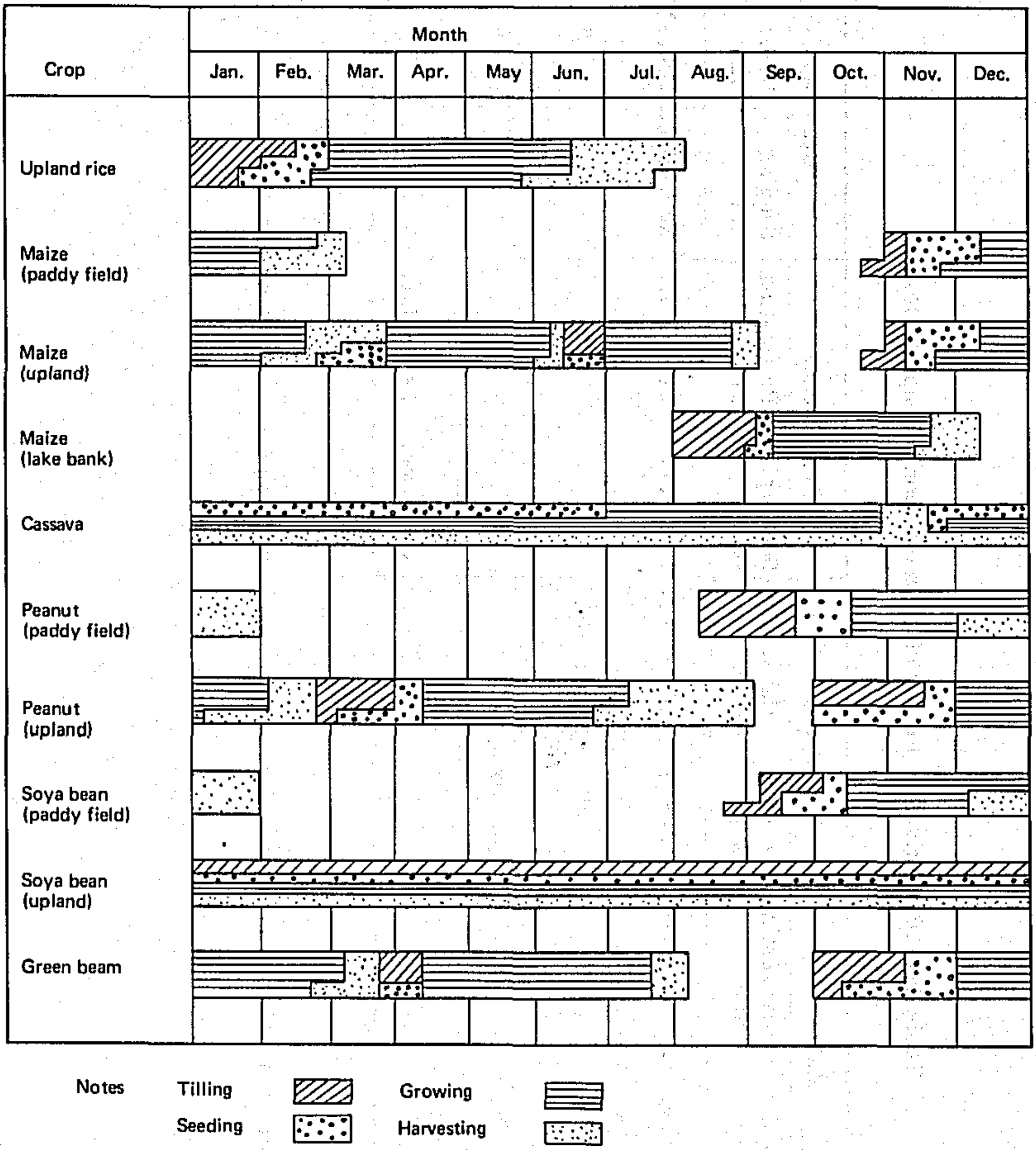
Rainfall determines the cultivation period for upland crops in this region. Generally speaking, the wet season is used for seeding and growing, while the dry season is used for harvesting. Therefore, the current cultivation practice will be ignored and a free cultivation system will be established if dry farms can also be irrigated. When farm crops are cultivated in paddy fields, the wet season is used for the cultivation of paddy rice and the dry season after the harvesting of paddy rice is used for farm crops. If improved irrigation facilities allow to provide irrigation water at any time in the future and a good drying and storing method is established, an optimum cropping system for paddy fields can be established for paddy rice and farm crops by studying the number of days required for paddy rice growing and for farm crop growing and for various works.

Table 2-1-11 shows the data of damages on farm crops obtained at the Agricultural Improvement and Extension Center of the Province.

Table 2-1-10 Cultivation Period of Upland Crops (Kabupaten Bone)

Kecamatan	Maize		Peanut		Green beans		Soya beans	
	Seeding time	Harvesting time	Seeding time	Harvesting time	Seeding time	Harvesting time	Seeding time	Harvesting time
T. Riattang	Nov. -Dec.	Feb. -Mar.	Jul. -Dec.	Oct. -Mar.	Nov. -Dec.	Feb. -Mar.	Nov. -Dec.	Feb. -Mar.
Pajakka	"	"	"	Feb. -Mar.	"	"	"	"
Mare	"	"	Nov. -Dec.	"	-	-	"	"
Lappariaja	"	"	"	"	Nov. -Dec.	Feb. -Mar.	"	"

Data obtained at Agricultural Improvement and Extension Center in Kabupaten Bone.



Data obtained at Agricultural Improvement and Extension Office in Kabupaten Soppeng

Fig. 2-1-3 Plantation Period for Dry Field Farming

Table 2-1-11 Damaged Area of Upland Crops
(Unit: ha)

Crop	Prefecture (Kabupaten)	Year 1968	1969	1970	1971	1972
Upland rice	Bone	15 (0.1)	74 (0.5)	14 (0.1)	39 (0.4)	5,261 (77.8)
	Wajo	27 (1.1)	304 (70.2)	1,135 (28.3)	35 (0.6)	3,756 (95.5)
	Soppeng	100 (3.4)	- -	- -	-	992 (80.5)
Maize	Bone	1,127 (2.0)	796 (1.4)	923 (7.8)	1,059 (5.7)	1,662 (2.6)
	Wajo	1,704 (16.8)	4,572 (23.8)	2,575 (39.3)	412 (6.6)	1,787 (4.2)
	Soppeng	1,289 (7.3)	186 (0.8)	305 (1.7)	30 (0.2)	653 (1.5)
Cassava	Bone	180 (18.7)	92 (8.9)	67 (7.3)	383 (33.3)	55 (2.4)
	Wajo	218 (28.7)	104 (13.2)	171 (21.0)	75 (3.1)	552 (18.6)
	Soppeng	- (0)	45 (31.3)	- (0)	- (0)	80 (47.1)
Peanut	Bone	38 (0.8)	53 (0.9)	32 (2.8)	74 (3.8)	512 (5.9)
	Wajo	401 (13.9)	159 (5.0)	223 (-)	13 (2.6)	279 (3.2)
	Soppeng	- (0)	2 (-)	- (-)	66 (4.0)	527 (17.9)
Soya bean	Bone	- (0)	- (0)	2 (13.0)	- (0)	6 (8.6)
	Wajo	314 (24.4)	83 (5.1)	122 (28.7)	33 (0.5)	336 (57.4)
	Soppeng	50 (8.3)	302 (8.8)	32 (5.7)	57 (11.3)	808 (35.0)
Green bean	Bone	99 (2.9)	32 (0.6)	51 (1.3)	36 (3.1)	1,232 (32.1)
	Wajo	2,076 ?	1,243 (13.8)	1,480 ?	18 (5.6)	1,468 (15.8)
	Soppeng	- (0)	- (0)	- (0)	10 (0.7)	292 (9.0)

Data obtained at Agricultural Improvement and Extension Center Office in South Sulawesi Province. The figures in the parentheses indicate the percentage of damaged area. Damaged area/Planted area x 100.

Table 2-1-12 Damaged Area and Ratio by Upland Crops

	1971				1972				1973			
	Desease & insect		Natural disaster		Desease & insect		Natural disaster		Desease & insect		Natural disaster	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Maize	133	(25)	403	(75)	210	(11)	1,646	(89)	757	(11)	6,069	(89)
Cassava	196	(52)	176	(48)	194	(43)	257	(57)	288	(78)	83	(22)
Sugar cane	42	(100)	-	(0)	26	(32)	56	(68)	29	(71)	12	(29)
Peanut	13	(100)	-	(0)	8	(3)	257	(97)	29	(15)	165	(85)
Green beans	-	(0)	-	(0)	142	(11)	1,135	(89)	125	(8)	1,514	(92)
Soya beans	-	(0)	82	(100)	-	(0)	335	(100)	-	(0)	10	(100)

Data obtained at Agricultural Improvement and Extension Center Office in Kabupaten Wajo.

Table 2-1-13 Average Yield of Upland Crops (by Kabupaten and years) current Kabupaten.

Unit: kg/ha

Crop	(Kabupaten)	Year					
		1968	1969	1970	1971	1972	1973
Upland rice	Bone	1,200	1,200	929	1,113	377	1,280
	Wajo	2,725	2,000	2,601	2,181	1,379	2,217
	Soppeng	1,559	1,348	2,000	1,185	1,661	1,979
Cassava	Bone	7,842	6,226	6,000	4,685	4,935	6,776
	Wajo	12,731	12,250	9,801	10,177	8,250	11,015
	Soppeng	10,000	10,000	10,000	10,000	9,010	7,984
Sugar Cane	Bone	5,685	3,525	3,350	2,096	3,170	3,469
	Wajo	8,419	8,000	7,826	6,648	4,770	5,880
	Soppeng	6,000	6,000	6,000	6,000	6,000	6,163
Peanut	Bone	730	467	450	410	416	570
	Wajo	867	750	700	758	760	691
	Soppeng	869	843	800	769	709	746
Green bean	Bone	598	592	500	400	510	451
	Wajo	587	600	656	709	571	540
	Soppeng	650	650	650	624	605	562
Soya bean	Bone	500	-	500	500	636	421
	Wajo	675	601	713	739	689	725
	Soppeng	965	946	750	700	690	784

Data were obtained at the Agricultural Improvement and Extension Center Office in South Sulawesi Province.

Although the causes of damages vary among different crops and regions, diseases, injurious insects, floods and drought are the major causes. The data on Kabupaten Wajo show that maize, peanuts and soya beans are subjected to large damages from floods and drought.

The natural disasters in this region include river inundation, submerging by rapid water elevation of Lake Tempe and drought. They are explained by the geographic conditions in Kabupaten Wajo. However, similar tendency is found both in Kabupaten Soppeng and Bone.

Corn borer give the largest damages on maize among all the injurious insects. They are followed by army worms. Damages by sheath blight are also serious. No chemical seems to be used in this region for minimizing these damages.

Table 2-1-13 shows the average yield of upland crops.

The average yield of upland crops is extremely low due to low soil fertility and non-fertilized cultivation. Neither new varieties nor new cultivation techniques (related to planting density and disease and insect prevention) have been introduced. Old practive and low morale among farmers also account for the low yield. Numerous improvements must be made in the future.

In addition to these ordinary upland crops, several export crops and cash crops are cultivated. The current state of these crops is summarized in Table 2-1-14.

Table 2-1-14 Production of Export Cash Products, Year and Plantation Area

Crop	(Kabupaten)	1971		1972		1973	
		Cultivated area (ha) (Number of planted tree)	Production ton	Cultivated area (ha) (Number of planted tree)	Production ton	Cultivated area (ha) (Number of planted tree)	Production ton
Coconut	Wajo	5,569	-	6,041	-	5,726	-
	Soppeng	(240,472)	2,242	(257,773)	2,267	(245,221)	1,209
	Bone	4,887	6,618	4,698	5,987	7,466	12,254
Kapok	Wajo	2,364	-	2,001	-	2,665	-
	Soppeng	(110,595)	494	(129,645)	475	122,252	476
	Bone	2,214	522	2,125	-	5,410	195
Coffee	Wajo	37	-	83	-	40	-
	Soppeng	(48,304)	529	(48,425)	1,612	(41,404)	16.02
	Bone	136	-	133	9.86	134	29.36
Tabacco	Wajo	901	-	1,549	-	132	-
	Soppeng	7,945	1,755	8,124	1,251	10,160	1,948
	Bone	174	37.8	175	52.5	1,939	129.0
Kemiri	Wajo	1,274	-	1,310	-	1,445	-
	Soppeng	(246,957)	843.1	(250,757)	829.2	(223,210)	829.2
	Bone	2,005	12,056	2,120	-	2,302	609,825
Pepper	Wajo	1	-	4	-	4	-
	Soppeng	-	-	-	-	-	-
	Bone	118.6	35.45	36.0	-	44.50	7.55
Sugar cane	Wajo	283	-	186	-	103	-
	Soppeng	81	555.0	50.0	72.0	16	48
	Bone	60.0	-	46.7	24,787	63.2	13,760

Data obtained at Agricultural Improvement and Extension Center Office in Kabupaten Soppeng and Bone.

The cultivated area of special crops and seasonings, such as coffee, tobacco, pepper, is extremely small, although that of coconut and kapok etc. is rather large. A small amount of fertilizer is used for these cash crops.

Although Indonesia was one of the major producers of sugar cane, its production has been dropping sharply. Sugar cane production will require sufficient study in the future for advantageous uses of irrigation water. Grain sorghum, which is stronger against drought than maize, is cultivated in progressive farms. This crop will become extremely important in view of the international shortage of feeds and the future of live-stock raising in Indonesia.

3) Live-stock raising

Table 2-1-15 shows the kinds and the number of live-stock that are raised by farmers. The number of hens and ducks is the largest in all of the three Kabupaten.

The number of buffaloes and horses is large in Kabupaten Wajo and Soppeng, while that of cattle is large in Kabupaten Soppeng and Bone.

These animals are set free around houses or in paddy fields after harvesting. Since they are given no concentrated feed, they are generally thin. Horses are of local variety and used as pack horses. Cows and buffaloes are used for tilling and land making in pairs. Work cattle along are raised. No beef cattle are raised by farmers. Hens are raised for obtaining eggs and for eating. Fatting method is never used among farmers.

Table 2-1-15 Quantity of Live-Stock

Year	Kabupaten	Horse	Cattle	Buffalo	Goat	Hen	Duck	Sheep
	Wajo	21,670	8,572	49,865	11,846			
1971	Soppeng	-	-	-	-			
	Bone	-	-	-	-			
	Wajo	21,678	10,195	54,720	12,709			-
1972	Soppeng	6,366	24,161	1,508	4,383	93,881	36,051	22
	Bone	24,205	48,609	40,744	10,686	1,021,170	33,084	-
	Wajo	23,262	9,272	55,992	17,861	-	-	-
1973	Soppeng	7,269	23,984	1,696	3,465	99,517	36,051	34
	Bone	21,360	85,163	36,040	-	-	-	-

Data obtained at the*Agricultural Improvement and Extension Center Office in* Kabupaten Wajo, Soppeng and Bone

4) Agricultural implements

Power machinery are hardly used in this region. Hand implements alone, except sprayers, are used. Table 2-1-16 shows the number of agricultural machinery owned in each Kabupaten.

Table 2-1-16 Number of Agricultural Machinery by Kabupaten

Kabupaten	Tractor	Pump	Sprayer		Duster	Thresher
			Power	Manual		
Wajo	-	16	19	306	100	15
Soppeng	2	1	10	280	75	6
Bone	-	6	16	75	125	-

Data obtained at Agricultural Improvement and Extension Center Office in Kabupaten Wajo, Soppeng and Bone.

The above figures indicate that the number of agricultural implements owned by each household is extremely small. The following figures were obtained from the planted area of paddy field. In other works, one sprayer is used for each 226 ha in Kabupaten Wajo, one sprayer for each 75 ha in Kabupaten Soppeng, and one sprayer for each 829 ha in Kabupaten Bone. This indicates that threshers and pumps are rarely used. Ordinary farmers still work with long hand hose and sickles (or aniani) alone. Efforts to introduce agricultural machinery must be made in the future for facilitating the mixture of organic matters, for preventing diseases and injurious diseases and for increasing transportation capacity.

The natural conditions, paddy rice plantation, upland crop cultivation, live-stock raising and agricultural machinery in this region were briefly described.

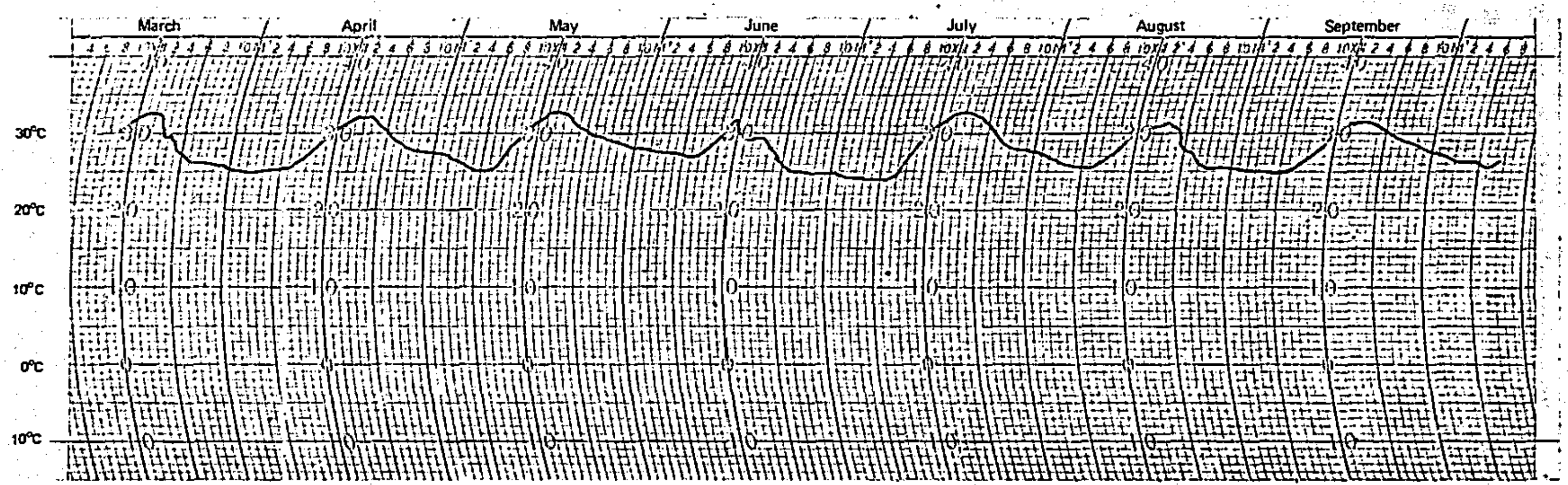


Fig. 2-1-4 Diurnal Temperature Change

Data were obtained at the Institute of Soil Research (BOGOR) in Indonesia

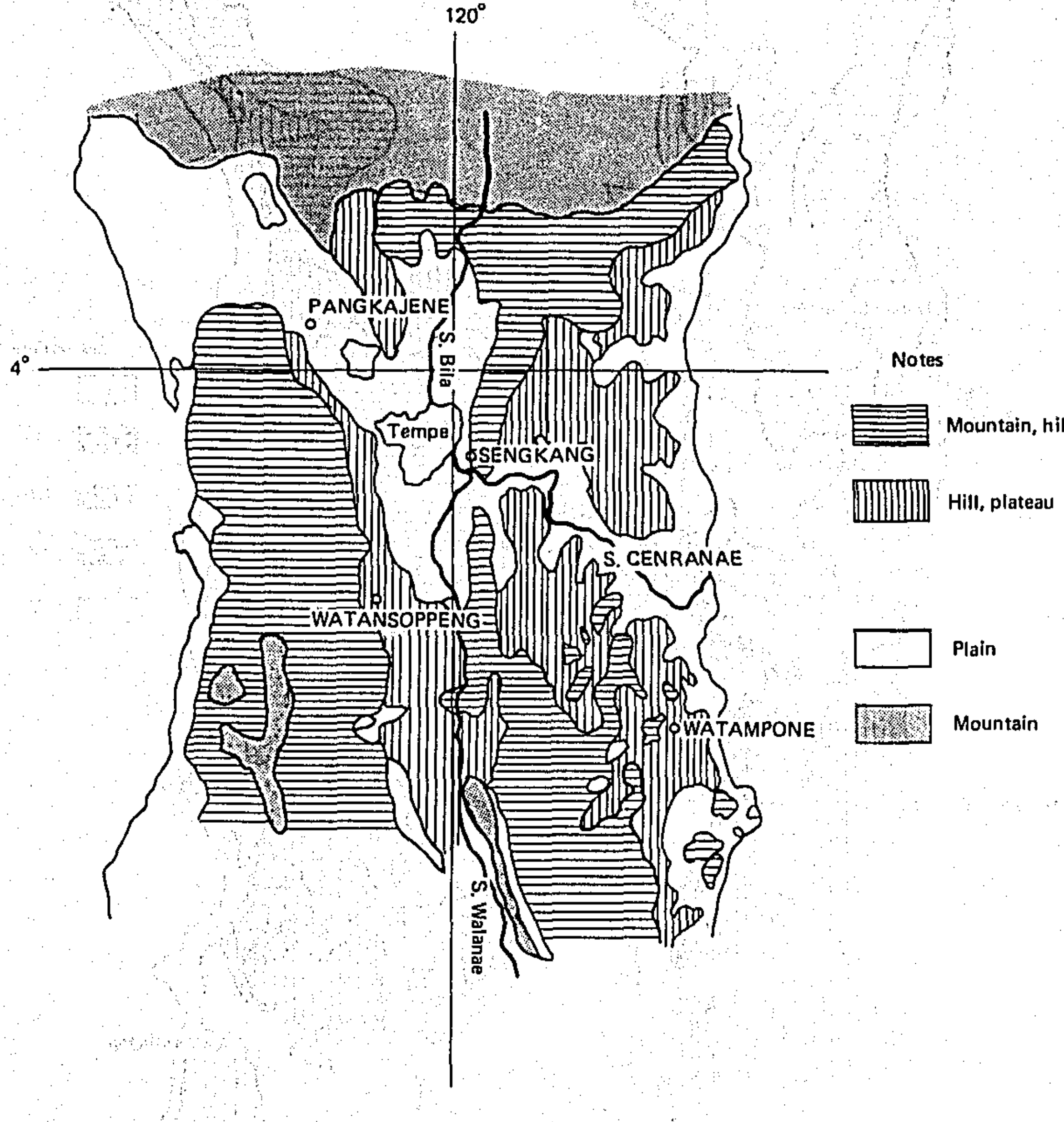


Fig. 2-1-5 Soil Classification by Altitude

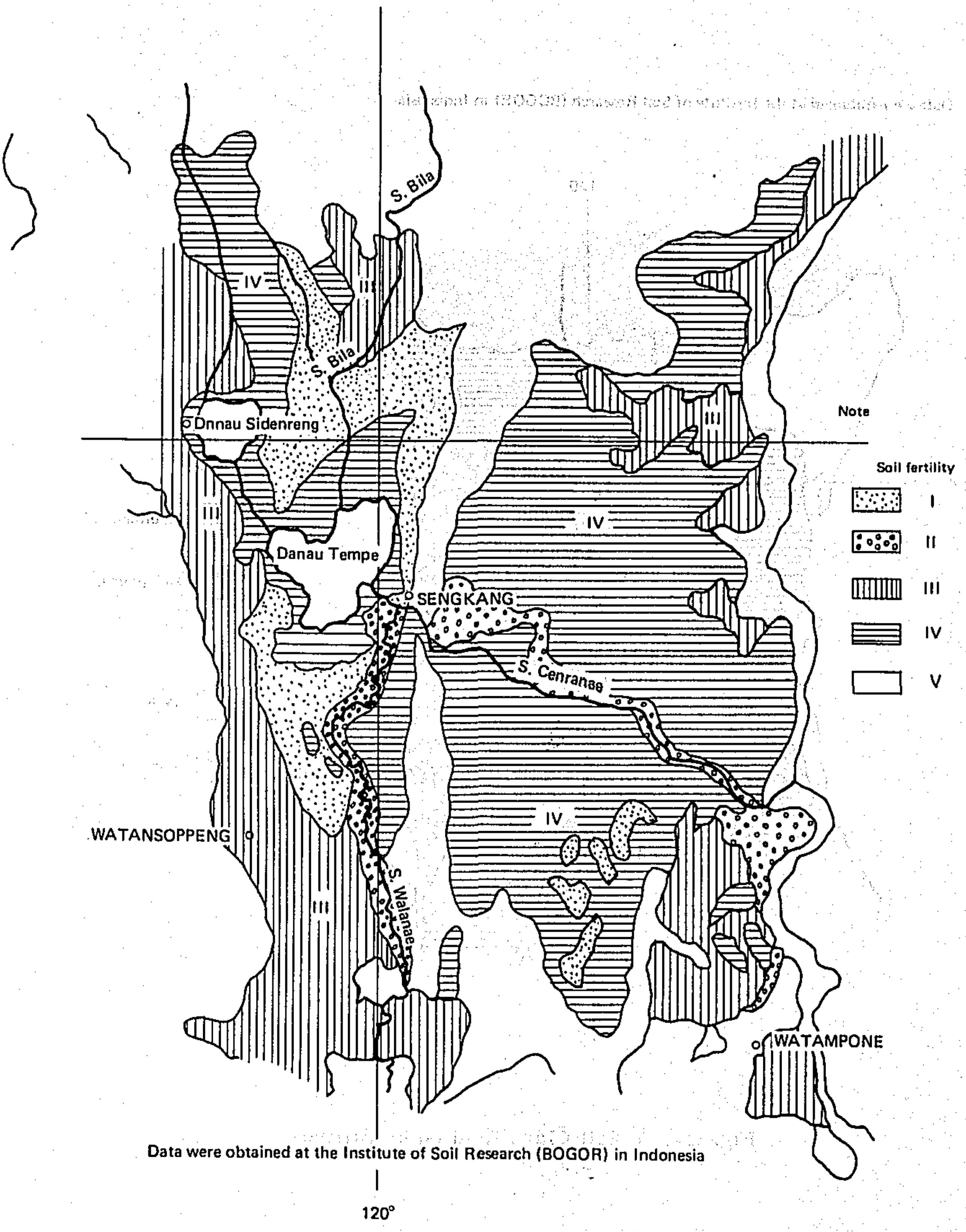
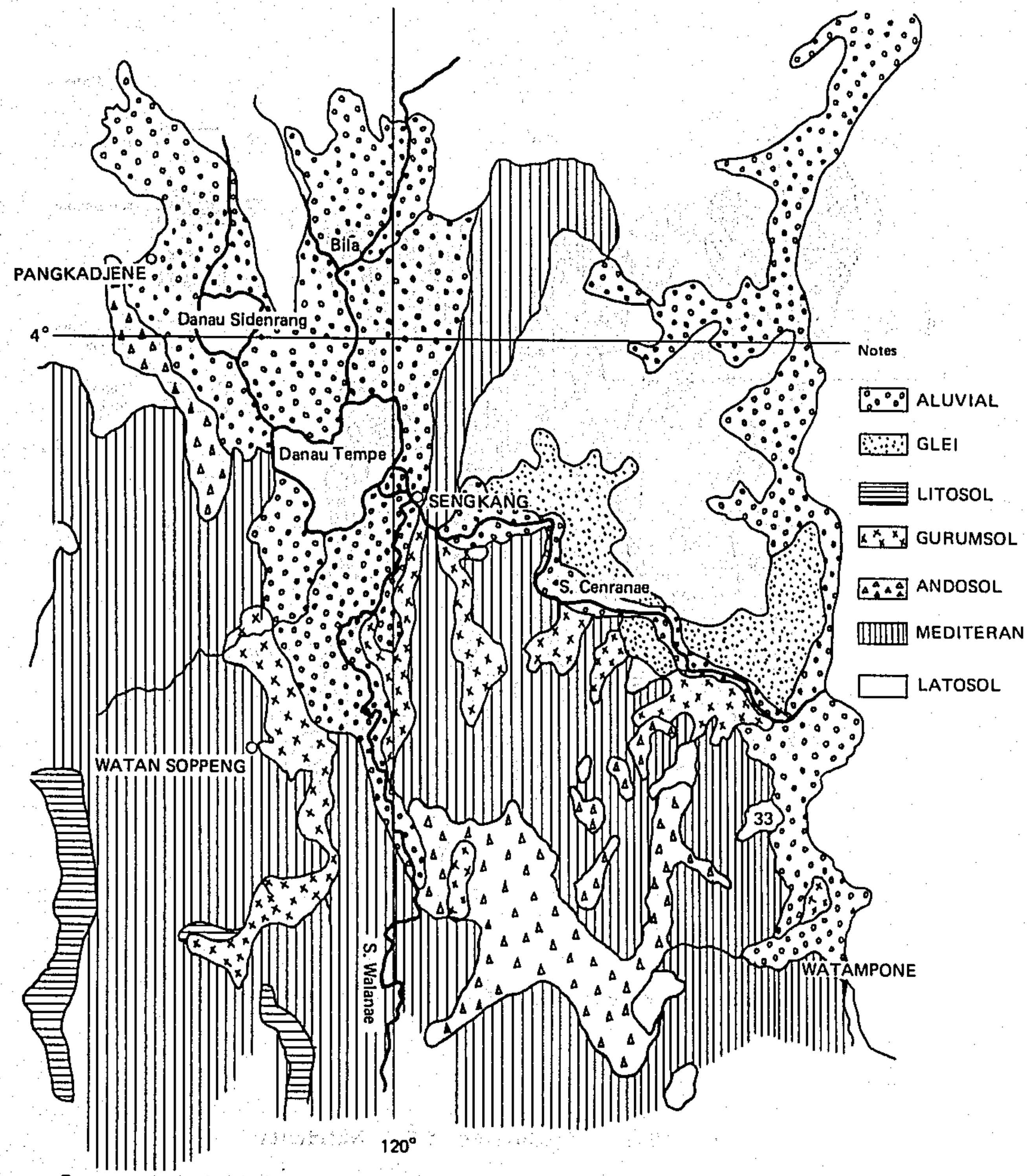
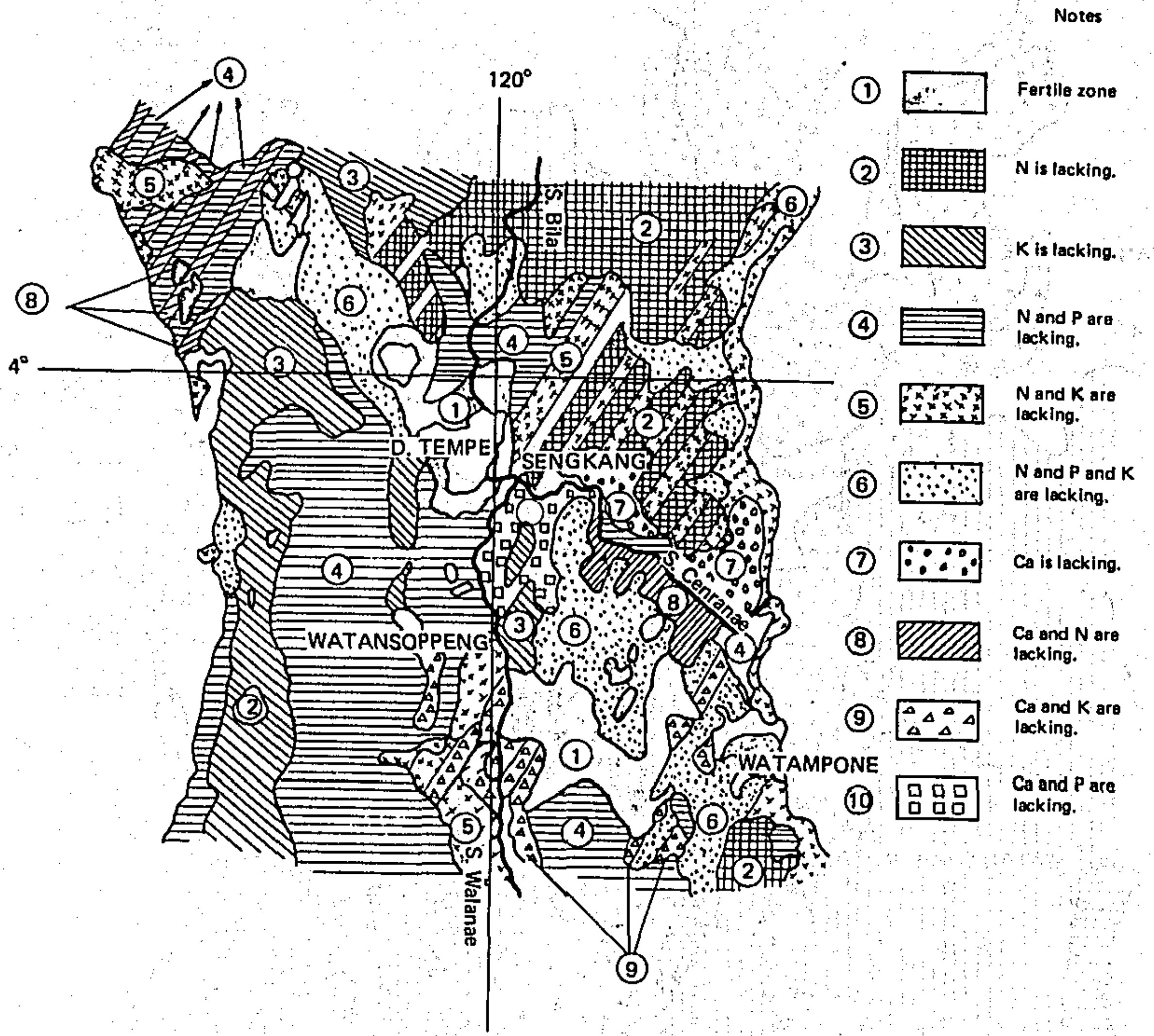


Fig. 2-1-6 Grades of Soil Fertility



Data were obtained at the Institute of Soil Research in Indonesia.

Fig. 2-1-7 Soil Type Distribution



Data were obtained at the Institute of Soil Research in Indonesia (Bogor).

Fig. 2-1-8 Evaluation of Soil Nutrients

Data were obtained at the Institute of Soil Research in Indonesia (Bogor).

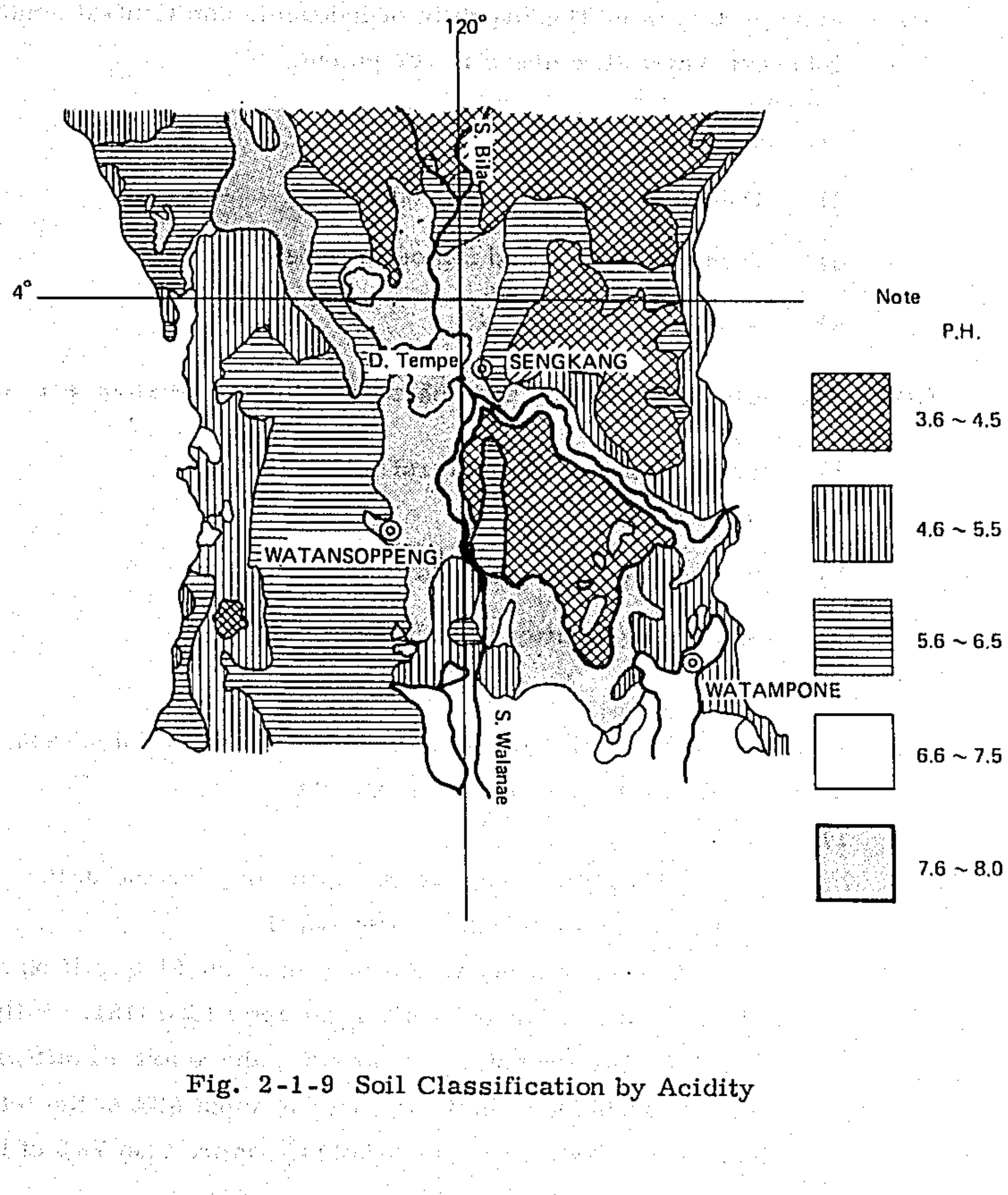


Fig. 2-1-9 Soil Classification by Acidity

2.1.2 Agricultural Economy

The discussions on agricultural economy were summarized under the following themes. However, it, was not possible to give sufficient explanation due to the shortage in time for data analysis and study.

Although detailed data analysis requires further surveies, the impressions and problems of the field survey are summarized below.

(i) Food problems in The Republic of Indonesia and Central South Sulawesi Water Resources Development

1) General

2) Domestic agricultural production

3) Demand, supply and import of rice

4) Summary

(ii) Agricultural conditions and characteristics of development region

1) Foundation for agricultural production (especially on land)

2) Socioeconomic conditions

3) State of agricultural production

(1) Food problems in The Republic of Indonesia and Central South Sulawesi Water Resources Development

1) General

Agriculture has overshelming importance in the economy of The Republic of Indonesia.

The area of cultivated land is about 14.5 million ha., which accounts for about 8% of the total land (181.1 million ha.). In The Republic of Indonesia, there are 15 million farm households, which account for about 63% of the total households (24 million households) more than 70% of the

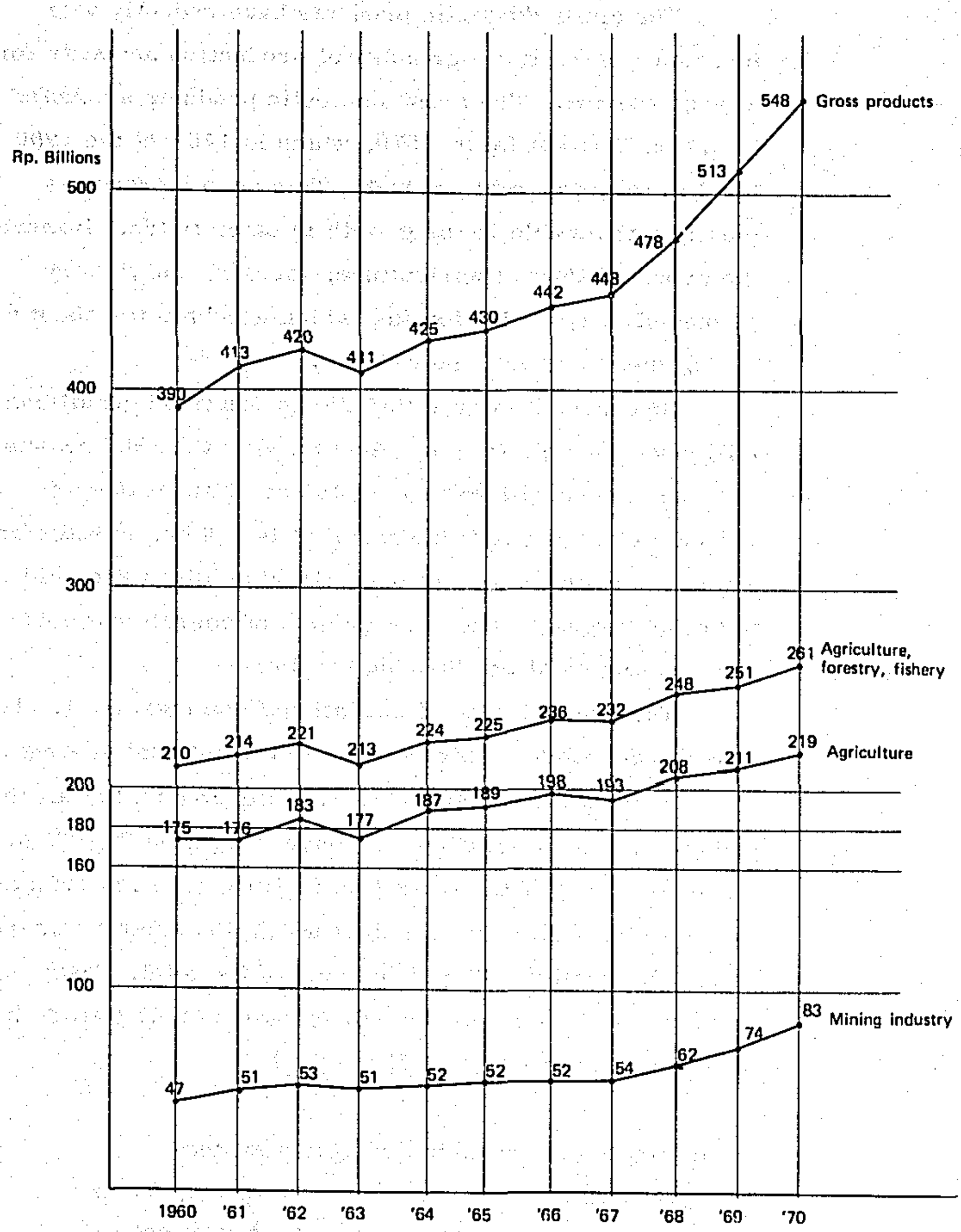


Fig. 2-2-1 Gross Domestic Products at Constant 60 Market Prices by Industrial Origin (Data Obtained from STATISTIK INDONESIA) (1970/71 BIRO PUSAT STATISTIK)

total population are engaged in agriculture.

The gross domestic products have recently been increasing sharply. Agricultural production accounts for a large portion. The gross domestic products amounted to 3,196.2 billion Rp in 1970, which is 140% of the 1960 level in terms of real product. This shap increase is mostly attributable to the growth in other fields. However, the gross product of agriculture, forestry and fishery amounted to 1,522 billion Rp, which accounts for about a half of the gross national product.

However, it is true that the agricultural conditions still have many problems. According to the 1963 census, one farm household manages only agricultural land of 1.1 ha. on the national average. It is 2.6 ha. in Kalimantan, where the average size of operational holdings are said to be the largest. The average size of operational holdings are the smallest (0.7 ha.) in Jawa.

The average size of operational holdings are 1.0 ha. in South Sulawesi. This is close to the national average.

It is said that about 70% (3.94 million ha.) of all the paddy fields (5.62 million ha.) have irrigation facilities. However, most of the irrigation facilities are imperfect. Paddy fields with fully technical irrigation account for only about one fourth (1.47 million ha.) of the total. Many of them have only semi-technical irrigation (1.47 million ha.) or village system (1.21 million ha.)

Paddy fields classified by irrigation system

1)	Irrigation	3,944,077 ha
	Fully technical	1,467,627 ha
	Semi-technical	1,263,649 ha
	Village system	1,212,801 ha
2)	Swamp	309,643 ha
3)	Rainfed	1,365,129 ha

Table 2-2-1 Farm Agriculture and Estates in Different Provinces (Data obtained from 1963 Census of Agriculture - BIRO PUSAT STATISTIK)

No.	Project	Number of holdings			Area (ha)					Remarks
					Farm agriculture		Estates			
		Farm Agriculture	Estates	Total	Total Area	Average size	Total Area	Average size	Total	
1.	Jawa Madura	7,935,109	637	7,935,746	5,646,993	0.7	524,492	823	6,171,485	
2.	Sumatera	2,205,246	343	2,205,589	3,908,578	1.8	1,003,247	2,925	4,911,825	
3.	Kalimantan	552,318	33	552,351	1,417,954	2.6	38,929	1,180	1,456,883	
4.	Sulawesi	774,558	89	774,647	966,327	1.1	17,730	199	984,057	
	(South Sulawesi)	(514,491)	(7)	(514,498)	(495,818)	(1.0)	(8,968)	(1,281)	(504,786)	Figures of 4. Sulawesi
5.	Others	769,239	18	769,257	944,016	1.2	6,446	358	950,462	
	Total	12,236,470	1,120	12,237,590	12,883,868	1.1	1,590,844	1,420	14,474,712	

Table 2-2-2 Paddy Intensification Programme (1968 - 1972)
(Data obtained from crop statistics for INDONESIA by
Mr. N. M. IDAIKKADAR - F. A. O. Agricultural Statistician)

(in 1, 000 ha.)

Division Year Wet season (W. S.) Dry season (D. S.)	BIMAS Gotong Royong		BIMAS		INMAS		Total	
	Normal	New	Normal	New	Normal	New	Normal	New
1967 - '68 W. S.	-	-	489	-	626	-	1, 115	-
1968 D. S.	-	-	256	18	208	-	464	18
Total 1968	-	-	745	18	834	-	1, 579	18
1968 - '69 W. S.	249	49	332	85	551	46	1, 132	180
1969 D. S.	267	230	79	18	171	53	517	301
Total 1969	516	279	411	103	722	99	1, 649	481
1969 - '70 W. S.	495	284	156	55	347	186	998	525
1970 D. S.	119	72	33	39	165	148	317	259
Total 1970	614	356	189	94	512	334	1, 315	784
1970 - '71 W. S.	-	-	667	384	679	270	1, 346	654
1971 D. S.	-	-	172	187	276	243	448	430
Total 1971	-	-	839	571	955	513	1, 794	1, 084
1971 - '72 W. S.	-	-	494	423	854	485	1, 348	908
1972 D. S.	-	-	144	182	317	322	461	504
Total 1972	-	-	638	605	1, 171	807	1, 809	1, 414

Note:
1) Normal: Improved local varieties of seed, namely bengawan, sigadis, syntha, dewitara and dewi ratih.
2) High yielding varieties - P. B5, Pelita 1/1 Pelita 1/2 and C4-63.
3) BIMAS Gotong Royong: It was carried out for effectively promoting BIMAS plan for obtaining the cooperations from foreign trade houses for material supply. (Mostly Swiss and West German trade houses. Mitsui, Mitsubishi and Nichimen of Japan also participated in the work in the east and the middle of Jawa.) It was discontinued after the dry season crop of 1968 - '70.

4) Grand total 5, 618, 849 ha

(The data were obtained from Mr. N. M. Idaikkadar, F. A. O. agricultural statistician.)

2) Domestic agricultural production

(Rice) Rice is the major in food crop.

Rice is cultivated mostly in paddy fields. Their irrigation conditions were described in 1).

Of the paddy fields with irrigation facilities (3. 94 million ha.), only about 27% (1. 07 million ha.) have enough water supply for double crops a year.

Most of the paddy field allowing double crops a year seem to be paddy fields with technically irrigation. This indicates that paddy fields with other irrigation facilities are not so different from rainfed fields.

Relation between irrigation and cropping season

(Area of irrigated paddy fields) (cropping season)

3, 944 thousand ha. → double crops a year 1, 071 thousand ha.

→ 1/2 double crops a year 890 thousand ha.

→ One crop a year 1, 983 thousand ha.

Paddy fields almost has'nt drainage facility. Since drainage is drained simply by natural drainage, paddy field are subjected to flood damages almost everywhere at the wet season. Thus, the imperfection of irrigation and drainage facilities in The Republic of Indonesia not only inhibits dry season crop, but also brings about large flood damages at the wet season. Therefore, land foundation, importantly including irrigation and drainage facilities, must be adjusted urgently for increasing and stabilizing rice production. This will require large investments, long period and advanced techniques. Projects for land foundation are already being carried out various places.

Along with these projects for land foundation, as a countermeasure to increase rice production should also be made to widely introduce good high-yielding seeds and to improve cultivation techniques (including the feeding of fertilizers and agricultural chemicals at the best time, in the best quantity.). The Bimas plan, the Inmas plan and other projects that are currently promoted in various places in Indonesia are geared for the same purpose.

It is said that the measure to increase rice production in The Republic of Indonesia cannot be discussed without the Bimas plan. Therefore, the Bimas plan is briefly described here.

At first, the Bimas plan was tried with the wet season rice of 1963/64 in Kurawang Kabupaten in West Jawa. It covered 100 ha. of paddy fields at that time. On the basis of its results, it was attempted with the wet season rice of 1964/65 as demonstration. (generally, called as Demas.) It covered 10,000 ha. of paddy fields in the same Kabupaten.

The average yield per unit of area during these two years was more than twice as high as the average yield per unit of area during the past 10 years. Encouraged with the good results, the government started full-scale enforcement of the Bimas plan with the wet season rice of 1965/66. The Inmas plan was also started with the wet season rice of 1967/68.

High-yielding varieties, namely IR (called as PB in Indonesia) 5 and 8 were introduced from IRRI in 1968. And the major efforts of the Bimas plan have been directed mainly to this variety since 1968. This is usually called as Bimas Baru (new Bimas) plan. By 1968 - 1969, the land covered by the Bimas plan increased excessively for independent efforts by Indonesia. Therefore, it has been vigorously promoted with the cooperation of foreign trading houses. This is called as Bimas Gotong Royong (Bimas GR).

For the intensive promotion of this Bimas plan, The Indonesian government newly established Badan Pengendali Bimas (Bimas Promotion Headquarter) as an organ directly under the Minister of Agriculture. It established lower ranking organizations in Propinsi, Kabupaten, Kecamatan and Desa for consistent administration.

However, the Bimas plan promoting method was changed by the Minister's message given in March, 1971. First, it was determined to discontinue Bimas G. R. requiring cooperations of foreign trading houses. It was also determined to enforce the Bimas plan in twenty-three provinces. (There are twenty-six provinces in The Republic of Indonesia, Maluku, Irian Barat and Sulawesi Tenggara alone are expected.) These twenty-three provinces were classified into the group A (10 states, namely, Jawa Barat, Jawa Tengah, D. I. Jogjakarta, Jawa Timur, Sumatra Utara, Sumatra Barat, Lampung, Kalimantan Selatan, Sulawesi Selatan, Bali) and the group B (13 states, namely, D. C. I. Jakarta, D. I. Aceh, Riau, Jambi, Sumatra Selatan, Bengkulu, Kalimantan Barat, Kalimantan Tengah, Kalimantan Timur, Sulawesi Utara, Sulawesi Tengah, Nusa Tenggara Barat, Nusa Tenggara Timur). Complete enforcement of the Bimas plan was requested for the group A, while slightly loose enforcement was requested for the group B.

Under the Bimas plan credits are used for purchasing fertilizers, seeds, agricultural chemicals that are necessary for rice cropping. According to the 1973 plan, RP23,000 of working expense was allowed per 1 ha., and 5,000 RP was provided wish cash and 18,000 RP in kind. The Bimas plan differs from the Inmas plan in that a credit system is adopted for the former. The two plans are identical in terms of the technical guidances provided by the government and the supply of production materials. They have a completely identical purpose to increase rice production.

Table 2-2-3 Credit to Farmers, Food Crop Sector

Year	Loans Issued: Value (million Rp)	Loans Issued: Number of Cases (thousand)	Repayment
1968	1,991	Collective loans (1968–1970)	64.4%
1969	2,305		52.2
1970	2,487		76.2
1971	10,968	1,678	87.2
1972	9,859	1,443	73.1

The source of the data is identical with that of Table 2-2-2.

Next, we are summarized the state of rice production. The rice cropping area has been increasing gradually with slightly yearly fluctuations. However, the production is still influenced by weather. The data aince 1955 show that the production was extremely low in 1963 due to severe drought damage. The production was also low in 1961, 1967 and 1972 because of drought damage or abnormal rainfall.
However, the production level has been rising sharply since 1968 and reached approximately 13.8 million tons in 1971. It is not clear whether this sharp increased production is attributable to the Bimas plan, or to IRRI's and local high-yielding varieties (Pelita 1/1. 1/2), or to meteorological conditions. In any event, all of these factors seem to have worked together to bring about this result.

The rice cropping in The Republic of Indonesia depends heavily on the amount of rainfall. It depends not only on the absolute amount of rainfall, but also on monthly rainfall. This is mostly attributable to poor conditions of irrigation and drainage facilities.

Since the irrigation facilities constructed by Holland have been considerably damaged, returning to the former condition these existing irrigation facilities for better flood control and better use of water power is also important subject.

The conversion factors for rice that are adopted in The Republic of Indonesia for statistics are shown below:
(The source of the data is identical with that of Fig. 2-2-2).

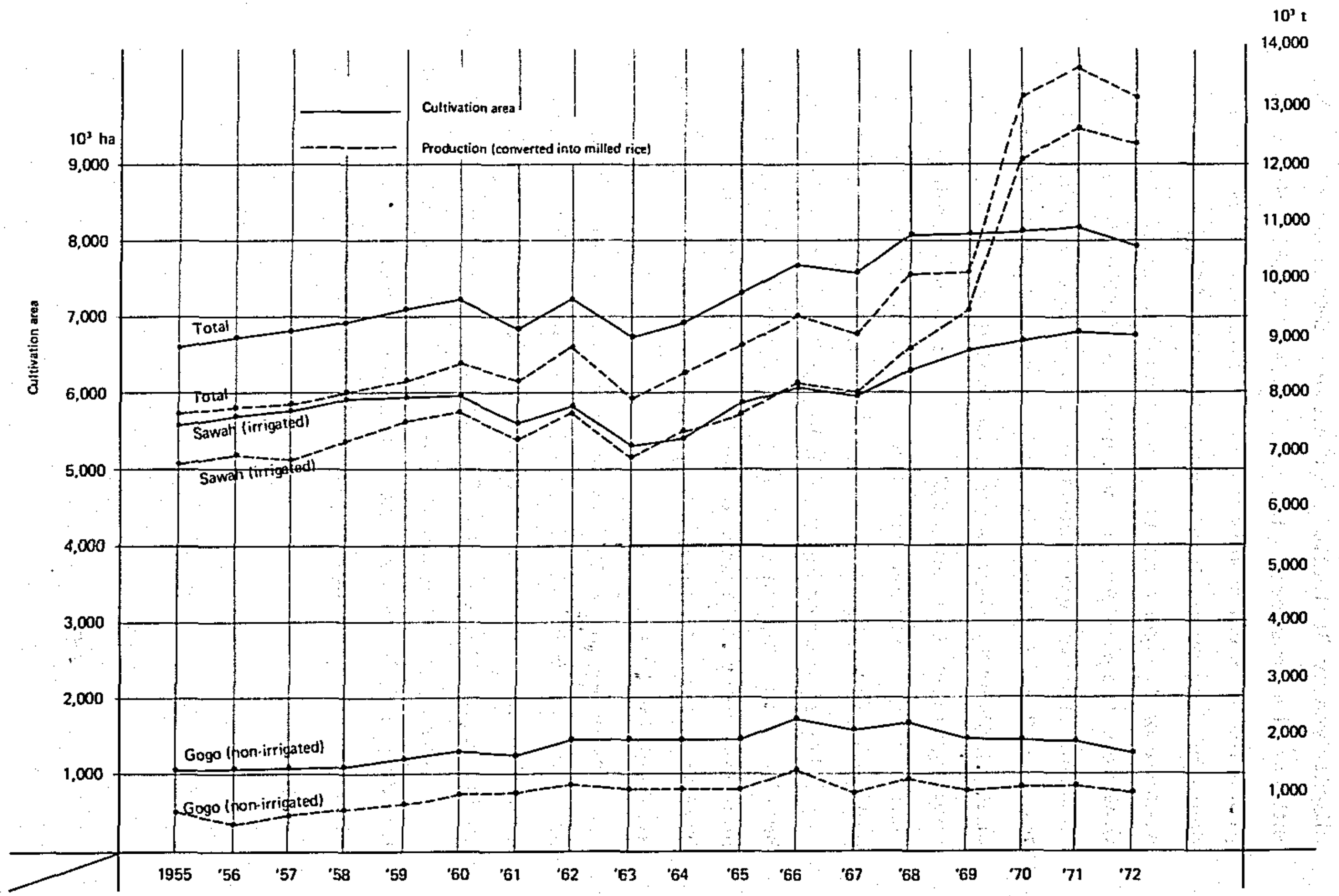


Fig. 2-2-2 Cultivation Area and Production of Rice in The Republic of Indonesia (The data were obtained from FAO Agricultural Statistician of Mr. N. M. Idaikkadar)

Table 2-2-4 Cultivation Area, Production and Average Yield Per Unit of Area of Rice

Year	Sawah (irrigated)			Gogo (non-irrigated)			Total			Remarks
	Area (mil. ha)	Production* (mil. ton)	Aver. yield (100 kg/ha)	Area	Production	Aver. yield (100 kg/ha)	Area	Production	Aver. yield (100 kg/ha)	
1950-54 (average)	5,133	11,794	22.98	1,008	1,293	12.83	6,141	13,087	21.31	* Production refers to dry stalk paddy. ** The coefficient of 69% was used for the figures in the parentheses for '70-'72 for the conversion factors between Wet Stalk Paddy and Dry Stalk Paddy in Jawa and Madura Island. (77% was used for the other years and the other districts.) It was for these three years alone that 69% was used for statistics. It was *changed into* 77% again since '73.
1955	5,517	12,985	23.54	1,054	1,447	13.74	6,570	14,432	21.97	
1956	5,701	13,308	23.34	1,001	1,311	13.10	6,702	14,619	21.81	
1957	5,748	13,242	23.04	1,050	1,435	13.67	6,798	14,677	21.59	
1958	5,914	13,881	23.47	1,076	1,463	13.60	6,990	15,344	21.93	
1959	5,936	14,228	23.97	1,217	1,722	14.15	7,153	15,950	22.30	
1960	5,975	14,876	24.90	1,310	1,984	15.15	7,285	16,860	23.14	
1961	5,584	13,935	24.96	1,273	1,965	15.44	6,857	15,900	23.19	
1962	5,836	14,855	25.45	1,447	2,256	15.59	7,283	17,111	23.49	
1963	5,329	13,286	24.93	1,402	1,970	14.05	6,731	15,256	22.67	
1964	5,484	13,990	25.51	1,496	2,202	14.72	6,980	16,192	23.20	
1965	5,875	14,968	25.48	1,452	2,104	14.49	7,327	17,072	23.30	
1966	6,011	15,517	25.81	1,680	2,443	14.54	7,691	17,960	23.35	
1967	5,995	15,303	25.53	1,521	2,095	13.79	7,516	17,398	23.15	
1968	6,364	17,195	27.02	1,657	2,355	14.21	8,021	19,550	24.37	
1969	6,544	18,383	28.09	1,470	2,081	14.16	8,014	20,464	25.54	
1970	6,679	21,280	31.86	1,456	2,121	14.56	8,135	(23,401) 25,382**	28.77	
1971	6,785	22,436	33.08	1,439	2,121	14.74	8,232	(24,557) 26,537	29.87	
1972	6,673	21,768	32.62	1,310	1,957	14.93	7,983	(23,723) 25,527	29.72	

(1)	(2)	(3)	(4)	(5)
Wet Stalk Paddy	100	130	144	170
Dry Stalk Paddy	77	100	111	131
Wet Stalk Paddy	69	90	100	118
Dry Paddy without Stalk (gabah)	59	76	85	100
Rice	40	52	58	68

Generally, "Paddy" means "Dry Stalk Paddy." Therefore, 52% is used for conversion into milled rice.

The factors are determined by the Central Statistics Bureau for Jawa and Mudura, and by the Ministry of Agriculture for the outer islands. The rice production in The Republic of Indonesia announced by dry stalk paddy. The factors of 77% between "wet stalk paddy" and "dry stalk paddy" was adopted by the both until 1968. However, it was changed into 69% for Jawa and Madura Island under the Central Statistic Office in 1969. It was unchanged (77%) for the outer islands. The figures in the parentheses of the total column for 1970 - 1972 in Table 2-2-4 are based on these coefficients and are officially announced figures. However, the Central Statistic Bureau determined to discard 69% and adopt 77% again from 1973. Since then, the coefficient of 77% has been used uniformly in The Republic of Indonesia. The productions that are outside the parentheses in the total column for 1970 - 1972 are based on 77%. Although these productions are not the officially announced ones, they were quoted here since they are based on the more uniformly adopted coefficient.

(Major crops other than rice)

Maize is next only to rice in its importance as food crop. It is the principal food in certain districts in Indonesia, but it is eaten with rice in the other districts. Maize is important crop for non-irrigatable upland and paddy fields at the dry season.

Although cassava has only low nutritive value, it can be cultivated even in infertile land. Therefore, it is widely used as supplementary food or emergency food. It seems that cassava is also processed and exported in the form of tapioca starch, tapioca chip or tapioca pellet as animal feed. Since cassava can be cultivated in extremely infertile land such land that is too poor for paddy or maize production or that has become too poor due to non-fertilizing method is usually used for cassava cultivation. Fig. 2-2-3 shows the production of the major crops other than rice.

The cultivation area of maize is determined by cultivation conditions. It changes sharply every other year (difference of more than 1 million ha.) However, the cultivation area of other crops seems to remain almost unchanged every year. Since their yield per unit area remains almost unchanged, their production remains at the same level.

The agriculture in The Republic of Indonesia can be roughly classified into "estate agriculture" and "farmer's agriculture". Food crops, such as rice and maize, have been cultivated by "farmer's agriculture." However, perennial crops, such as sugar cane, tobacco, tea, coffee, rubber, etc., have been cultivated mostly by "farmer's agriculture", but partly by "estate agriculture".

Estate agriculture is mostly found in Jawa and Sumatra. It is hardly found in South Sulawesi covered by the present survey and is gradually disappearing nationally.

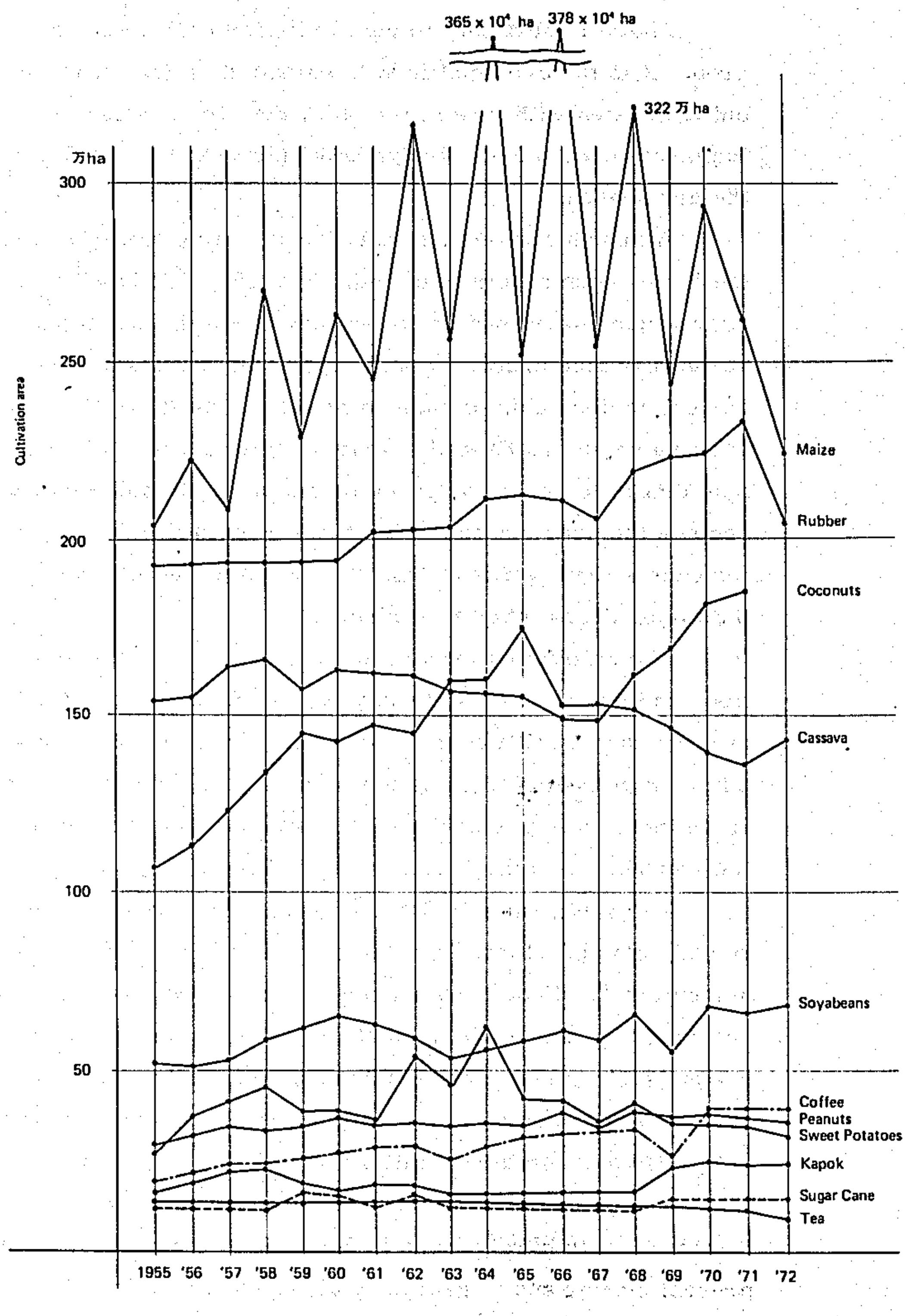


Fig. 2. 2-3 Cultivation area of major crops except rice
(The source of the data is identical with that of table 1-2)

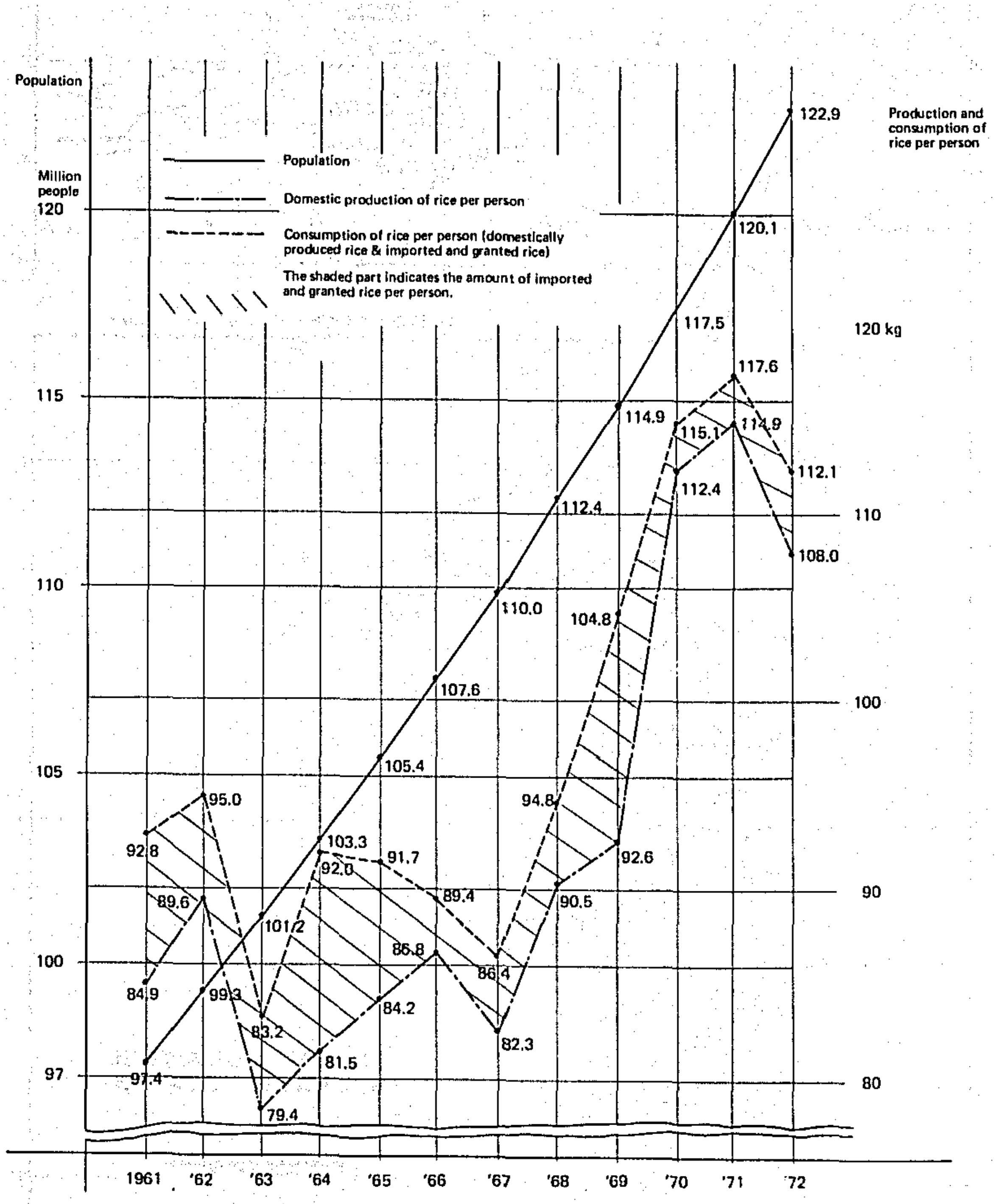


Fig. 2-2-4 Transition in Population, Domestic Rice Production and Consumption per Person

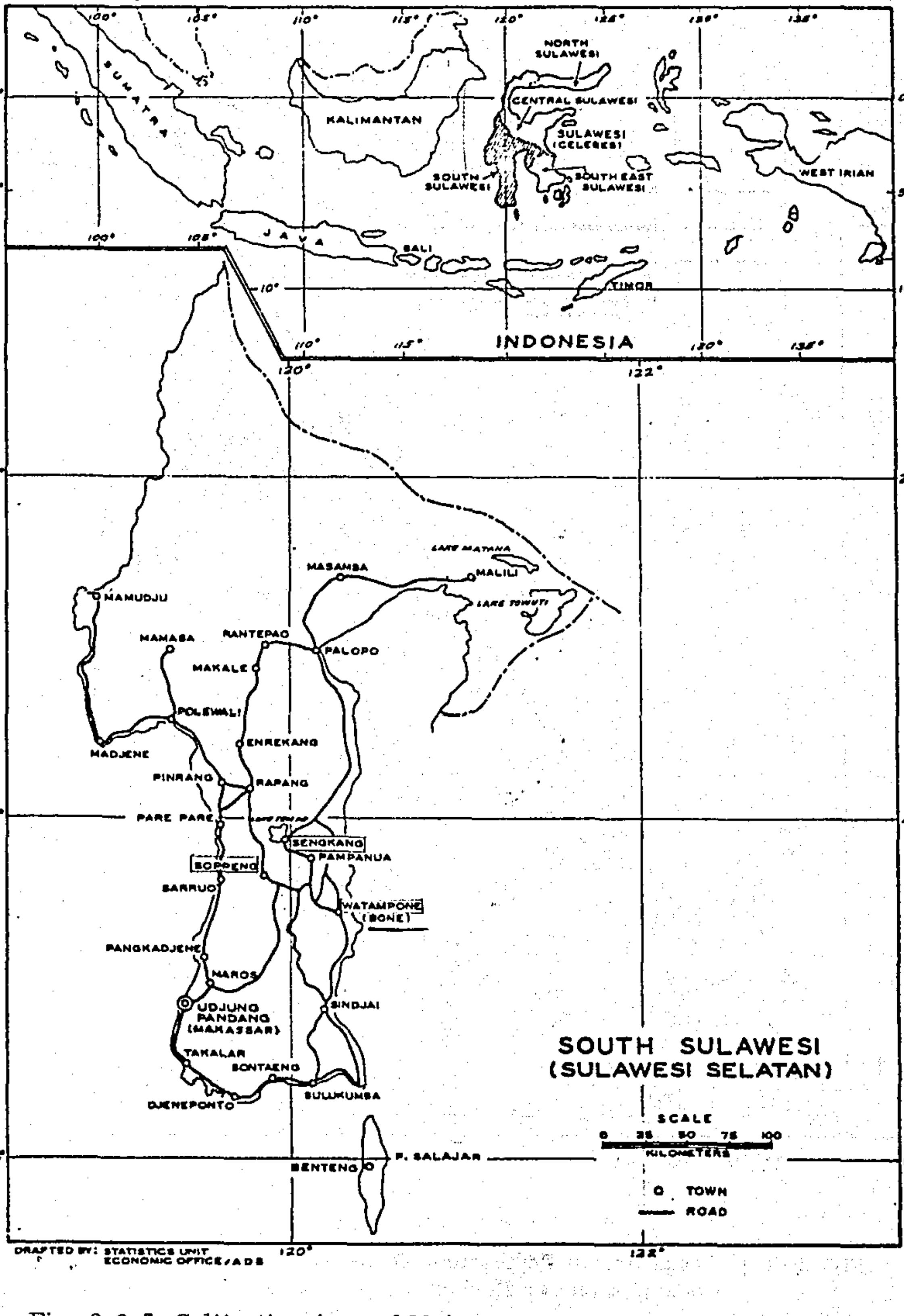


Fig. 2-2-5 Cultivation Area of Major Crops Except Rice
(The source of the data is identical with that of Table 1-2)

3) Demand, supply and import of rice

Rice is the staple food in Indonesia. The price of rice changes, sharply, depending on its production and demand-supply relation. Smooth transportation is difficult even within the country because of the poor rice marketing system. Considerably large difference in the price of rice is found between Jawa Island and the outer island even at one time.

Suppose that the consumption of rice per person can be obtained from the population, and the total domestically produced rice, imported rice and granted rice. The yearly rice consumption was around 90 Kg per person until 1968. It exceeded 100 Kg per person in 1969 partly because large import and grant. Since then, the average consumption has remained at 110 Kg due to the steady growth of domestic production. However, it still is not sufficient.

Most of imported rice comes from Thailand and Burma. It costs Indonesia as much as 70 million dollars per year (average of the nine years, from 1963 to 1971), it seems to be a large burden for Indonesia.

Table 2-2-5 Imported Amount of Rice and Foreign Currency Payment

Year	Imported Amount (including granted amount)	Imported Amount	Imported Value
	(thousand tons)		(million dollars)
1961	767		
1962	536		
1963	487	487	70
1964	1,085	1,085	153
1965	787	819	133
1966	280	281	58
1967	456	57	14
1968	486	486	96
1969	1,347	238	45
1970	324	324	52
1971	494	60	9
1972	500		

Source of data:

The figures in (1) are based on listenning

The figures in (2) and (3) are based on STATISTIK INDONESIA (1970/71 BIRO PUSAT STATISTIK)

4) Summary

The annual increasing rate of population is about 2.4% in The Republic of Indonesia, which is more than twice as high as the rate in the advanced countries. On the other hand, the increasing rate of food production, especially rice production, has been below that of population. This has created serious problems. For this reason, the first 5-year plan was made and is putting into practice. As a result, rice production increased sharply during the recent years. Although the rice consumption per person increased accordingly, it is still quite below the target (rice consumption of 120 Kg per person in 1973) of the first five year plan. It is still an important project to increase the production of food, especially rice.

Table 2-2-6 Target Rice Production Under the First Five-Year Plan and Results

		'69/70	'70/71	'71/72	'72/73	'73/74
Cultivation area (thousand ha.)	Plan Result	7,600 8,014	7,960 8,135	8,320 8,222	8,760 7,983	9,300
Production (thousand tons)	Plan Result	10,520 10,641	11,430 13,199	12,520 13,799	13,810 13,274	15,420
Domestic production per person (kg/year)	Plan Result				108	120

Note: "Plan" means the first five-year plan.
The figures of "Result" are based on Table 2-2-4 and Fig. 2-2-4.

The fiscal year of 1973 is the final year of the first five year plan. The actual achievements will be quite lower than the target. For this reason, the Indonesian Government is studying the second five-year plan (beginning in 1974) with the major efforts directed to increase food production. It was not possible to obtain specific target figures of the second five-year plan. The figures that were obtained verbally are given below tentatively.

Table 2-2-7 Target Rice Production Under the Second Five-Year Plan (Draft)

	1974	1978	
Harvest area (thousand ha)	8,500	8,700	0.59%
Production (thousand tons)	15,036	17,332	3.63
Average yield (t/ha)	3.38	3.74	
Average yield (milled rice) (t/ha)	1.77	1.99	

The target of the second five-year plan is compared below with the statistically available figures of 1972.

	(1972)	(1978)	Increase	('78/72)
Cultivated area (thousand ha)	7,983	8,700	+717	(1.1)
Production (thousand tons)	13,274	17,332	+4,058	(1.3)
Yield per unit of area (t/ha)	1.66	1.99	+0.33	(1.2)

Thus, to increase rice production is planned by expanding cultivation area and increasing yield per unit area.

To achieve this target, irrigation and drainage facilities (especially, irrigation facilities) must be improved and increased for stable rice production, adequate fields for rice cultivation must be expanded and fields allowing double crops a year must also be expanded. Concurrently, the Bimas plan and the Inmas plan must also be promoted vigorously.

In any event, it is essential to improve the conditions of irrigation facilities for achieving these targets as well as for promoting the Bimas and Inmas plans.

The Indonesian Government recognizes these problems fully. It is determined to repair, rehabilitate and improve existing facilities and constructing new irrigation facilities for achieving the targets of this second five-year plan.

The Central South Sulawesi Water Resources Development was taken up from this view point. It is urgently important to begin these projects quickly. Generally speaking, water resource development projects require huge investments and many years. In view of the world-wide drought of 1972 and the world-wide food shortage, it will become more and more difficult to import foods from foreign countries. Therefore, early starting and early completion of projects are important. In other works, projects with immediate results, must be carried out quickly, regardless of their scale.

This should be fully considered in effort for promoting the project of the central South Sulawesi water resource developments. It will be effective and efficient to carry out this project by steps.

(2) Agricultural Conditions and characteristics of development region

1) On foundation of agricultural production (especially on land)

The land that is used for agricultural purposes is roughly classified into paddy fields (called as sawah) and upland (called as tanah-kering). The ratio of the two varies sharply among Kabupaten. The ratio of paddy fields and upland is 62:38 in Wajo prefecture, the farmer is greatly larger than the latter. But in Kabupaten Bone and in Kabupaten Soppeng, the latter is larger than farmer. The ratio is 41:59 in the total of South Sulawesi.

Selection between paddy field and upland seems to depend on the possibility for irrigation. Arable land is used as paddy field as long as enough water can be obtained from irrigation facilities or rainfall. In fact, there are no irrigation facilities for upland.

With regard to irrigation for paddy fields, almost one half of the paddy fields in South Sulawesi, have some irrigation facilities, while the other half are feel by rain-fed alone. Interests in irrigation facilities seem quite large, if the substance and function of those left out of consideration. Approximately 16% of total the paddy fields have technical irrigation facilities.

On the other hand, in Kabupaten Wajo where the ratio of paddy fields is the highest, 97% of total the paddy fields are rain-fed paddy field. Almost no paddy field has irrigation facility. This seems to be closely related to its location. Since the paddy fields in Kabupaten Wajo are distributed in the low flat area around Lake Tempe, their soil has large soil moisture due to sufficient overflowing water from the upstream part. Furthermore, it is technically impossible to construct irrigation facilities because of flood damages and absence of good water conservation.

It is Kabupaten Bone that is next to Kabupaten Wajo in terms of the ratio of rain-fed paddy fields. They account for about 80% of total the paddy fields. However, Kabupaten Bone has the irrigation facilities constructed by Holland and small other facilities.

Among the three Kabupaten, Soppeng Kabupaten has relatively large rainfall. Paddy fields are distributed from the gentle slope land with a mountain chain in the back to the flat land. With large and small rivers, this Kabupaten has the best water supply conditions among the three Kabupaten. The number of irrigation facilities (mostly simple head works) seems quite large, though their scale is small. In fact, rain-fed paddy fields account for only 13% of total the paddy fields, slightly less than 90% of the paddy fields seem to have some irrigation facilities. However, there is no large scale water irrigation facility due to relatively large rainfall and rich water conservation most of them are simple so-called semi-technical or village-system irrigation facilities.

Table 2-2-8 Luas Tanah Pertanian
(Date of Investigation: Sep. 14, 1973)

		Bone	Wajo	Soppeng	Sulawesi-Selatan Total
Sawah	Technical	(9.9%) ha 7,474	-	(11.6) 2,500	(15.5) 78,445
	Semi-technical	(6.8) 5,150	(0.6) 400	(38.9) 8,400	40,640
	Village-system	(4.8) 3,634	(2.5) 1,800	(35.7) 7,721	(22.7) 114,875
	Sederhana	(78.5) 59,198	(96.9) 69,363	(13.8) 2,992	(53.8) 271,994
	Total	(100.0) 75,456	(100.0) 71,563	(100.0) 21,613	(100.0) 505,954
Tanah-Kering (upland)	Tegalan	71,723	31,119	32,489	435,165
	Ladang	14,763	12,322	-	245,855
	Pekarangan	-	783	960	41,307
	Total	86,486	44,224	33,449	722,328
	Grand Total	161,942	115,787	55,062	1,228,282

Note: (1) The data were obtained from the Kepala Dinas Partanian Rakyat Propinsi Sulawesi Selatan

(2) "Ladang" is land for planting upland rice and corn.

(3) "Tegalan" is land for planting permanent crops, such as fruits, banana, coconut.

(4) "Pekarangan" is land around houses and used for planting vegetables and banana, etc.

The functions of irrigation facilities and irrigation conditions are suspected on the basis of dry season harvest area and wet season harvest area. (Dry season harvest area and wet season harvest area of rice depend on the amount of rainfall to a large extent. They are not necessarily adequate for estimating the effects of irrigation facilities.)

For the wet season, more than 80 - 90% of total the paddy fields are counted as harvest area in most Kabupaten except 1972 (year of large drought). This situation seems relatively stable. The 1972 drought brought about the largest damages to Kabupaten Wajo; where irrigation conditions are extremely poor and unstable. No harvest was obtained from one half of all the paddy fields. On the other hand, Kabupaten Soppeng shows relatively stable situation. The harvest area in this Kabupaten did not decrease much in 1972. This means that rice production depends not only on rainfall, but also on irrigation conditions discussed above. This clearly shows that good irrigation facilities make large contribution to stable rice production.

Table 2-2-9 Rating (%) of Harvest Area for Total Paddy Field Area

		1968	1969	1970	1971	1972	
Bone	W. S.	94.5%	91.2	96.2	91.7	70.6	(16,258 ha)
	D. S.	8.1	13.0	5.5	99.2	7.9	
Wajo	W. S.	86.8	85.5	93.3	77.8	51.2	
	D. S.	41.6	13.7	238.5	161.0	72.0	
Soppeng	W. S.	91.9	97.8	90.7	89.6	87.4	
	D. S.	10.1	9.4	41.4	95.9	13.1	
Solawesi-Selatan Total	W. S.	91.8	86.8	88.9	84.2	68.8	
	D. S.	23.2	26.2	31.3	57.7	27.1	

(1) W. S. = Wet season

$$\frac{\text{Wet season harvest area of each year}}{\text{Total paddy field area (1973)}}$$

(2) D. S. = Dry season

$$\frac{\text{Dry season harvest area of each year}}{\text{Paddy fields with irrigation facilities ('73)}}$$

Now, all of the existing irrigation facilities are head works. None of them can store water, like dams. Therefore, dry season rice cropping depends completely on river discharge. Therefore, cultivation area change sharply each year.

It is Kabupaten Soppeng that relatively large dry season cropping is obtained. About 10% of total the paddy fields seem to allow cultivation in an ordinary year. In 1971, the dry season harvest was almost as large as the wet season harvest. On the other hand, dry season cultivation is limited to certain exceptional districts in Kabupaten Wajo and Bone.

Table 2-2-10 Transition in Dry Season, Wet Season and Upland Harvest Area of Rice

Kabupaten		1968	1969	1970	1971	1972
Bone	W. S.	71,282	68,827	72,586	69,172	53,255
	D. S.	1,309	2,121	888	16,131	1,287
	Total			73,474	85,303	54,542
	Upland	11,387	14,960	11,267	9,711	6,759
Wajo	W. S.	62,137	61,167	66,804	55,679	36,609
	D. S.	916	302	5,248	3,543	1,585
	Total			72,052	59,222	38,194
	Upland	2,477	433	4,012	5,784	3,932
Soppeng	W. S.	19,866	21,137	19,597	19,361	18,896
	D. S.	1,879	1,754	7,708	17,850	2,447
	Total			27,305	37,211	21,343
	Upland	2,953	2,026	1,666	1,333	1,232
Sulawesi-Selatan Total	W. S.	464,272	439,216	449,556	426,122	348,187
	D. S.	54,323	61,232	73,246	134,966	63,360
	Total			522,802	561,088	411,547
	Upland	49,886	55,879	43,537	44,264	33,704

In sum, wet season rice production seems to be relatively stable in the three Kabupaten (Bone, Wajo, Soppeng) due to relatively rich rainfall, although the absolute production shows yearly fluctuations (it will be discussed later). Dry season crop is limited to certain exceptional paddy fields in Bone and Wajo Kabupaten, though it is possible to some extent in Kabupaten Soppeng. It seems insufficient.

In view of the food problems in The Republic of Indonesia and the development of regional agriculture, water resources developments in this region facilitates the expansion of rice cropping cultivation area and help to relieve the food problem in The Republic of Indonesia. And that it will be a basis for future development of regional agriculture.

In this sense, adequate and strong administrative guidances for farm households are desired consurrently with water resources developments.

Such administrative guidances should not only include instructions on agricultural management and techniques, but also are directed to the future development of regional agriculture in consideration of agricultural problems in The Republic of Indonesia.

2) Socioeconomic conditions

a. As Fig. 2-2-5 shows, The Republic of Indonesia consists of numerous islands (more than 3,000 islands). The largest island is Kalimantan Island (550 thousand Km^2, which accounts for 27% of the whole country). It is followed by Sumatra Island (540 thousand Km^2), West Irian Island and Sulawesi Island is the fourth largest island in Indonesia.

Its total area is 228 thousand Km^2, which accounts for about 12% of The Republic of Indonesia.

Sulawesi Island is divided into four provinces, namely, North Sulawesi, Central Sulawesi, South Sulawesi and South East Sulawesi. Currently, The Republic of Indonesia is divided into 26 provinces (administrative divisions). Four of them are in Sulawesi Island.

The region for the central South Sulawesi water resources development is located almost at the center of South Sulawesi State.

The capital of South Sulawesi Province is Ujung Pandang (old Makkasar), located in the south of the east coast. It is said to have the population of about 560 thousand. It is becoming more important as the center of traffics, transportation, commerce, industry and administration. It is developing as the seventh city in The Republic of Indonesia.

It is said that Sulawesi Island in the most advanced island among the outer islands. Especially, South Sulawesi Province is said to enjoy the most advanced stage, chiefly in agriculture.

Table 2-2-11 Area and Population in Sulawesi (1971)

Province of	Area	Population
North Sulawesi	24.3 10 thousand km^2	1,718 thousand
Central "	88.6	914
South "	82.8	5,189
South East "	32.0	714
Total	227.7	8,535

The source of the data is identical with that of Fig. 2-2-1.

Automobiles are used exclusively for traffics within the province. Bus routes cover almost the entire region, with Ujung Pandung as the center. They allow relatively easy travelling.

Inter-city trunk roads have been constructed, especially in the south. However, minor roads to be connected to the trunk roads have not been constructed sufficiently. The road conditions in the north are still poor.

b. The present investigation covered three Kabupaten (Wajo, Bone, Soppeng), located in the south of South Sulawesi province. The investigation mission went to Sengkang (with the Bupati office of Kabupaten Wajo where we stayed as the basic for field survey) via Moras (about 30 Km between Ujung Pandung and Maros). The road conditions were relatively good and it took about 4 - 5 hours by car. (See Fig. 2-2-5 for reference.)

Sengkang is a small town with the population of about 40 thousand, located near Lake Tempe.

It is about 40 Km (one hour car trip) from Soppeng (the Bupati office of Kabupaten Soppeng) and about 80 Km (two hour car trip) from Watampone Bupati office of Kabupaten Bone). Administratively, a Regency (Kabupaten) is divided into districts (Kecamatan), which are also divided into villages (Desa).

Kabupaten Wajo	10	Kecamatan
Kabupaten Soppeng	5	"
Kabupaten Bone	21	"

No data on Kecamatan was obtained from the present survey. And we have no time to analize to the extent. Therefore, the data are summarized by the unit of Kabupaten.

c. Of the three Kabupatens, Kabupaten Bone has the largest population (about 600 thousand). It is followed by Kabupaten Wajo (about 300 thousand) and Kabupaten Soppeng (about 230 thousand) in this order. According to the information obtained at the field, these three Kabupaten previously formed one large Kabupaten and Watampone of Bone Kabupaten was the center of the Kabupaten.

Table 2-2-12 Population by Kabupaten

unit: person

Kab.	Division	1971	1972	1973	Remarks
Wajo	Male Female Total Ratio of farmers	 322,225	 325,298	 305,275	
Soppeng	Male Female Total Ratio of farmers	112,091 117,832 229,933 88%	116,328 115,818 232,146 88%	114,338 118,712 233,050 88%	
Bone	Male Female Total Ratio of farmers	284,759 312,184 596,943 75%	285,945 315,768 601,713 75%	285,375 321,526 606,901 75%	
Entire South Sulawesi Province	Male Female Total		2,596,622 2,695,463 5,292,085		

The data were obtained from provincial and Kabupaten agricultural offices.

Let's describe the present condition of the Bimas and Inmas plans, which are directly related to increasing of food production. Since irrigation facilities are the necessary conditions for these plans, the state of progress seems to have correlation with the availability of irrigation facilities as related some time ago.

In other words, the Bimas and the Inmas plans are widely applied in Kabupaten Soppeng in the best irrigation conditions. The plans were applied to 89.2% (17,541 ha) of all the paddy fields (21,613 ha) in 1973. This means that the plans were applied to almost all the paddy fields in irrigation conditions.

On the other hand, in Wajo the plans are not widely carried out because of extremely poor irrigation conditions. They were applied to only 18% (13,000 ha) of all the paddy fields (71,563 ha) in 1973.

In other words, paddy fields without irrigation facilities are not ready for the Bimas and the Inmas plans. They exist simply as paddy fields of low productivity and little contribution to increasing food. To increase the productivity of paddy fields and to increase food production, irrigation facilities must be improved at the first stage and the Bimas plan and the Inmas plan must be carried out at the second stage. This indicates the importance and the necessity of irrigation facilities.

Table 2-2-13 Application of Bimas plan and Inmas Plan

Unit: ha

Kabupaten	Bimas Plan			Inmas Plan			
	1971	1972	1973	1971	1972	1973	Remarks
Soppeng	4,155	10,281	7,541	2,000	6,890	10,000	
Wajo	787	5,042	10,000	-	3,334	3,000	

The data were obtained from the Kabupaten agricultural offices.

One of other important factors that determine the agricultural development in the future is farmer's consciousness.

Energy for growing out of the present conditions and making new progresses rarely come from farmers themselves or from agricultural societies.

It is generally said that farmers are extremely conservative. Left the degree of rich and poor out of consideration. This seems attributable to the fact that they can it least produce the necessary food for themselves.

Group activities and organizations among farmers seem to indicate the state of problem-consciousness among farmers. Group activities, whether or not directed by leaders, etc., seem to be the first developmental stage of agricultural societies based on intention. As witnessed in the agricultural societies in the world, group activities and organizations among farmers were attempts to protect and maintain agricultural societies and to protect the life of farmers.

It is widely known that agricultural cooperative societies led the history of farmers' organizations. In any event, study groups working for the development of agricultural society with same intention or common operations (common sales of agricultural products, common purchase of agricultural materials and equipments, common field works, etc.) are important for the development of agricultural societies.

Table 2-2-14 shows the beginning of organizations among farmers in this region, although neither their contents nor their activities were investigated. However, these groups are still exceptional.

Table 2-2-14 Farmers' Groups

	Group		Remarks
	Number of groups	Number of members	
Soppeng	61	1,315	
Bone	63	1,389	

The data were obtained from Kabupaten agricultural offices.

When irrigation facilities are completed, group cultivation system must adopted for the rational use of water. This will develop into common sales of agricultural products, common purchase of agricultural materials, etc.

Currently, agricultural products are sold freely.

Its effects on price fluctuations are studied below. At present, agricultural products are sold by merchants in The Republic of Indonesia, rather than by completely free system. Therefore, the price depends on the quantity of available products. This applies to rice, the staple food. Fig. 2-2-6 shows the price fluctuation of milled rice (local variety called as Beras bulu) during the recent three years.

The price of rice remained almost stable (30 - 40 Rp/Kg) until June, 1972. However, it began to rise suddenly from July due to the drought. It reached the peak in Jan. - Feb., 1973 due to the sharp cut in the yield of the wet season crop. It went above 100 Rp/Kg. It was not possible to meet demand with supply from the government stock due to the shortage of the obsolute quantity and the sudden price rise. A large amount of rice had to be imported.

It is reported that more than 1 million ton (even 1.5 million ton) of rice had to be imported in 1972. This was a large burden on the foreign currency situation.

It is true that farm households' economy is extremely unstable because of such large price fluctuations. It is of course impossible to solve these problems by organizing farmers. However, there are clear advantages for facing with problems as organizations.

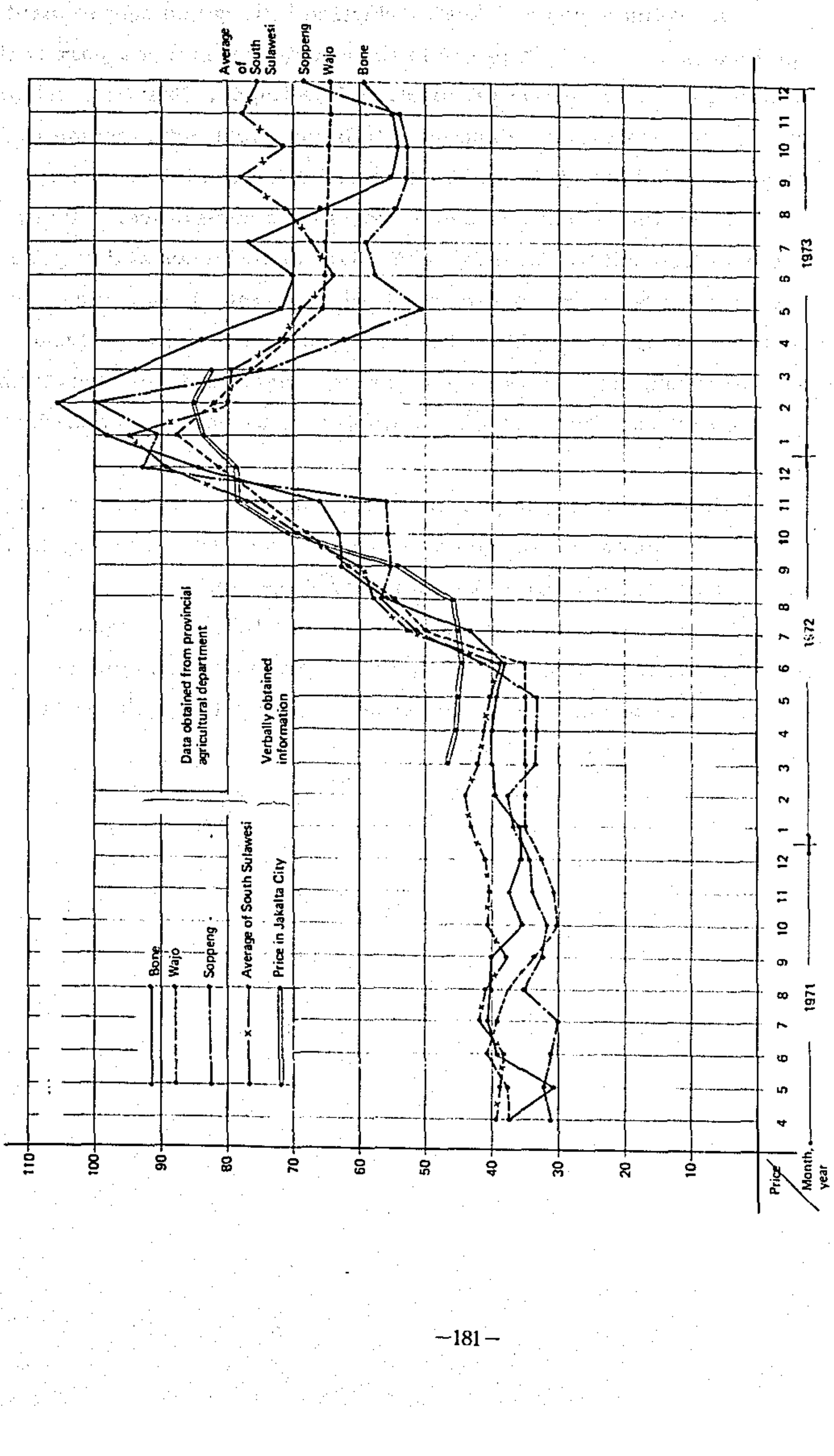


Fig. 2-2-6 Price of Milled Rice (R/P/Kg) - Local Variety (Beras bulu)

The socioeconomic situation of this region can be summarized as a considerably developed agricultural village region. Farmers account for 70 - 80% of the total population.

In ordinary years, rice production is large enough to meet the local demand. It is possible to transfer or export a part of the production. Cash crops (coconut, coffee Kapok, Tabacco, rubber, etc.) are transferred or exported to bring about cash income to farm households. This makes a contribution to their economy.

Many improvements can work as the prime mover for the regional agricultural development. Group activities and organizations among farmers require the largest attention from the socioeconomic standpoint. There are numerous kinds of group activities and organizations and various regional differences must be taken into account. It will be important to start with possible things.

Therefore, it will be important to grasp the current conditions in agricultural villages and problem recognition among farmers for studying the direction for future development.

Concrete methods and ideas must be studies to organize farmers for increasing the agricultural production in emergency and for rationalizing the use of water. Efficient administrative guidances are expected for it.

Table 2-2-15 Farm Households Classified by Size of Landholding (1973)

Land Holding (ha)	Bone	Wajo	Soppeng	Total of Sulawesi
0.1-0.5	30,750	7,821	7,293	188,886
0.5-1.0	22,150	9,273	9,735	132,462
1.0-1.5	9,850	6,468	4,881	71,288
1.5-2.0	2,700	2,904	1,716	27,312
2.0-3.0	3,100	2,442	1,452	26,497
3.0-4.0	1,000	660	264	8,799
4.0-5.0	550	231	165	4,001
more than 5.0	300	297	264	8,167
Total	70,400	30,096	25,773	443,556

The data were obtained from the provincial agricultural service.

3) State of agricultural production

Table 2-2-15 and Fig. 2-2-7 show the production of major crops in this region.

Rice and corn are the major food crops in all the prefectures, although some yearly differences are found. The production of cassava is extremely small. The harvest area of rice tends to be larger than that of corn in all the prefectures. The difference between the two is extremely small in Kabupaten Soppeng. In 1973, the harvest area of corn was larger than that of rice in Kabupaten Bone and Soppeng.

The production of rice is extremely large in this region. Therefore, corn is cultivated not only for local consumption, but also for other regions.

The corn production has remained almost at a fixed level, though with slight ups and downs. However, the production droped to are third in 1972 due to the large drought. People obviously suffered from considerable food shortage in this year. However, the production rose again to the normal level in 1973. It even rose above the normal level in some prefectures. In any event, corn production depends heavily on weather and other natural conditions. The drought of 1972 clearly indicates this.

Table 2-2-16 Production of Major Crops
(The data were obtained from the Provincial Agricultural Service)

Kabupaten	Year	Padi-sawah		Padi-Ladang		Total production of rice	Corn		Cassave	
		Harvest area (ha)	Production (t) (1)	Harvest area (ha)	Production (t) (2)	(1) + (2) (t)	Harvest area (ha)	Production (t)	Harvest area (ha)	Production (t)
Bone	1969	69,015	138,370	11,390	10,641	149,011	67,254	48,926	910	5,666
	1970	75,029	205,977	14,749	13,705	219,682	43,337	30,335	985	6,005
	1971	71,967	160,233	9,672	10,766	260,999	24,760	18,583	691	3,237
	1972	19,097	53,241	1,498	564	53,805	17,748	10,694	778	3,829
	1973	68,153	187,549	6,937	8,448	195,997	70,489	52,903	2,124	14,395
Wajo	1969	49,696	131,740	4,027	8,064	189,804	9,780	10,357	602	7,375
	1970	58,842	199,881	2,877	7,482	207,363	13,806	10,050	733	7,187
	1971	52,133	177,479	5,749	12,538	190,017	4,108	4,360	1,583	16,100
	1972	13,026	27,269	139	191	27,460	8,105	8,331	1,698	14,009
	1973	53,025	199,405	1,721	3,816	203,221	38,944	44,744	3,624	33,312
Soppeng	1969	21,621	69,008	2,026	2,732	71,740	18,688	18,612	132	1,325
	1970	20,246	68,285	1,666	3,333	71,618	22,398	22,174	106	1,060
	1971	28,134	112,891	1,333	1,578	114,469	18,553	15,605	155	1,550
	1972	19,988	56,678	240	399	57,077	15,289	13,832	74	667
	1973	18,152	88,137	1,240	2,454	90,591	44,485	41,201	119	950
Total of Sulawesi Selatan	1969	466,869	1,201,489	50,610	68,498	1,269,987	316,061	224,783	44,684	341,217
	1970	480,280	1,625,928	65,777	41,754	1,667,682	280,850	212,767	35,963	267,073
	1971	481,944	1,621,412	61,561	20,493	1,641,905	194,711	144,449	32,634	265,597
	1972	359,170	1,205,860	20,493	27,388	1,233,248	167,364	117,845	42,576	315,745
	1973	456,913	1,540,166	33,094	43,897	1,584,063	408,895	343,134	40,170	309,624

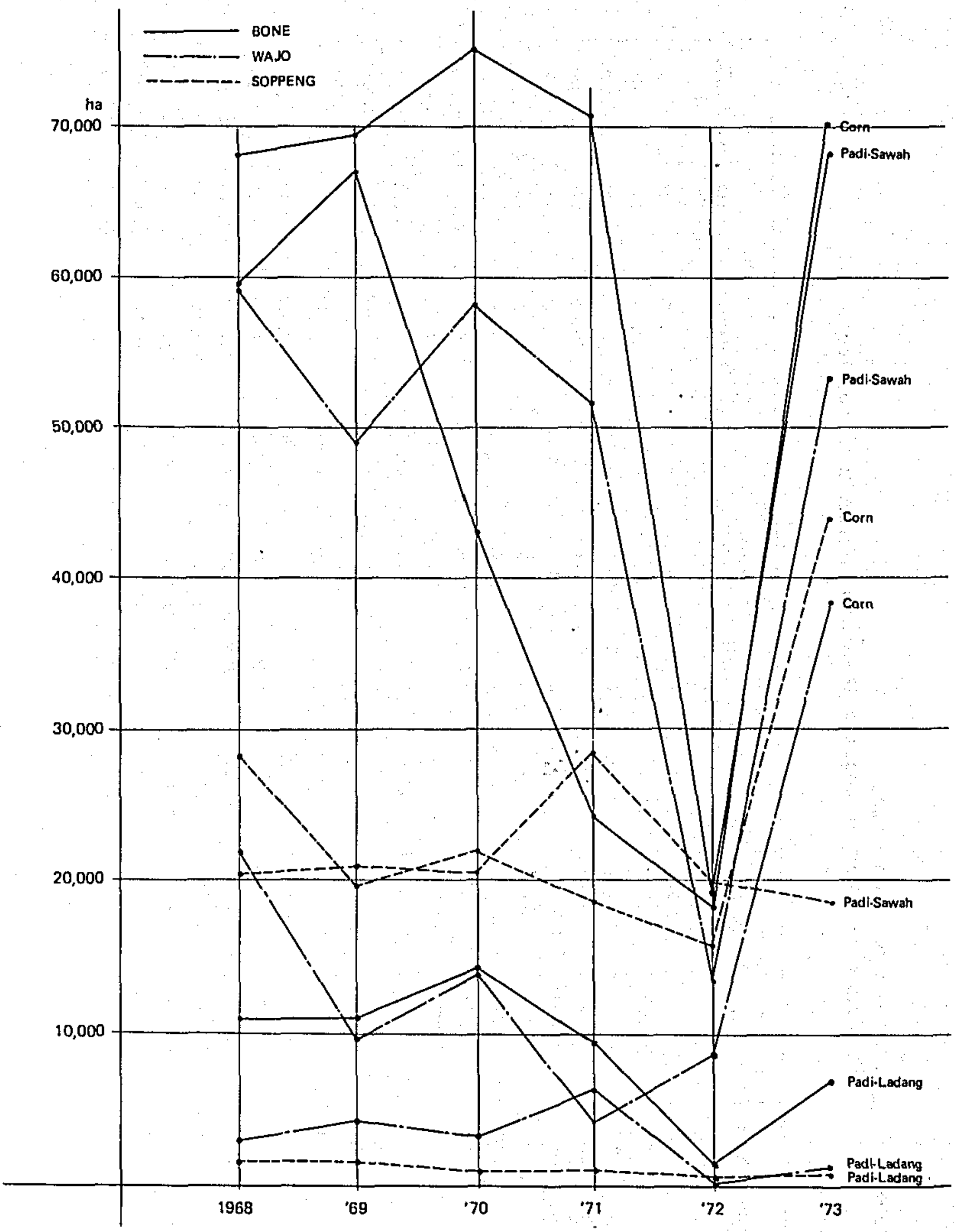


Fig. 2-2-7 Transition in Harvest Area of Paddy Rice and Corn in Three Kabupaten

Fig. 2-2-8 shows the production of rice and corn per head in the three Kabupaten. The figures were obtained by dividing the production of rice and corn by the population in this region.

In other words, the rice production per head is around 200 Kg. It is even above 300 Kg in some cases. In other words, the rice production is sufficient for local demand in this region. A considerable amount of rice seems to be carried to other districts.

However, the rice production is around 150 Kg in the entire Sulawesi Selatan. Since this means a good balance between demand and supply, there is no surplus production for other districts.

In any event, these figures are quite higher than the national standard in The Republic of Indonesia. (See Fig. 2-2-4 for reference.)

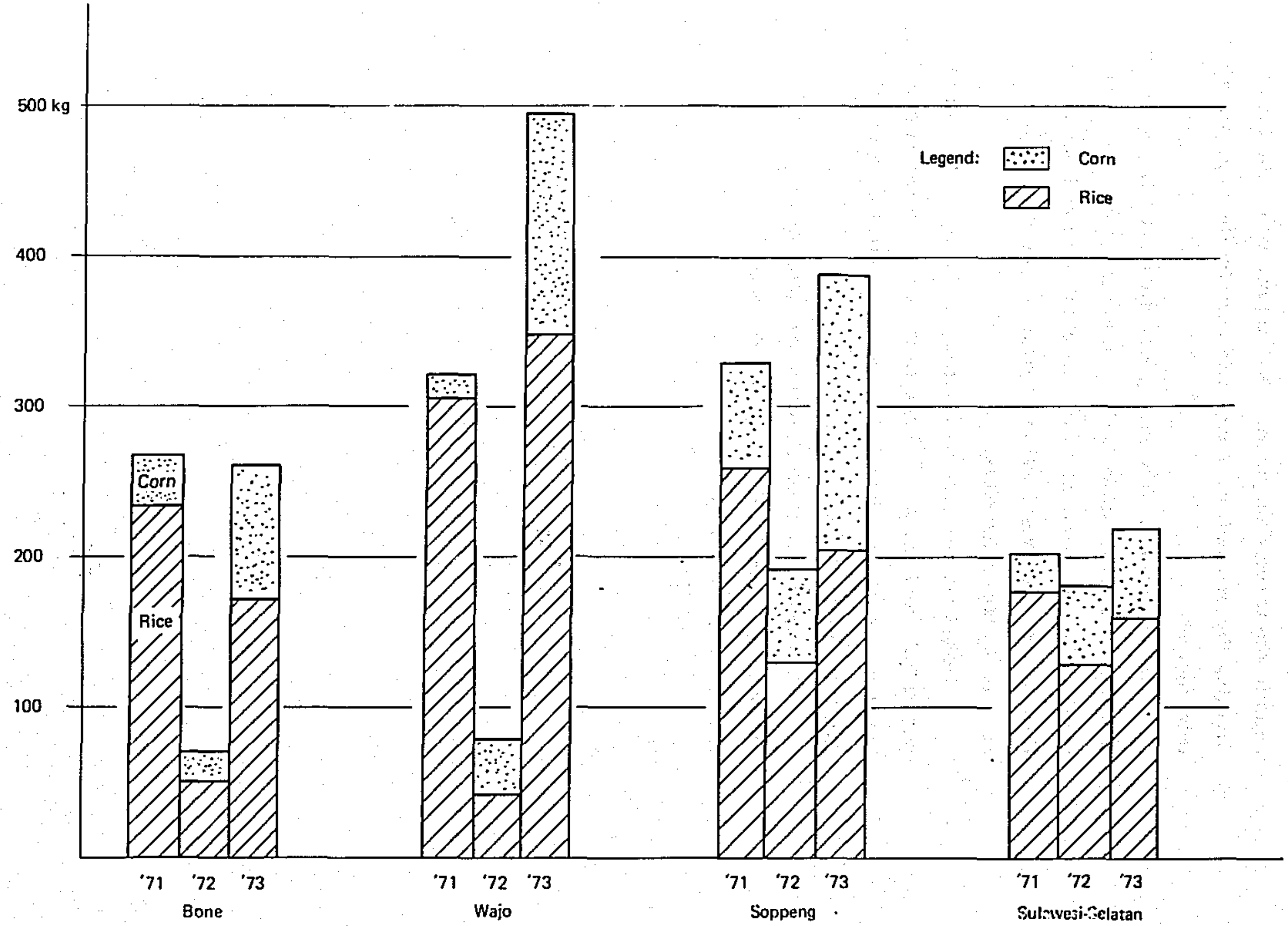


Fig. 2-2-8 Production of Major Food Crops Per Head

(The data were obtained from the provincial agricultural service)

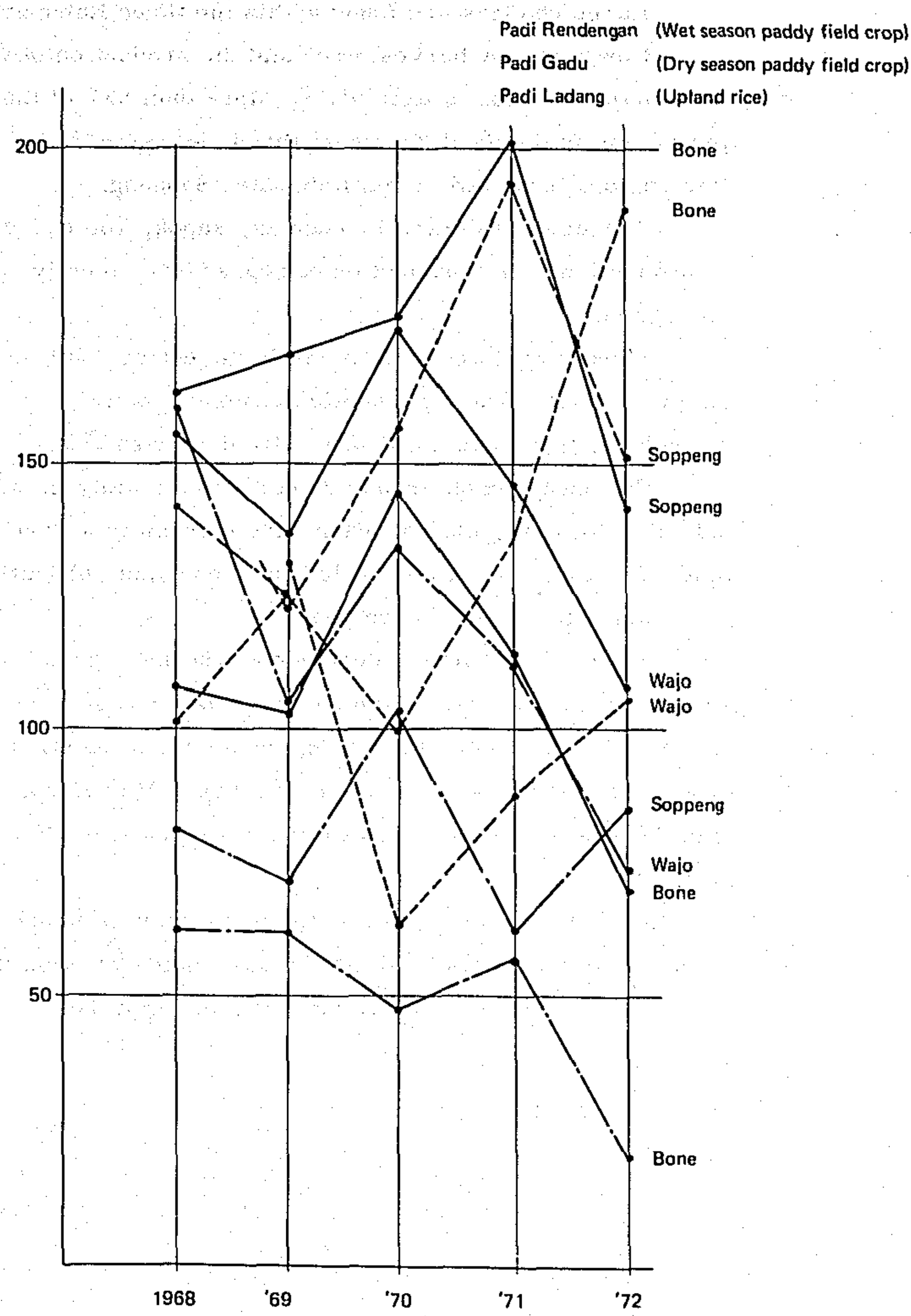


Fig. 2-2-9 Transition in Yield Per 10 Ha.

Finally, Table 2.2-17 shows the figures related to the cultivation and production of cash crops for export.

Large changes are found within the three Kabupaten.

However, the harvest area and the production of tabacco remain quite stable in each year. More than 95% of the tabacco production in the South Sulawesi Province comes from this region, especially from Kabupaten Soppeng.

Tabacco is followed by coconut, kapok, komiri, etc., in production. The production of pepper has recently been increasing.

These crops are still minor in the entire South Sulawesi State. Their production changes yearly. Therefore, they have not really settled as cash crops.

Currently, cash crops are cultivated mainly in the upland. However, the conditions are extremely severe. Since successive cropping is difficult, constant cultivation area cannot be secured each year.

In view of the future development of the regional agriculture, it is good to make efforts to increase rice production. However, increasing cash crop production must also be considered at the next stage. Therefore, this must be studied sufficiently at the stage of master plan preparation.

It must be emphasized that studies must be made from a high stand point with sufficient consideration in the development of local farmers and local agriculture.

Table 2-2-17 Cultivation and Production of Major Export Crops (The data were obtained from the provincial and Kabupaten agricultural offices

Kabupaten	Year	Coconut		Tabacco		Pepper		Kapok		Coffee		Kemiri	
		Harvest area (ha)	Produc-tion (t)	Harvest area (ha)	Produc-tion (t)	Harvest area (ha)	Produc-tion (t)	Harvest area	Produc-tion	Harvest area	Produc-tion	Harvest area	Produc-tion
Bone	1969	2,392	2,392	6,176	1,544	('71) 119	35	600	300	10	3	1,206	403
	1970	3,940	3,940	151	61	('72) 35	-	628	300	8	9	1,512	410
	1971	-	-	174	38	('73) 45	8	2,215	522	-	-	2,095	12,056
Wajo	1969	4,199	4,697	1,351	675			251	50	-	-	238	138
	1970	4,500	4,500	100	40			267	1,450	-	-	280	194
	1971	-	14,299	1,150	290			-	1,470	-	2		1,357
Soppeng	1969	651	652	6,941	3,145	('71) 2,668	2.7	451	275	6	4	197	197
	1970	503	498	7,450	3,525	('72) 1,494	1.3	500	75	8	4	197	197
	1971	-	506	13,296	21,472	('73) 1,494	1.5	-	4,988	-	16		843
Total South Sulawesi	1969	53,509	59,757	15,214	5,737			8,600	1,533	10,254	4,966	9,576	4,739
	1970	58,142	61,366	8,433	3,927			2,897	2,664	10,148	5,776	8,921	2,292
	1971	22,887	49,800	15,021	22,075			2,846	18,576	10,195	6,859	4,136	20,797

2.1.3 Irrigation

(1) Present Conditions of Benefited Areas

The prospective benefited areas are four Kabupaten: Sidrap, Wajo, Soppeng, and Bone

According to the data obtained from the water resources sections of the three regencies we visited, the existing irrigated areas are as follows:

Table 2-3-1 Irrigated Areas in Benefited Kabupaten

Unit: ha

Classification	Wajo	Soppeng	Bone
Technical irrigation area	-	2,000	7,000
Semi-technical irrigation area	500	3,600	5,000
Village irrigation area	5,110	7,995	23,000
Rain-fed paddy field	63,586	16,961	39,000
Upland	45,184	32,000	86,000
Total	114,380	56,693	160,000

(See Fig. 2-3-1)

The table shows that the area of irrigated paddy fields is small, whereas rain-fed paddy fields and dry fields account for a very high percentage. Most of the rain-fed paddy fields are left unattended in the dry season.

1) The greater part of the area in the neighborhood of the Bila, Boya, and Gilirang rivers is very gently, evenly sloping rain-fed paddy fields. A part of the area, or an area of about 4,000 ha on the left bank of the Bila, is already irrigated

by a tributary, the Larumpu River. The Boya River, a large tributary of the Bila River, has a Bulucenrana Weir, constructed around 1930, by which 3,600 ha is now irrigated. But both the intake structure and the distribution system of the weir need repair and rehabilitation. The rehabilitation would allow the irrigation of 5,500 ha.

2) According to our preceding report, the prospective irrigation area along the Cenranae River was to be irrigated by the natural intake of 4.0 to 5.5 m in elevation controlled by the regulating gates near the outlet of Lake Tempe. However, Survey conducted this time shows that the taking water by gravity is infeasible. That is, since the true height is 3.0 m in elevation even at the Swampy area down in the benefited land, the main irrigation canal needs to be extended over 30 Km. The benefited land is made up of gently undulating rain-fed paddy fields and swampy ground.

3) The Lawo, Langkemme and Walanae Rivers Irrigation Project Area (for which weater is to be taken at Ludunge) is a littoral terrace area along the Walanae River. Most of the area is gently undulating rain-fed paddy fields and dry fields.

4) The Sanrego River Irrigation Project Area is a basin on the right bank of the Walanae River. Along the upper reaches are somewhat rolling dry and rain-fed paddy fields, while along the lower reaches are level rain-fed paddy fields and dry fields.

5) The Walanae River Irrigation Project Area (for which water is to be taken from the Mong Dam) is a wide area covering the medium - and low - level parts along the right bank of the Cenranae River, Kabupaten Bone. (A part of the area is semi-technical irrigation area.)

Table 2-3-2 River Basin Characteristics at Prospective Location of Intake Facilities

River	Catchment Area (Km^2) (A)	River Length (Km) (B)	Max. Elevation of Catchment Area (m) (C)	Elevation at Intake Site (m)	Max. Head of Catchment Area (m) (D)	(D)/(B)	(A)/(B) (Km)	Remarks
Bila	341	28	3,073	50	3,023	1/9.3	12	
Boya	552	60.6	3,200	35	3,165	1/19	9.1	
Gilirang	70	17	200	45	155	1/110	4.1	
Cenranae				4.0				Water surface
Lawo	64	15	1,357	60	1,297	1/11.5	4.3	
Langkemme	102	14.4	1,463	175	1,288	1/11	7.1	
Sanrego	189	27.5	1,600	165	1,435	1/13	6.9	
Waranae (Ludunge)				33				
Walanae (Mong)	2,710			35				

Table 2-3-3 Observed River Conditions at Intake Sites

River	River Breadth (m)	River Gradient	Average grainsize (cm)	Droughty-Water Discharge (m^3/s)	Specific Discharge at Droughty time ($m^3/sec/Km^2$)	Remarks
Bila	70 - 100	1/500 - 1/700	3 - 4	4 - 5	0. 013	
Boya	110	1/500 - 1/600	3 - 4	5 - 6	0. 012	Bulu Cenrana completed in 1930.
Gilirang	30 - 40	1/1000	1 - 2	1 - 2	0. 02	
Cenranae	70 - 100		0. 04			
Lawo	30 - 70	1/70	5 - 10	2 - 3	0. 039	
Langkemme	30 - 50	1/10 - 1/ 20		5 - 6	0. 054	Torrents
Sanrego	40	1/70 - 1/100		8	0. 042	Outcropping rocks seem on riverbed
Walanae (Ludunge)	80	1/500 - 1/700	3 - 4	30	0. 014	

(2) Brief Description of Intake Sites

The prospective locations of intake facilities are shown in Fig. 2-3-1, the river basin characteristics at the prospective locations in Table 2-3-2, and the observed river conditions at the prospective intake sites in Table 2-3-3.

A more detailed description is given below.

1) Bila, Boya & Gilirang

These areas are located to the north of Lake Tempe. The Boya River is a tributary of the Bila River, which flows into Lake Tempe.

The Gilirang River flows directly into Bone Bay on the eastern side.

a) Location of planned Head Works in the Bila River

As shown in Table 2-3-2, this river is in a very steep location. It is expected, therefore, that rainfall runs down into the river fairly rapidly. When a survey was conducted on February 11, in 1974, the river discharge was about 50 m^3/s, in spite of the dry season and the water was clear. Judging from the fact that rafts were operated, it is considered that the forestal conditions are relatively good.

The droughty-river discharge provides a very important factor for establishing an irrigation plan. Based on a survey through interviews, the droughty-river discharge is estimated at 4 to 5 m^3/s. The value is practically reasonable, as compared with the specific discharge of Japanese rivers.

b) Proposed weir site

This river has a 110 m - wide, 3.6 m - high Bulucenrana Weir.

The weir was completed in 1930, and its expected amount of water to be taken is 5.6 m^3/s.

When a survey was conducted on February 17, 1974, the river discharge was estimated at 50 to 60 m^3/s. As shown in Table 2-3-2, the catchment area at this point is far larger than the intake site of the Bila River. The mountain on the eastern side of this catchment adjoins the catchment of the Bila River, and the altitude is of about 3000 m. The northern side is surrounded by the mountains of 2000 m in elevation, and the western side forms an elevation of 500 to 800 m. Accordingly, the droughty discharge is comparatively large, as shown in Table 2-3-3. The specific discharge in a droughty period is 0.012 $m^3/s/Km^2$ assumed as an appropriate value.

c) Proposed weir site on the Gilirang River

This river is formed by the erosion in a hilly district. As shown in Table 2-3-2 even the maximum elevation is only 200 m. According to a survey, the vegetation is poor and the water - holding capacity of ground seems inadequate. As shown in Table 2-3-3 the droughty discharge is therefore estimated at 1 to 2 m^3/s. The rainy season lasts from June to August, while the dry season covers a very long period extending from December to the next May.

The river is at the stage that bank erosion is progressing, and the erosion at the time of flood is expected to be large.

2) Proposed Intake site on the Cenranae River

The currently proposed intake site is near the confluence of the Cenranae and the Walanae. For the rising period of Lake Tempe, the Walanae River flows into both Lake Tempe and the Cenranae River. For its reducing period the Walanae River, together with the water of Lake Tempe, flows down into the Cenranae River. This is the typical flow pattern. This is due to the fact that the discharging capacity of the River is small as compared with that of the Waranae River and that the water of Lake Tempe empties into Bone Bay through the Cenranae River in the dry season. Thus Lake Tempe performs the function of a kind of flood control. Since the external force applied to the river flow is only gravity, such a phenomenon is affected by the condition of the Cenranae River, including the water level of Bone Bay and the condition of the estuary.

Storing the discharge of the Walanae River in Lake Tempe to utilize it as irrigation water is the plan in this area. Although the surface slope in this neighborhood is very complicated the size of bed material is pretty small. The river bredth is about 100 m, and the depth is estimated at about 3 m for the low - water period.

3) Proposed Intake site in the Lawo River

The catchment area at this site is very small (refer to Table 2-3-2. The watershed is adjacent to the catchment area of the Langkemme. The droughty discharge is said to be 2 to 3 m^3/s, or a unit river discharge of 0. 039 $m^3/s/Km^2$, which seems to be a too large figure. The river discharge on February 16, 1974 was estimated at about 10 m^3/s. Taking water is already done by a masonry weir, however, the amount is very small. This intake site is situated on the concave side of a bend, (left bank) where outcropping rocks are seen and the flowing course is stable.

4) Proposed Intake site in the Langkemme River

This river is a tributary of the Mario River, which joins the Walanae River at a point upstream of the Mong Dam. On the northern side of its catchment area, this river adjoins the Lawo River, and the whole catchment area is surrounded by mountains about 1000 m in elevation. The intake site is situated on a stream formed by agglomerate. The river slope is estimated at 1/10 to 1/20. The droughty river discharge is estimated at 5 to 6 m^3/s, but the resultant unit river discharge of 0.054 m^3/s might be too large. The river discharge on February 16, 1974, was estimated at 10 to 15 m^3/s.

It is said that the rainy season in this area begins in March and ends in July, while the dry season lasts from August to next February.

5) Proposed Intake site on the Sanrego River

This area is located along the uppermost reaches of the walanae River. The proposed intake is planned for the irrigation on the right bank (in Bone regency) of the Walanae River. According to the interiews made on a field survey, the droughty water discharge is about 8 m^3/s. It is said that the river discharge is constant because it is derived from ground water coming out of a spring. This discharge represents a considerably large unit river discharge.

The river discharge is large from February to April and is small from July to September. The period in which the paddy fields need the water supply is from April to August.

When a survey was conducted on February 15, 1974, the river discharge was estimated at about 40 m^3/s. Outcropping rocks are seen on the river bed, and the river gradient is large, and the Sanrego at the intake site is regarded as a so-called stream.

6) Proposed intake site at Ludunge on the Walanae River

This site is on the main stream of the Walanae River and is located downstream of Mong Dam. When a survey was made on February 12, 1974, the riverdischarge was estimated at about 300 m^3/s. Droughty water discharge is said to be about 30 m^3/s. Outcropping rocks are seen on the proposed intake site.

(Note) Results of the Sounding of Lake Tempe

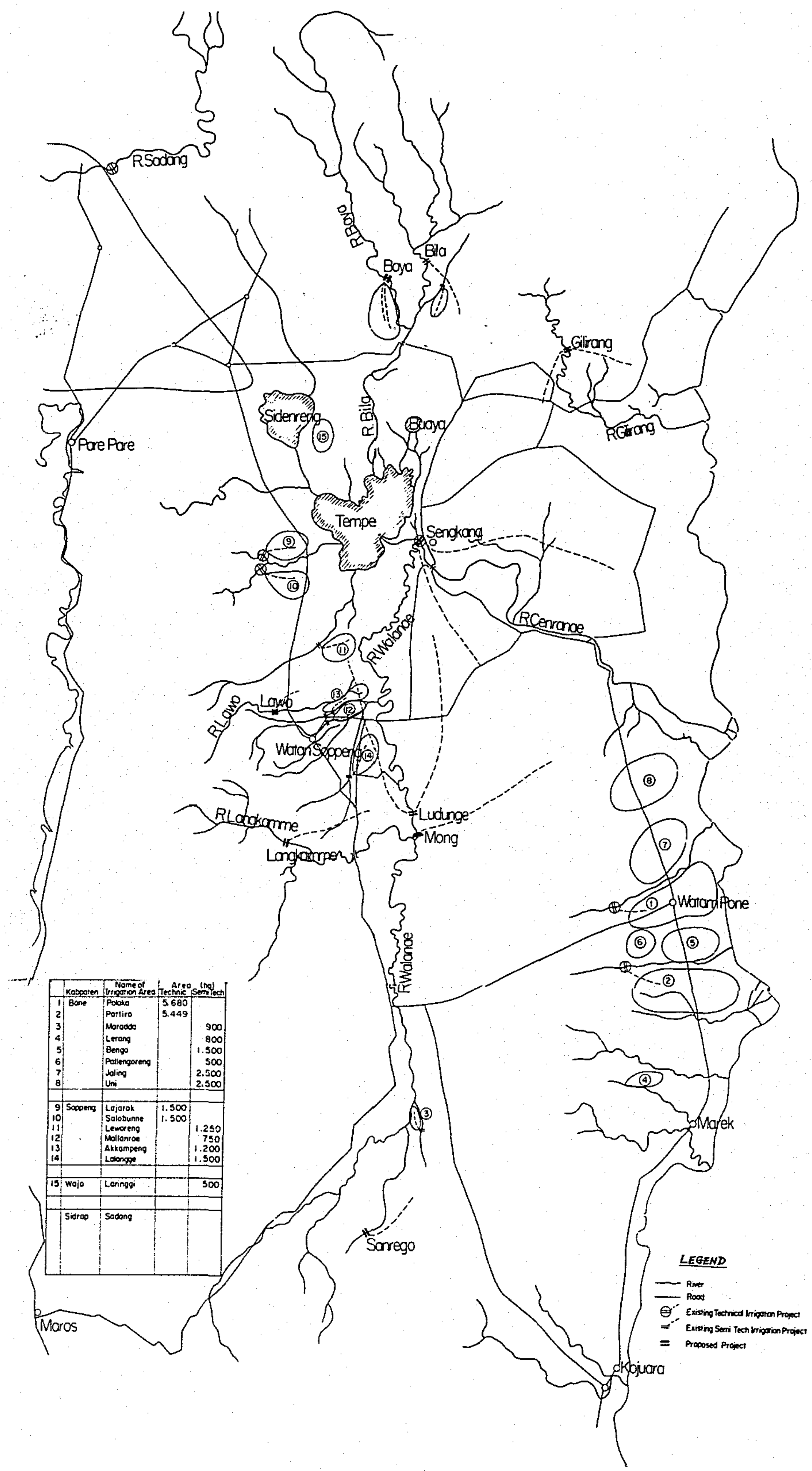
The water depth and the water level of Lake Tempe, unknown so far, were known as shown in (Fig. 3-1) by sounding by means of an echo-sounder and by a bench make survey.

It is known that the bench marks now usable around Lake Tempe are:

Wp, 84 - EL,18. 00 m

Wp, 106 - EL, 8. 00 m

(See the one - to - fifty - thousand topographical map.)



	Kabpaten	Name of Irrigation Area	Area (ha) Technic	Semi Tech
1	Bone	Polaka	5.680	
2		Pattiro	5.449	
3		Maradda		900
4		Lerang		800
5		Benga		1.500
6		Pallengoreng		500
7		Jaling		2.500
8		Uni		2.500
9	Soppeng	Lajarok	1.500	
10		Salobunne	1.500	
11		Leworeng		1.250
12		Mallanroe		750
13		Akkampeng		1.200
14		Lalongge		1.500
15	Wajo	Laninggi		500
	Sidrap	Sadang		

Fig. 2-3-1 Proposed Irrigation Project Areas

2.2 Problems in the Present Conditions

2.2.1 Agriculture

The present conditions of the surveyed area and a few problems were pointed out in section "Natural Conditions and Existing Agricultural Situation." A few remaining problems are taken up here. Some observations are made about them to provide data for the establishment of the goal for each stage of agricultural development of the surveyed area.

(1) Natural conditions

The natural conditions that have the greatest influence on agriculture are the amount of rainfall and the utilization of river water. Especially, it can be said that the development of agriculture in this area in the future will depend on how to utilize river water, and a planmust be formulated from a long-term point of view. The current floods, the fluctuation of the water level of Lake Tempe, and the like cause serious damage to the crops. Thus the control of river discharge resulting from the irrigation plan will directly help eliminate those causes. Also this effect should be added to the effects of irrigation. Meanwhile, there is a considerably wide damp zone is this area. It would be worthy of consideration to dig it somewhat deeper and apply anti-leakage measures so that it can be positively utilized as a fish farm for the encouragement of inland waters fishery.

The stablization of the water level of Lake Tempe will be studied from a different aspects. If the water level is stablized in the future, the lake field on the coast of the lake will be stabilized, thus it will be improved the present unstable utilization of up-land crop fields. Accordingly, the utilization plan for this area should be fully examined in the future as a part of the plan for the development of the region comprising paddy rice fields, up-land crop fields, grassland (for stock raising), and others.

The devastation of the up-land crop fields, after cleared by burning, in the mountainous area and the sloping land needs to be considered in conjunction with errosion-control and forestation in the public works, together with a river training project.

Soil conditions are discussed in their respective sections, because they are directly related to paddy rice cropping and upland cropping.

(2) Paddy Rice Cropping

The factors now needed for paddy rice cropping in the surveyed area are summarized as the stable supply of water, the improvement of farming techniques, and the augmentation of the soil productivity of paddy fields. These points are brifly studied as follows:

1) Stable Supply of Water

The total area of rain-fed paddy fields in Kabupaten Wajo, Soppeng, and Bone is estimated at 90,018 ha based on Table 2-1-3, which accounts for 91.5% of the total area of paddy fields (98,431 ha.) In some years, the paddy fields with no irrigation facilities suffer drought damage even in the rainy season. In the dry season, it often becomes impossible to plant or harvest rice. The planting and harvesting areas are shown in Table 2-1-17. The data for three years indicate that the area that could not be harvested was large, proving the instability of paddy rice cropping. The breakdown of the causes of the impossibility of harvesting is not known. But a high percentage of the damage seems attributable to drought in view of the fact that the percentage of the unharvestable area sharply increased to 67.5% in the droughty year of 1972.

The total rice production in Wajo, Soppeng, and Bone from 1970 to 1973 is shown in Table 2-1-18.

Table 2-1-17 Planted Area, Harvested Area, Unharvestable Area, and Their Rations

In hectares

Year	1971			1972			1973		
Kabupaten	Planted Area	Harvested Area	Unharvestable Area	Planted Area	Harvested Area	Unharvestable Area	Planted Area	Harvested Area	Unharvestable Area
Wajo	62,297	52,105	10,192	41,700	13,026	28,674	65,572	53,025	12,547
Soppeng	33,699	32,134	1,565	21,787	9,842	11,945	35,824	24,261	11,563
Bone	83,190	71,874	11,316	65,388	19,097	46,291	89,324	68,061	21,263
Total	179,186	156,113	23,073	128,875	41,965	86,910	190,720	145,347	45,373
Harvested Area Planted Area (%)	100	87.1	12.9	100	32.5	67.5	100	76.2	23.8

Note 1. Rainy-season cropping + dry-season cropping.

2. Calculated from data of the Kabupaten agricultural office of Wajo, Soppeng, and Bone.

Table 2-1-18 Rice Production of each Kabupaten

In tons

Kabupaten	Year			
	1970	1971	1972	1973
Wajo	199,881	177,492	27,268	199,404
Soppeng	68,285	112,891	56,678	88,136
Bone	205,978	160,233	53,241	187,548
Total	474,144	450,666	137,187	475,088

Source: Data of the South Sulawesi Agricultural Service.

This table indicates that the production in the droughty year of 1972 was the smallest, or represented a decrease of 329,429 t from the average production of 466,616 t in 1970, 1971, and 1973. This decrease in production is equal to 171,305 t in terms of cleaned rice. If each person consumes 0.11 t per year, then the rice for 1,557,300 persons was lost probably because of drought. If 20% of the damage had been prevented by irrigation facilities, the rice for about 310,000 persons could have been secured. Furthermore, if there are irrigation facilities, the existing unstable rice cropping will be stabilized by the constant supply of water, thus making it easier to introduce new cultivation techniques. Thus it is highly likely that production per unit area will also increase. Accordingly, it will be understood that the greatest question in rice cropping in this area is the stable supply of water.

2) Cultivation Techniques

There seem to be many problems in the present conditions of paddy rice cultivation techniques in this area. They include the variety of rice the amount of seeds sown in the seeding bed, the nursery duration the planting density, fertilizing, the prevention of the damage by diseases and insects, and water control. Many of the problems are already pointed out in the preceding paragraph "Paddy Rice Cropping." In many cases, the basic causes of the problems are the cropping of rice in rainfed paddy fields, the economic condition of farm households, and the low productivity of land.

As seen from a different perspective, the cause common to those individual problems is that little study has so far been made about the suitability of this area. Generally, the growth and harvest of crops are greatly influenced by natural conditions and soil characteristics. It is considered, therefore, that the concrete measures most suitable to the natural conditions and the soil characteristics in this area should be studied promptly in connection with those individual problems.

Judging from the above situation, it is important to study the suitability of the area and establish the most effective cultivation techniques. Some individual problems that can be improved in the existing circumstances are studied as follows.

During the field survey this time, it was observed that the growth of rice was not uniform even in the same section of paddy field. It is found that the cause is the uneven plowing and soil preparing: Rice grows well in the wet, concave part but not so well in the dry, convex part of the paddy field. Accordingly, plowing and soil preparing should be so done as to make the surface of the paddy field even.

One of the most important factors in paddy rice cropping is the control of water. Generally paddy rice most seriously needs water in the root-taking, heading, and flowering stages. A water shortage in the root-taking stage decreases the number of panicle per plant. A drought in the booting and heading stages results in the small number of panicle with fewer grains and poor ripening, thus markedly decreasing the yield.

But deep water in the paddy field after booting puts soil in reductive conditions and impairs the function of the roots bringing about a cause of loot-lot. It seems necessary to establish water control systems in the paddy rice cropping of farm households as early as possible, though there are some difficulties in the present conditions.

A common method of eliminating the damage caused by disease is the springkling of fungicide. But in view of the farmhouses' present economic conditions and cultivation practices, the introduction of varieties of rice highly resistant to diseases should be carried out, although it has already been examined by the Agricultural Research Institute, Marros. Further, it is necessary to re-examine the local varieties. In the main island of Jawa, there is a variety, similar to Buru, that can yield 7 t/ha, according to Mr. Sugo head of the food production increasing project in Western Jawa. Besides, Pelita 1 is highly resistive to Leaf blight.

The introduction of improved varieties needs to be considered in conformity with the local conditions. Meanwhile, much damage is caused by field mice inthe districts. One of the causes is that the harvest time differs from one area to another, extending over a long period, in which the rice is damaged by field mice. Since it is very difficult to catch field mice, the cropping period should be unified to shorten the overall harvest time. In addition, the rationalization of reaping operation should be studied.

As seen from the viewpoint of growing strong seedlings, it is fully practicable at present to improve the form of nursery beds, the sowing of seeds in nursery beds, the time of transplanting to paddy fields, the depth of planting, fertilizers, and varieties. It is expected that if some of them are improved, the crop will increase by 20 to 30%.

3) Maintenance and promotion of the Productivity of Soil.

The problems about the soil of many of the paddy fields include a high clayey degree, the small content of organic matters, the poor physical character of soil, and the low productivity of soil. At present, straw is either burnt or fed to livestock left at large. But straw should be decomposed into soil as far as possible, because it is a precious source of organic matter in a paddy-field area.

Directly digging raw straw into paddy fields is difficult in the light of the shape of the farm implements (plow) now used. For this reason and in consideration of the nitrogen absorption in the process of decomposition of straw in soil, the method should be taken under which straw is mixed with dung to make manure.

The application of compost increases the organic matter in soil, remarkably improves the physical character of soil, and promote the aggregated structure for better shock-absorbing function. As a result, the yield of paddy rice increases, and the productivity of soil is maintained. Under the present circumstances, this seems to be the best, feasible method with much economic effect.

Additional methods effective to the promotion of the productivity of soil include the introduction of green manure crop, the improvement of soil by rotating rice and upland crops, deep plowing, and fertilization. Suitable methods should be introduced as soon as possible.

(3) Upland Cropping

As mentioned before modern cultivation techniques are neither diffused nor taught in this area. The farmhouses know only the conventional methods.

The major problems in upland cropping are the maintenance and improvement of soil productivity and the modernization of cultivation techniques. The problem common to paddy rice cropping and upland cropping is the farmers' consciousness about productivity.

1) Maintenance and Promotion of Soil Productivity

It is considered that the present most important question in upland cropping in the surveyed area is to increase the productivity of the upland fields. The surveyed area is hot throughout the year and has concentrative downfalls. Consequently, the speed of decomposition of the organic matter in soil is high, and large amounts of effective base are erroded. Furthermore, farmhouses give non the manure, depending on the nearly complete robbery-type farming. (An extreme example is seen in land-borning farming. Even if maize or upland rice is grown, the yield shaply decreases in two or three years. After the land is abandoned. Alang-Alang occurs, devastating the land.)

Table 2-1-19 shows the secular changes of corn and soybean crops in the surveyed area.

Table 2-1-19 Secular Changes of Corn and Soybean Crops

Kg/ha

Crop	Kabupaten	1968	1969	1970	1971	1972	1973
Corn	Wajo	820	727	700	750	603	705
	Soppeng	1,317	1,058	760	1,061	1,027	1,279
	Bone	1,000	997	989	841	904	663
Soybean	Wajo	500	-	500	500	636	421
	Soppeng	675	601	713	739	689	725
	Bonc	965	946	750	700	690	784

Source: Data of the Kabupaten Agricultural Office of Wajo, Soppeng and Bone.

The yield per unit area has a tendency to decrease as years go by. The decrease is mostly, even if not entirely, attributable to the decline of soil productivity. (Suppoing that the cultivation method is the same each year, damage by insects and discases, etc. does not result in a gradual decrease in yield.

As a means of preventing the decline of soil productivity, the remains of crops should be positively used as manure. It has greater effect in upland cropping than in paddy rice cropping. At present, some farms grow Kurotararia and Sesubenia as green manure crops. Such green manure crops should be grown positively and decomposed into soil to help maintain the productivity of soil. Although upland cropping is now done without fertilization, the most economic fertilization method should be worked out.

2) Cultivation Method

Upland cropping in the surveyed area is done under the conventional method, and there are many problems in the cultivation techniques for individual crops. Generally, there is no standard crop culture method established for individual areas. Besides, no measures are taken for the improvement of cultivation techniques. Therefore, concrete measures at each of the stages ranging from plowing to harvesting need to be established in conformity with the local weather, soil and economic conditions.

For this purpose, the problems in the existing cultivation techniques for each kind of crop should be reconsidered over a considerably long period to work out technical improvements.

The problems in the cultivation techniques of maize representative upland crop in the surveyed area, are discussed, and some solutions are described below.

The corn cultivated in this area is designed to be used grain, and none of it is used as green feed for livestocks. In view of the fact, the factors related to the production of grain requires consideration. The first one is to ensure the optimum number of plants per unit area. Concretely, the number of heads per and the planting density are determined by the productivity of soil, the crop rotation system, the form characteristics of cultivated varieties, and other local conditions. Generally, the number of heads per plant is large, the planting density is low and the height of plants is short. Thus it is necessary to limit the number of heads per plant to one or two as far as possible (by thinning out) and to consider the method of raising the planting density. Maize is a crop that abosorbs large amounts of fertilizer. Since the local variety is especially adaptable to scarce fertilization, the productivity of soil declines steeply. Thus continuous cropping must be avoided.

It is recommendable to grow some kinds of beans (soybeans, green bean) after corn. It is necessary to dig green manure into soil to restore its productivity. Further, full attention should be paid to damage by diseases or insects, because these are apt to hit group cultivation and high-density cultivation more often.

Second, since the productivity of soil is relatively low in this area, it is necessary to study the most economical quantity of fertilizer application and the suitable data of fertilization. A test made by Bogor proves that the application of even small amounts of nitrogen is highly effective to the increase of yield.

The application of 30 kg of nitrogen per ha works to double the yield, as compared with the situation in which no fertilizer is given. The result of this test seems to indicate that fertilization is necessary even in the present conditions.

Table 2-1-20 Effects of Rate of Nitrogen on Yield of Maize

Nitrogen applied \ Variety / Item	PENJALINAN (85 day type)		HARADAN (100-day type)	
	Yield (Kg/ha)	Increase %	Yield (Kg/ha)	Increase %
0	700	(100)	900	(100)
30	1,440	(206)	2,200	(244)
60	2,000	(286)	3,150	(350)
90	2,150	(307)	3,520	(391)
120	2,200	(314)	3,540	(393)

Note: Average in 10 test sections.

Source: Results obtained by the Bogor Agricultural Experiment Station.

Third, no rational rotation system is established at present. Injury by continuous cropping is the problem reguiring the greatest attention in upland cropping. The study of this problem is often late because the damage is not noticeable. Yield decreases as a result of the combination of such adverse effects of continuous cropping as uneven absorption of soil nutrition, accumulation of germs and insects, and change of soil microbes. The pattern of this trend differs from one kind of crop to another, and it is necessary to make full studies about individual kinds of crops. From the viewpoint of land utilization, too, it is necessary to establish a highly effective rotation system. The elimination of damage by diseases and insects is an important matter that has direct effect on yield. It is necessary to consider the introduction of disease-resistant varieties as a countermeasure against downy mildaw and to study the effective use of agricultural chemicals as to Army Worm and Corn borer. Technical improvement measures should be established step by step in accordance with the economic conditions of the farm households. Besides, many problems are yet to be studied, including the variety, the amount of seeds sown and control operation (intertillage, ridging).

A problem common to paddy rice cropping and upland cropping is a lack of the farmhouses' positive interest in cultivation techniques. It is understood that they are content with self-sufficient agriculture because they can enjoy the relatively favorable natural circumstances. In the future, however, these farmers' consciousness should be improved for a higher standard of living, in view of the social importance of the production of major national food.

Another problem is the devastation of land after being cleaned by burning at mountainous area. Prompt measures should be taken.

(4) Livestock Raising

It seems that the form of livestock raising in the surveyed area is the most rational locally. But it is considered that demands for animal protein will increase as the paddy rice cropping area is expanded and the main food is secured, helping raise the standard of living. Therefore, the present pasturing system will probably be inadequate to meet such a future situation. Also there are problems in the system in view of its connection with the method of maintaining the productivity of soil to improve the agricultural productivity. It is considered that diverse studies should be made about an intensive raising system. For this purpose, livestocks should be positively used for agriculture, unused land should be improved to secure animal protein the production of feed should be increased, and the planned raising of livestocks should be done.

(5) Agricultural Implements

In the surveyed area, there are very few kinds of Agricultural implements and their number is small at present. This seems to be the natural consequence of the fact that agricultural population accounts for a large percentage, providing abundant cheap labor. It is understood that the effective use of Agricultural implements is difficult in the existing conditions where basic preparations are delayed. On the other hand, in view of the low productivity of soil and the low soil fertility the decomposition of organic matter into soil is indispensable, as stated before, to the improvement of soil productivity.

The small plow now owned by the farm households can not provide deep plowing and its reverse-turning performance is poor. Thus they are inadequate to be used for the decomposition of organic matter into soil for the purpose of soil improvement. Accordingly, it is necessary to consider introducing powered machines as a part of a land improvement project, without given top priority to the labor-saving cropping.

Such powered machines should be selected in consideration of the present sectionalization of paddy fields and farm road conditions. The size (horsepower) and the kind of such machine must be fully studied.

It will become necessary to shorten the working period in the future if irrigation facilities are prepared in the surveyed area the paddy rice cropping area increases, and planned cultivation is carried out. The introduction of labor-saving machines is not necessary under the present conditions. In the future, however, agricultural development should be made step by step in alignment with the overall program for water resources development in this area. Thus the introduction of rice planting, harvesting, and threshing machines should be considered as early as possible. Besides, the cropping area in the dry season will increase to be harvested in the rainy season. It is expected that in this case, the drying of grains will bring about a problem. Therefore, the introduction of grain dryers should also be considered.

2.2.2 Agricultural Economy

The characteristics and the problems of the local agriculture are listed below.

(Basic production structure)

(1) Of the land use for agriculture, the proportion of the paddy fields usable for rice cropping is large. Its count for about 60%, in Wajo, and about 50% in Bone. But the percentage stands at about 40% in Soppeng, overweighted by that of uplands.

(2) Generally, the preparation of irrigation facilities for paddy fields are poor, and a large percentage of the paddy fields are rain-fed paddy fields. That is, almost no paddy fields are provided with irrigation facilities in Wajo. In Bone, about 80% are rain-fed paddy fields. Although about 90% of the paddy fields in Soppeng have irrigation systems, they are small in scale, most of them being head works of simple construction.

(3) As a result, water supplies to the paddy fields are insufficient and unstable. They agricultural production is greatly affected by weather conditions.

(4) Although the paddy fields are sectionalized at random, it does not seem to be adversely affecting the effeciency of farm working at present because they are mostly conducted by manual labor. But this matter should be fully studied for the future. It should be noted that this will pose a problem in connection with water control such as effective use of water in the stage in which irrigation facilities are prepared.

(5) A problem related to the sectionalization of paddy fields is that there are few farm roads in the fields. Since the farm mechanization seems to be a future subject, the preparation of farm roads will only have to be dealt with as a future issue. But it seems

necessary to make farm roads needed at least to make the carriage of farm produce easier and more efficient.

(6) Since some areas sustain damage by floods, it also seems necessary to prepare drainage canals to facilitate the discharge of water to rivers and the like;
However, it is inevitable that natural drainage occupies the greatest part.

(Socioeconomic conditions)

(1) In considering agricultural problems, socioeconomic conditions have to be dealt with as given conditions. Therefore, the actual conditions must be considered as important restrictive factors in studying the direction of agricultural development.

(2) This area are pure agricultural and fishing districts, and this structure will not charge considerably in the future. Accordingly, agricultural trends have a vital significace to the development of of the local society. It would not be too much to say that the local economy will not grow without the growth of agriculture.

(3) From this perspective, it becomes necessary to prepare socio-economic conditions as prerequisites to the development of agriculture. Such preparations include the preparation of roads, port facilities, and shipping for making it easier to transport farm produce to the markets. The improvement of the circumstances of farming villages is also necessary.

(4) In the meantime, organizing farmers is pointed out as an agricultural internal problem. This is not difficult.
As an example, it is too inefficient to do the rice transplanting or harvesting in the adjoining paddy fields at the same time. For the elimination of this minus factor, what should be emphasized are group cultivation and joint operation within fixed areas, and con-solidated water control systems for the rational distribution and

use of water that make irrigated paddy field by same cannel object.

(5) With these as a starting point, the organization should be developed for the joint sale of agricultural products, the joint purchase of agricultural materials, and the diffusion of the processing of farm produce. Furthermore, it will be necessary to develop it into a kind of cooperative association for the protection of common interests.

(6) Administrative guidance and an administrative organ are keenly desired for the materialization of these goals.

(Agricultural production)

(1) The principal edible agricultural products are rice and corn, and the standard of their production is considerably high.

(2) The major crops cultivated to obtain cash are tobacco, coconuts, peanuts, and soybeans. Especially, this area are the main producing centers of tobacco and soybeans in Sulawesi Selatan. But these cash crops are upland crops, and are now grown under very unstable production conditions. Thus the production of these crops, except tobacco and a few items, is unstable. Consequently, these crops are lacking in the vital requisites of cash crops - constant, abundant production with influence on the market.

(3) From the viewpoint of the local agricultural industry's growth in the future, the cash crops are important items, and it is considered that the local agricultural product ion will be impracticable without the cash crops.

2.2.3 Problems on Intake Facilities Plans

In case of planning the construction of intake facilities, the following matters shall be taken into considerations:

a) The area to be irrigated, and the required mixmum intake capacity.

b) The intake level necessary for leading water into the area to be irrigated, including the energy loss head of driving channels.

c) The discharge of river from which water is to be taken in. (The maximum flood discharge, the flood discharge to occur once a year, the mean discharge, the droughty discharge, and the daily change of the river water level through a year.)

d) The intake site at the place where the river course is stable.

e) No sediment flowing into the main irrigation canal on taking irrigation water.

Of the above, item c) is complexly affected by such various factors as 1) the topographic slope, 2) the vegetation in the river basin and the geological structure, 3) the variation of rainfall intensity with altitude, 4) the pattern of rainfall (an observation network and evaluation of squally rain), 5) the ratio of the length of the rainy season to that of the dry season, which affects ordinary water discharge and droughty water discharge, and 6) the storage effect of the river course. Thus forecasting analysis based on rainfall precipitation will be taken up as a future question. Also for the purpose of such analysis, it is most important directly grasp the discharge of the river.

As for item d), this condition can be met at a place where outcropping rocks are seen on the concave side of a meandering river.

As for item e), firstly the place just downstream of the concave side of the bend satisfies the condition in view of the load transport mechanism of the river (Fig. 2-3-3). Secondly, it is advisable to limit to less than 40 cm/sec in the average velocity of flow upstream of the intake site at the time of taking water. To meet this condition, a considerable part should be of a movable weir type. But such a intake structure requires full consideration based on the topographic conditions, the electric power available, and the local economic factors. In the case of the conventional fixed weir, it is recommendable to construct a sedimentation basin after the intake.

Then, each of the proposed intake sites is expanded.

(1) Bila, Boya & Gilirang

1) The proposed Intake Site on the Bila River

The water is to be taken from the left side of the river. This proposed intake site is on the concave side of the bending part, satisfying the basic intake conditions. At present, the concave side is covered with tree, and the geology of the bank is not known. Being of the geology that is free from erosion, the site will be suitable as an intake site.

2) The Proposed Intake Site on the Boya River

The Bulucenrana Weir was constructed in 1930, and the originally planned amount of water of 5.6 m^3/sec is taken in. The increase of the intake volume to meet the extension of the irrigation area in the future can be materialized by improving the existing intake gate, sedimentation basin, and main driving channel.

3) The Proposed Intake Site on the Gilirang River

This river is at the stage that meandering is still developing by the erosion of the banks. Therefore, the meandering forms upstream and downstream of the planned head work site shall be fully studied.

(2) The Proposed Intake Site on the Cenranae River

At present, the intake site is to be constructed at a place near the river confluence with the Walanae River close to Lake Tempe. Depending on a future plan for improvement of the Cenranae River, the intake site may be constructed just downstream of the confluence of the Cenranae and Walanae rivers. In either case, the intake structure shall be of a modern, fully movable weir type.

In the meantime, it is impossible to irrigate the areas along the Cenranae River by the natural head alone based on the gates regulating water level of Lake Tempe.

Thus the pump-up system will have to be adopted. In case of carrying out the plan, the overall Centranae River program, the handling of Lake Tempe, and the related economic characters.

(3) The Proposed Intake Site on the Lawo River

The area to be irrigated exists along the left bank of the Lawo River. Therefore, water will be taken in from the left side of the river. The prpposed intake site is at a suitable place on the concave side of a river bend where outcropping rocks are seen and the river course is stable.

(4) The Proposed Intake Site on the Langkemme River

This river is a stream flow on piled up Agglomerete. The right bank of the proposed intake site is a sheer cliff, and a landslide is seen on the left bank from which water is to be taken in. Although there is no particular problem about the intake site, it is thought that the control of taking water will be very difficult. Therefore, some idea will be needed about the intake structure.

(5) The Proposed Intake Site on the Sanrego River

This river is a stream on the bed of which outcropping rocks are seen. The intake site is on the concave side of the right bank, however, the formation of spiral flow is weak. It would be advisable to remove the boulders on the riverted and to build a revetment of vertical wall, on the side of the intake.

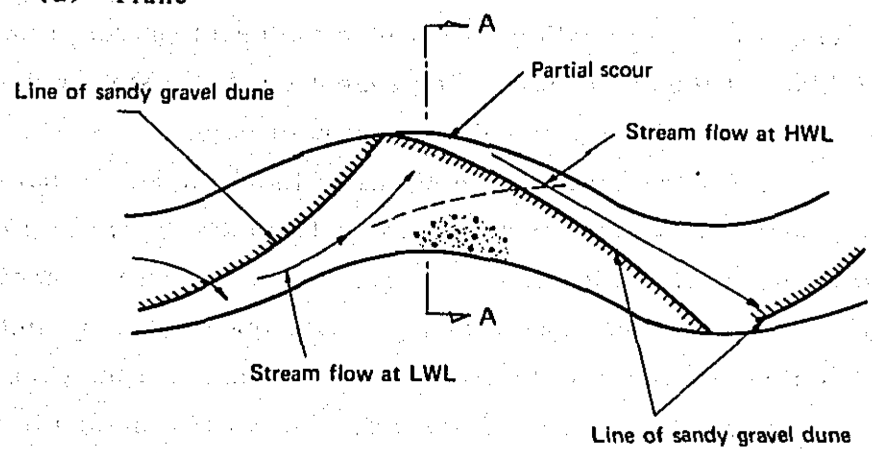
(6) Taking water at the Ludunge Point

Constructed in the main stream of the Walanae River, this intake site is situated downstream of the Mong Dam now being planned. Outcropping rocks are seen along the bank near the site where head works are to be built. There is no hydraulic problem about the proposed intake site. In principle, this intake structure will be of an all movable weir type.

(7) Taking water at the Mong Dam

There is no problem about taking water. However, the various hydraulic problems about the dam itself should be studied by experiments.

(a) Plane



(b) A − A Cross Section

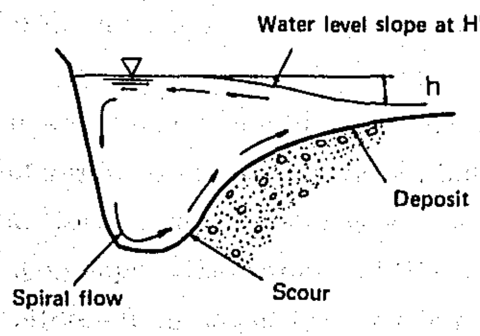


Fig. 2・3 − 3 The Condition of Flow and River-bed at the Curve

2.3 The Direction of Development

2.3.1 Agriculture

The following three stages can be considered for agricultural development based on the Central South Sulawesi Water Resources Development Program:

(1) The Augmentation of Rice Culture

The increase of food production is urgently called for in South Sulawesi. The measure that will have the greatest and most immediate effect will be to augment rice culture, which is suitable to the locality conditions of the monsoon district.

Developing new paddy fields is feasible. But in view of the present local conditions, increasing the cropping ratio in the dry season, in which the ratio is now low, seems to be a measure having a more immediate effect than the development of new paddy fields. At the same time, the present low yield standard should be improved for the increased production of rice.

As for the existing conditions of the district, cropping in the dry season is small because of the extremely few irrigation structures. Even in the rainy season, cultivation is completely affected by weather conditions. In consequence, many meteorological disasters occur owing to droughts and floods, and the crop situation is unstable. Besides, since the cultivation method is rough, the yield level is low.

From the above, it may safely be concluded that the principal restrictive factor in paddy rice culture in this district is the availability of water.

Therefore, if the planned water resources development is carried out and the stable supply of water becomes available, cropping in the dry season will increase, and the paddy field rice cropping area will be remarkably expanded. Furthermore, since stable water management becomes feasible, the foundation for the improvement of paddy field rice culture techniques will be established, ensuring the full utilization of those techniques for a higher yield level.

However, the improvement of paddy rice culture vitally requires the introduction of improved varieties and the overall promotion of water management techniques, fertilization techniques, and techniques for the elimination of diseases and insects. The higher-level targets can be achieved only after these techniques are thoroughly learned and actually utilized by the farmers.

In the stage in which water resources development is carried out, therefore, it is necessary to establish a system under which the aforesaid paddy rice cultivation techniques can be fully utilized.

If the stable supply of irrigation water becomes possible and the appropriate rice culture techniques are promoted, a remarkable increase of yield will be materialized.

The preparation of the irrigation system and the promotion of the rice culture techniques will bring on a great increase in the dry season cropping ratio because the sunshine condition is better in the dry season than in the rainy season. Thus, increased rice production will be ensured.

(2) Rotation of Paddy Rice Culture and Upland Cropping

When the production of rice is stabilized by the augmentation of paddy rice culture, it should be considered to adopt in some areas the rotation of upland cropping, designed to obtain cash, and paddy rice cropping.

The principal plant grown in the upland fields of this area is maize. Besides, peanuts, cassava, and soybeans are grown. Generally, however, their yields are small and the productivity is low. As cash crops, coffee, coconuts, tabacco are grown in some parts, but the area is too small to create an adequate production district.

It is considered that the small yields of upland cropping are generally due to the following factors:

Cultivation is not intensive, with no such materials as fertilizers invested because of the low prices of upland crops. The productivity of soil has considerably declined because appropriate soil management is not conducted.

Crops are affected by rainfall conditions to a considerable degree.

But in the stage in which irrigation and drainage facilities are fully prepared, water management techniques for crops will become positively utilizable. In this stage, therefore, the advanced utilization of land by rotation should be considered.

If the rotation of paddy rice culture and upland cropping is conducted in paddy rice fields, the soil structure will be improved, thus ensuring the stable production of upland crops. Further, the introduction of cash crops suitable to the locality conditions will further stabilize the agricultural production and will certainly raise the income level of the farm households.

(3) Augmentation of Livestock Farming

In this area livestock such as chickens, ducks, cows, water buffaloes, goats, and sheep is kept in open space. But since they are given no concentrate, the qualitative evaluation of animal protein is considered insufficient. It is expected that the demand for animal protein will rapidly increase with the improvement of eating habits in the future. But the present pasturing system alone will be inadequate to fully meet the additional demand. That is, as for waste lands, alang alang occur because the lands are left as they are, with no care taken, after being cleaned by burning. Thus the productivity of the waste lands is extremely low. If the present haphazard pasturing system is continued, the productivity of the waste lands will further decline. Consequently, good feedstuff will not be obtained, making it difficult to produce animal products of high quality. The augmentation of livestock farming must include not only the quantitative increase but also the qualitative improvement, the improved evaluation of animal protein, and the establishment of the position as an excellent livestock supplying district.

In the future, therefore, it will be necessary to consider positively the development of good grassland. That is, highly productive grassland needs to be made by plowing alang alang into soil by large machines and by introducing green manure crops and the like. And, livestock suitable to this area should be introduced properly.

2. 3. 2 Agricultural Economy

To establish the course of the development of this area, we will arrange the water resources development, and the agricultural development of the area and various related measures that accompany with it.

Of the improvement of basic structures related to the Central South Sulawesi water resources development, we shall begin with:

(1) Preparation of Irrigation Facilities

The necessity of preparing irrigation facilities is already mentioned repeatedly, and the development project is being promoted on the basis of such existing conditions. Thus it will not be necessary to repeat the point. But what should be noted is that the largest restrictive factor in the formulation of an irrigation plan is the absolute amount of river discharge. Conversely, unless water storage facilities such as dams are made, the benefited area has to be determined within the scope of the river discharge. In considering the development of over The Republic of Indonesia or regional agriculture, the conceptions of future development should be studied by grasping and analyzing overall local problems. Based on the results, surveys need to be made for the formulation of an overall development program, or a so-called master plan, covering the whole area.

Then, under the master plan, feasibility surveys for the concretization of individual projects are made; the projects are thus promoted step by step. The above is the procedure generally followed for regional development.

But when the stage of development of over The Republic of Indonesia and local agriculture is taken into consideration, it is certain that the pressing problem of the early increase of rice production will not be solved if feasibility surveys are made and projects are promoted only after the formulation of a master plan.

It is unavoidable, therefore, to make feasibility surveys, within the scope of the findings of the present preliminary surveys, for those particular projects whose location in the master plan to be made in the future is nearly apparent. From a different point of view, it may be said that such a way of starting project early is desirable under the current circumstances.

Subsequent feasibility surveys should be conducted from the viewpoint of the early establishment of a setup for increasing rice production, the effective utilization of the present ineffective river discharge, and the securing of stable supplies of irrigation water. With regard to the contents of the projects, it is necessary to consider such measures for increasing yield of rice as are based on the construction of simple water intake facilities, i. e. head work, instead of preparing irrigation projects only after the construction of dams which takes long time.

In this case, however, it is needless to say that such irrigation plans must be made not only from the viewpoint of the availability of abundant river discharge or a suitable location for head works but also in full consideration of the course of development of local agriculture, the water shortage conditions in the area, or the farmers' consciousness.

Consequently, the irrigation benefited area and the order of starting project must be determined. Concretely, the determination should be made in the following sequence:

As for the benefited area:

1) In the first stage, it is necessary to repair the irrigation facilities in the areas being incomplete ones such as the semi-technical and the village systems, and so on, including the

repair and improvement of those. Because, it seems that many of the areas that have such inadequate facilities have relatively abundant water resources, and also have comparatively excellent agricultural conditions and pretty advanced stage of agricultural development, and are expected to yield a sufficient effect through relatively small investment.

Accordingly, it will greatly contribute to the increase of rice production to convert the area into a two-rice-crops-a-year district by fully stabilizing the paddy rice culture in the rainy season and conducting paddy rice cropping in the dry season, too, as far as water conditions permit.

2) Dealt with in the second stage is irrigation planning for the areas having no irrigation facilities where rice culture is conducted only in the rainy season.

This area is a rice culture district, entirely subject to the natural conditions such as rainfall. The locality conditions seem comparatively good. But direçtly sustaining the damage of droughts and others, the area is lacking in the function of constantly producing and supplying rice to meet the demand.

It is desired, therefore, that rice culture in the rainy season be first stabilized by improving the irrigation facilities in this area and at the same time that an irrigation plan be made on the basis of a double rice-crops-a-year within a feasible range.

3) Studied in the third stage is an irrigation program for unlands, forestry and waste lands, where rice is not cultivated at present.

As compared with areas 1) and 2), this area is under less favorable locality conditions and natural conditions, including rainfall. But when it is necessary to formulate an irrigation plan from the viewpoint of the development of local agriculture and the necessity of increasing rice production, the development of the area will be promoted as far as water resources permit.

Since this area seems to require considerable investment in view of its locality conditions, the potential economic benefits of such projects must be fully studied. The benefited area should also be studied in detail, such as low plane fields concentrated and adjoining the existing paddy rice fields.

4) Mentioned above is the general way of thinking about the benefited area. As a specific problem in the area in question, it is necessary to consider using effectively the low plane around Lake Tempe. Although the district, it can not be used as paddy rice fields owing to the change of the water level of Lake Tempe. At present, only corn is grown mainly in the dry season, when the water level of Lake Tempe lowers. Stated from the aspect of land utilization, this district seems to be highly productive, and it is considered that its effective utilization will greatly contribute to the rapid increase of agricultural production.

Thus the district should have been taken up in the first stage in the formulation of a development plan. But as dealt with elsewhere, the district requires considerable investment and time for flood control and also involves many difficult technical problems. With considerable priority, however, the development of the district should be studied both technically and economically to consolidate the direction of development.

Next, the order of starting development is studied as follows:

1) Based on those effects of development that can be expressed in figures, the efficiency of investment in each project is calculated, and the obtained value is used as one of the bases of determining the order of commencement.

Although only very rough estimates can be made at the time, the estimated investment efficiency of each project is shown in a separate table. Having high efficiency are such districts as Bila , Boya, Langkemme, and Sanrego. Having low investment efficiency are such districts as Cenranae, Walanae (Mong Dam), and Walanae (Ludunge), Having intermediate investment efficiency are such districts as Gilirang, and Lawo.

2) Then the urgency of each project is examined on the basis of the present conditions of rice production in the district where the project is located. Since detailed data could not be gathered in the surveys conducted this time, the urgency can not be examined in detail. But the precedence of Kabutapen can be grasped pretty accurately. That is, in terms of the output per head of the population shown in chart 2-2-8, Wajo has the largest figure, followed by Soppeng and Bone in this order. Especially, Bone's corn production is smaller than the other Kabupaten, and the degree of necessity of growing food crops is the highest. From the conditions of production bases such as irrigation facilities, it can be said that the degree of urgency of projects is high.

Of the three Kabupaten, Wajo boasts of the largest production per head. But on account of the drought in 1972, Wajo suffered most serious damage, sustaining a large decrease in output. Besides, since the constant supply of fixed quantities of rice is more important on the demand side, it is highly necessary and urgent that the irrigation facilities be improved in Wajo, where most of the paddy rice fields are rain-fed.

Lastly, Soppeng's rice output per head is smaller than Wajo's. It is because a considerable percentage of agricultural production is accounted for by such cash crops as tobacco and soybeans. That is, Soppeng's agricultural production is accounted for by such cash crops as tobacco and soybeans. That is, Soppeng's agricultural production structure is not entirely dependent on food crops such as rice and corn.

It is attributable to the fact that Soppeng enjoys favorable natural conditions, including a comparatively large rainfall, and that many of the paddy rice fields have some form of irrigation facilities. In consequence, agriculture production is relatively stable, not much affected by the drought in 1972.

From the above comparison, it can be said that the urgency of improving irrigation facilities is not so keen in Soppeng as in Bone and Wajo, though the necessity is still great in Soppeng.

But it is because the urgency of improving irrigation facilities is much higher in Bone and Wajo. Needless to say, when compared with mainland Java and other areas having improved irrigation facilities, Soppeng has greater necessity and urgency of improvement of irrigation facilities.

3) Lastly, in conducting feasibility surveys this year and selecting the projects that can be started next year, the degree of difficulty of collecting and preparing basic data must be considered as one of the determinative factors.

That is, since irrigation projects involve considerable investment and their effects take place over a long period of time, they must be based on carefully formed plans. From this sense, it would be effective to carry out feasibility surveys concerning those projects (Sanrego, Bila , etc.) for which preliminary surveys have already been made and basic data have been prepared in The Republic of Indonesia.

(2) Direction of Agricultural Development in the Future

The greatest problem in this case is related to crop cultivation plans, especially cultivation plans for rice and for other crops. Concretely, it is an important problem that should be examined as cropping patterns in the stage of formation of the plans. Therefore no conclusion can be reached in the present stage, but the basic way of thinking is summarized below.

As mentioned repeatedly before, rice output in Bone, Wajo, and Soppeng is on a considerably high level in usual years, nearly fully meeting the demand in the region. Accordingly, from the viewpoint of ensuring self-support of rice, the necessity of increasing rice production can not be emphasized.

But Indonesia as a whole, especially Java, has been suffering from the constant shortage of rice. Although the situation is being improved considerably, the urgent increase of rice production is still necessary. That is, in terms of the demand and supply of rice in whole The Republic of Indonesia, increasing rice output is much needed and has a great significance.

Besides, when the level of agricultural techniques and the organizations for diffusion of the techniques are taken into consideration, rapidly changing the crops cultivated is not advisable because it will cause various troubles, disrupting the smooth development of local agriculture. In other words, plans must be based on the cropping patterns conformable to the existing technical level. This is why the plans for gradual development have to be formed.

The steps are:

1) forming the cultivation plans principally designed for increasing rice output for the present, and

2) increasing the means by which farm household can obtain cash income, in the second stage, by introducing cash crops other than rice, with attention paid to the demand-and-supply

situation of rice and the establishment of organizations for diffusion throughout the country.

(3) Related Measures

Even if irrigation facilities are improved and agricultural output is increased, their effects will be halved, will not bring on real local development, and will not contribute to the development of the local farm households and agriculture unless related measure are taken in parallel. Therefore the following two best measures will be needed:

1) Improvement and establishment of the means of carrying out agricultural products.

What should be done first is improving the roads. In the districts in question, the roads connecting the cities seem to be in a relatively good condition. But they will become insufficient when large quantities of farm produce come to be moved and carried out in the future. Accordingly, it is necessary to improve these trunk roads.

What comes second is the improvement of branch lines connected to these trunk roads and of intra-farm roads. Especially, the improvement of intra-farm roads is highly necessary for other reasons, thorough water control and diffusion of farming technique and soon. It will not require so much investment and is expected to bring on effects in many aspects.

Therefore, the improvement of intra-farm roads should be considered as a problem not for the distant future but for the present time.

The next point is to improve inter-island or domestic shipping. What is noticed promptly from the statistics of retail prices of rice in The Republic of Indonesia is that the same kind of rice is sold at a price two times higher in a district than in another district at the same time. Moreover, as once occurred in South Sulawesi, the price of rice falls heavily once the production of rice increases slightly. Although various factors are associated with it, the greatest trouble is that shipping is not fully prepared. About domestic shipping, there are many problems such as a shortage of vessels, the poor maintenance and management the limited number of ships, the low efficiency of shipping, and the insufficient port facilities. Improving this domestic shipping situation seems to be the task that should be urgently tackled for agricultural development of the outer territory.

Moreover, for the stabilization of the rice price, it is necessary to establish a sales system chiefly on the side of producers. This is a matter dependent on the farmers' consciousness, but it is now unrealistic to expect the farmers to make efforts for the establishment of such a system. Rather, powerful administrative guidance has to be made. In The Republic of Indonesia, where a management system is not firmly established, it is necessary to set up an external sales system chiefly through the efforts of the provinces and Kabupaten.

2) In connection with the establishment of a sales system mentioned above, it is desirable to exercise powerful administrative guidance for the organization of the farmers.

First, as a preliminary step, it is necessary to endeavor to diffuse cultivation techniques by setting up pilot farms based on the planned cropping patterns. Concrete measures for the step are mentioned elsewhere (Agriculture).

Second, it is necessary to promote group culvitation with a view to rationalizing water control. As often seen in the districts having irrigation facilities, once the restrictive factors concerning water are removed, the planting and the harvest of rice are done in adjacent fields at the same time in extreme cases. This is the very proof of inadequate water control. Therefore, troubles are seen in many aspects, such as damage by diseases and insects, frequent damage by rats, and the faster aging of soil. It is said that in some cases, the removal of the restrictive factors brought about a decrease in production instead of helping increase output.

Accordingly, in the stage in which irrigation facilities are fully prepared, it is necessary to perform guidance recommending a unified cultivation system at least in a benefited area dependent upon the same source of water. The planting and the harvest of rice at unified times is the first step toward the establishment of a sales system mentioned before. Further, the rationalized utilization of water would make it possible to expand the cultivated area.

(4) Agricultural Development of External Territory and Immigration Problems

Always causing trouble in the development of the external territory is immigration. But as far as seen from the surveys in South Sulawesi conducted in a short period this time, development was pretty advanced and there were not very large forests or waste lands that could be developed. As for some undeveloped districts, their development will probably be achievable through the transfer of native inhabitants or extension of their farming size without carrying out immigration on a large scale.

Such being the consideration, no detailed remarks were heard about immigration, and little data could be collected about immigration.

It is not considered that immigration will cause a basic problem in the execution of the Central South Sulawesi water resources development program.

Cropping and Rotation Patterns

Cropping and rotation patterns of both paddy field and upland fields are to be determined on the basis of a comprehensive judgement of various factors such as socio-economic condition, farmland and farm management conditions, management policy, etc.

For establishment of cropping patterns and satisfactory rotations in the project area, it is necessary to give consideration due to all the above-mentioned factors as well as to the stagewise development target of local agriculture which is based on and compatible with the water resources development programme.

Hence, it is believed that the fundamental and practical cropping and rotation patterns will be established for each district after detailed surveys to be conducted in future.

A review of the general cropping pattern in the project area made on the strength of the present preliminary survey indicates that the double paddy cropping should be realized by promoting the irrigation in the dry season in the initial stage of development. This should be ensued by the improvement of fertilization techniques and introduction of upland crops (maize, soybeans, etc.) to establish alternative land use system since double cropping is liable to invite the decline of soil fertility if it lasts too long. Further, cash crops should be introduced for alternative cultivation with paddy so as to improve the paddy field productivity.

Example:

Initial Stage	Wet season cropping + Dry season cropping (paddy only)				
Second Stage	Paddy	+	Upland crops	+	Paddy
Third Stage	Paddy	+	(Cash crops Upland crops	+	Paddy

In planning the cropping pattern for upland fields, due account should be taken not only of the above-mentioned factors but also of the injury of continuous cropping and preservation of soil productivity.

Upland paddy calls for rotation with other crops because it is most vulnerable to the injury of continuous cropping of all upland crops. Hence, the cropping pattern of upland fields should be so planned that soybeans, groundnuts, etc. will be grown after harvesting upland paddy.

Maintenance of soil productivity should be given the prime consideration in formulating the upland field cropping pattern of the project area. Accordingly, continuous cropping of maize or other crops having a large absorption power of manure should be avoided. The cropping pattern should be such that maize is grown by rotation with soybeans, groundnuts, green gram, etc., and it should also include green manure crops.

Example:

1. Maize Boybeans Maize Green manure crop
   Maize Groundnuts Maize
   (Main crop: Maize)

2. Upland paddy Groundnuts Maize Upland paddy
   Soybeans

When the upland crop cultivation techniques are improved and the planting ratio of cash crops is increased, the cropping pattern will become more complex. Further, introduction of livestock farming will call for cultivation of forage crops in the formland area. Thus, the cropping pattern must undergo large changes in the course of future development. In formulating the master plan for the area's agricultural development, therefore, careful study must be made so as to establish cropping patterns which are suited to each development stage.

Stage-Wise Development Target of Project Area (Draft)

Stage	Primary Target	Technical Improvements	Proposed Measures
Stage I	Productivity improvement of paddy (wet and dry season paddy cropping)	1. Breeding 2. Rearing of good seedlings. 3. Improvement of cultivation techniques. 4. Improvement of water management. 5. Improvement of soil fertility preservation system.	Study of adaptability of local and improved varieties; improvement of nursery bed; study of seeding time, seeding rate, nursery period and nursery fertilization; study of transplanting time, optimum planting density, dosage of fertilizer application and fertilization period; discontinuance of plot-to-plot irrigation and establishment of a rotional water utilization system; efficient use of compost; introduction of green manure crops; etc.
Stage II	Establishment and extention of paddy cropping techniques	1. Introduction and extension of improved varieties. 2. Establishment and extension of improved cultivation and water management techniques. 3. Establishment and extension of soil fertility preservation techniques.	Introduction and extension of improved varieties based on the outcome of Stage I; rearing of sound seedlings; pest and disease control; establishment and extension of improved cultivation techniques centering on fertilization; study of a cropping pattern for alternative land use system; soil improvement; etc.
	Productivity increase of upland crops	1. Improvement of upland cropping techniques. 2. Fertility improvement of upland field.	Establishment of cultivation techniques of maize, groundnuts, soybeans and cash crops (e.g., varieties, planting density; fertilization, pest and disease control, etc.); establishment of a rotation cropping system; introduction of green manure crops; soil improvement; etc.

Stage III	Improvement of total productivity of paddy and upland crops.	1. Establishment and extension of a rotation cropping system involving paddy and upland fields. 2. Introduction of mechanized farming.	Establishment and extension of a cropping pattern for alternative land use (paddy upland crops paddy); extension of cash crops; establishment of an advanced water utilization system; establishment and extension of mechanized farming (paddy and upland crops.)
	Promotion of livestock farming.	1. Exploitation of uncultivated land. 2. Introduction of forage crops in farmland area. 3. Systematic raising of domestic animals.	Introduction of forage crops and establishment of their cultivation techniques; establishment and extension of live-stock farming techniques; etc.

2.4 Plan for Irrigation Projects

2.4.1 Outline of Plan

(1) Planned Areas

1) In accordance with the previous report, the planned area is divided into nine individual ones in terms of water source.

2) Since no data are available on the river discharge, the droughty discharge is estimated, at the present stage, by way of the catchment area, yearly and monthly rainfall, field surveys, and personal interviews.

3) As for water requirement, such factors as seasonal water requirement, area corresponding to each cropping pattern, and its seasonal disposition can not be determined concretely. It is, therefore, assumed that 1 m^3/sec of diverted water is correspondent with irrigation of 1,000 ha.

Based on the above, the planned areas are shown below.

Table 2-3-4 Summary of Planned Irrigation Areas (ha)

No.	Name of Individual projects	Assumed minimum river dis-charge	Planned irrigate on area in previout report	Planned irrigation area in this report	
			Rainy season	Rainy season	Dry season
1-1	Bila	4-5m^3/s	49,000	15,000	5,000
1-2	Boya (of which already irrigated area)	5-6	10,000	15,000 (3,600)	6,000 (1,000)
1-3	Gilirang	1-2	14,000	5,000	2,000
2	Cenranae from Lake Tempe	(enough)	15,000	15,000	15,000
3	Lawo	2-3	4,000	6,000	2,500
4	Langkemme	4-5	15,000	15,000	5,000
5	Sanrego	8	20,000	20,000	8,000
6	Walanae (Ludunge)	(enough)	15,000	15,000	15,000
7	Walanae (Mong Dam)	(enough)	90,000	35,000	35,000
	Total		229,000	141,000	93,500

Note: Cenranae Irrigation Project in this report needs pumping facilities.

(2) Detailed Description about Individual Areas

1) Bila, Boya, Gilirang River planned Irrigation Area

For topographic reasons, the rainy season is short, or lasting about three months, in this area. Accordingly, it is considered that irrigation will produce a greater effect in this area than in other areas.

Rainy season	:	June, July and August
Dry season	:	December, January, February, March, April and May
Intermediate season	:	September, October and November

Droughty discharge in the dry season seems pretty small. ($Qmin = 0.010$ to $0.012\ m^3/sec/km^2$)

1-1) Bila River Area

An area of 15,000 ha, excluding the area of 4,000 ha already irrigated by a tributary, will be irrigated. A one-to-five-thousand topographic map of 15,000 ha is to be made by the Indonesian Government in 1974/1975. It shall be extended further. This area is flat and will require only some channel structures.

1-2) Boya River Area

The Boya River has a catchment area larger than that of the Bila River, the main stream, and has a comparatively abundant discharge. Under rehabilitation and extension plans, an area of 15,000 ha on the right bank, including 3,600 ha already irrigated, will be irrigated. The head works shall be rehabilitated, the sedimentation basin shall also be rehabilitated and improved, and the trunk road shall be improved and widened. The area lying between the right bank of the Bila River and the left bank of the Boya River is in a high elevation and has to be excluded from the irrigation area.

1-3) Gilirang River Area

Since the catchment area and the droughty discharge of the river are both small, the area of about 5,000 ha can be irrigated. However, large areas of rain-fed paddy fields and dry fields need irrigation. It is regrettable that only a limited water source is available.

2) Centranae River Coastal Area

This area was originally scheduled to be irrigated with water of Lake Tempe. However, according to the results of the survey conducted this time, gravity irrigation is impracticable, and it is absolutely necessary to pump up water 9 to 10 m in height. The water utilization of Lake Tempe shall be determined through the comprehensive study of the relations between flood control, inland fishery, and water supply for irrigation. For this reason, the preparation of basic data will first be required.

Another idea about the irrigation of this area would be waiting for water supplies under the Walanae and Bila river dam plan to be formulated in the future, instead of depending upon the pumping up of water.

3) Lawo River Irrigation Area

At present, 300 ha are irrigated by a simple stone-heap weir and 200 ha are irrigated by free intake of water. But the permanent weir construction will make it possible to irrigate about 6,000 ha.

4) Langkemme River Irrigation Area

To materialize irrigation by free intake, village inhabitants tried to build a driving channel from the planned intake site. However, the works were given up halfway, and the channel has not used yet.. The causes of the failure include water leakage and refilling by land sliding, because the works were implemented was at the foot of the mountain and along the river. Therefore, a driving tunnel of about 1,000 m will be made absolutely necessary for the present plan. The kind of rock is aggremerate.

It is also feasible to construct a small dam at the planned intake site in the future for the more effective use of irrigation water.

5) Sanrego River Irrigation Area

Surveys and plans for this area have been strenuously carried out by the Indonesian Government, as mentioned below.

a) A one-to-five thousand topographic map covering 10,000 ha has been completed.

b) The layout of water channel is completed.

c) The target irrigation area is 5,000 ha in the rainy season and 2,000 ha in the dry season.

d) A topographic survey of the intake site will be carried out in 1974/75.

e) After the survey, a weir will be designed by the Directorate of Irrigation.

At present, accessibility is very poor, and a 7 Km walk is necessary. Since a spring exists in the water source, a droughty discharge of about 8 m^3/sec can be expected. The irrigation area shall cover about 30,000 ha in the rainy season.

6) Walanae River Irrigation Area (Intake at Ludunge)

Since water is taken from the main stream of the Watanae, the intake capacity will be enough. The benefited area can be a low-level area of 15,000 ha along both the banks.

7) Walanae River Irrigation Area (Intake at Mong Dam)

This area covers 35,000 ha out of the area of 54,000 ha which can be irrigated in Bone. However, since there is a mountaneous region between the Mong Dam and the irrigation area, the construction of a driving channel will require such structures as tunnels and aqueducts, and long driving canals.

Table 2-3-5 Estimated Project Volume & Cost

No.	Area	Intake facilities	Distribution system			Project cost 10^6Rp
			Primary canal	Secondary canal	Main structure	
1-1	Bila	Head works	km 37.5	km 55.0		2,796
1-2	Boya	Head works (rehabilitation)	12.0 (construction)	60.0 (construction)		2,191
			10.0 (rehabilitation)	24.0 (rehabilitation)		1,012
1-3	Gilirang	Head works	20.1	21.3		953
2	Cenranae	6 pumps x ϕ1,200 (500 P.S.)	67.5	33.8	Aqueduct 200 m	3,950
3	Lawo	Head works	15.0	30.0		1,240
4	Langkemme	Head works	30.0	50.0	Driving tunnel 1,000 m	3,314
5	Sanrego	Head works	47.6	68.8		3,748
6	Walanae (Ludunge)	All movable weir	68.8	35.5		3,865
7	Walanae (Mong Dam)	A dam	83.8	146.3		10,434
	Total					32,550

(See Fig. 2-2-2)

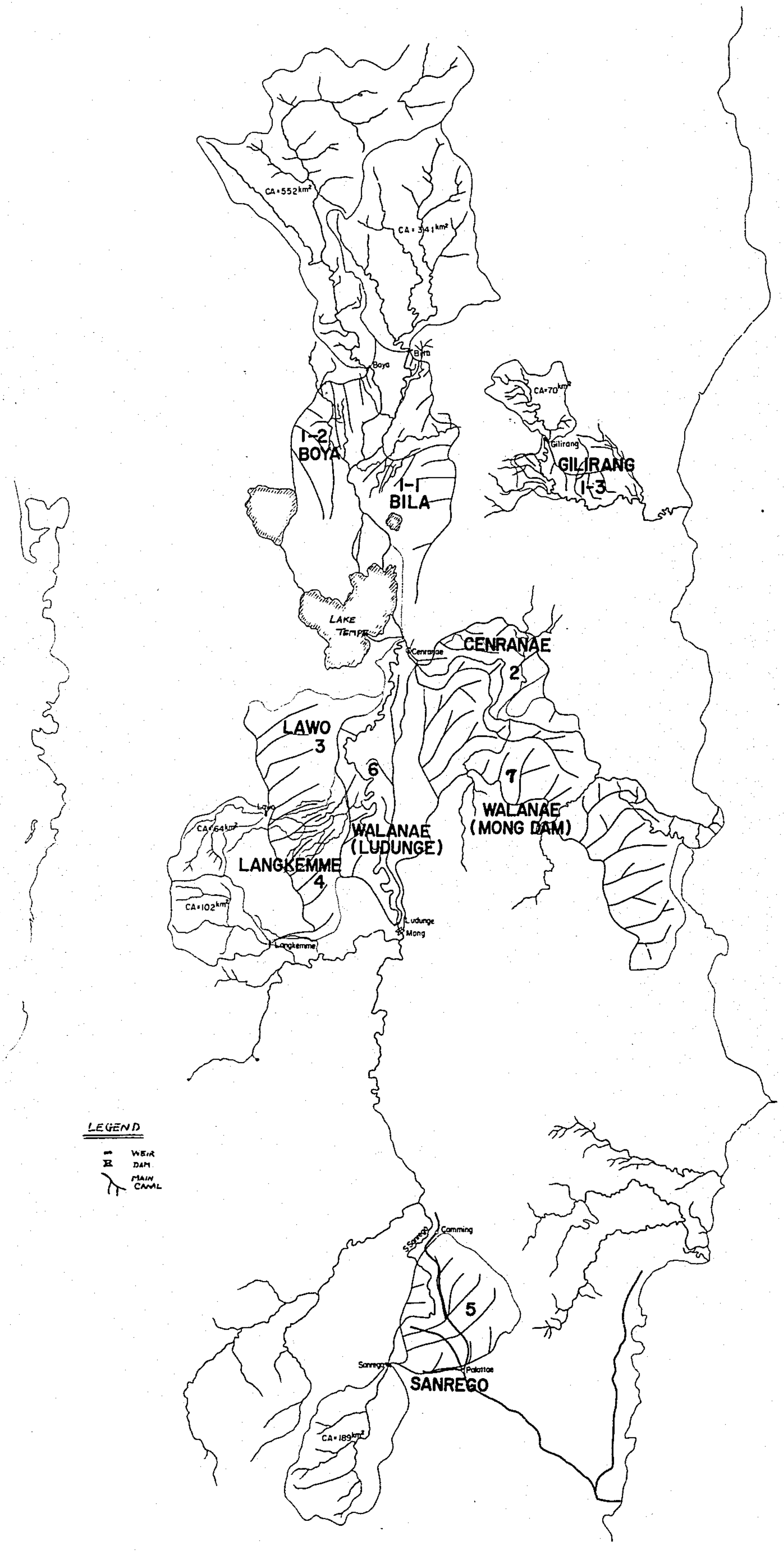


Fig. 2-3-2 Proposed Irrigation Projects

These nine areas are so-called large irrigation area. Needless to say, there are many other areas suitable for small-scale quick yielding projects (taking water from tributaries). It is hoped that these projects will also be carried out very soon.

2-4-2 Order of Priority of Planned Irrigation Areas

The order of priority must be determined not only on the basis of the benefit-cost ratio but also in consideration of social precedence and the degree of preparation of the data needed for individual projects.

(1) Summarized Table

Table 2-3-6

No.	Area	B/C		B/C	Given Score			Compre-hensive priority
		6%	12%		Social precedence	Necessary data & Topographic map	Total Score	
1-1	Bila	2.21	1.46	3	2	3	8	I
1-2	Boya	2.18	1.49	3	2	2	7	II
1-3	Gilirang	2.14	1.39	2.5	2	1	5.5	III
2	Cenranae	1.55	1.09	1.5	2	1	4.5	IV
3	Lawa	2.16	1.38	2.5	1	1	4.5	IV
4	Langkemme	2.06	1.29	2.5	1	1	4.5	IV
5	Sanrego	2.09	1.43	3	1	3	7	II
6	Walanae	1.75	1.11	1.5	1	1	3.5	V
7	Walanae (Mong Dam)	1.59	1.04	1.5	2	1	4.5	V

Standard of Score to be given

B/C				Social precedence		Necessary data	
6%		12%					
1.0 - 1.5	1	1.0 - 1.2	1	Low	1	Not completed	1
1.5 - 2.0	2	1.2 - 1.4	2	High	2	Partially completed	2
2.0 -	3	1.4 -	3			Nearly completed	3

1) The B/C ratio is calculated in the basic data shown in (2) below.

2) Social precedence is fixed on the basis of the contents explained in 2. 3. 2 Direction of Development - Agricultural Management.

3) The degree of preparation of necessary data is based on the result of the survey in February, 1974.

Benefit does not include the one obtainable from fish farming in paddy fields. The benefit shall be calculated in detail and included in the future.

(2) Basic Data

Table 2-3-7 Benefit Estimate

Net income coefficient: Paddy 50%, Maize 35%

No.	Project	Paddy in Rainy Season				Paddy in Dry Season				Maize				Net Income	B/C	
		Planted area	Increased yield	Product	Net income	Planted area	Increased yield	Product	Net income	Planted area	Increased yield	Product	Net income	Total	6%	12%
		ha	t/ha		x10^6 Rp	ha	t/ha	t	x10^6 Rp	ha	t/ha	t	x10^6 Rp			
1-1	Bila	15,000	2.0	30,000	300	5,000	2.7	13,500	135.0	10,000	2.5	25,000	175.0	610.0	2.21	1.46
1-2	Boya	11,400 (already irri-gated 3,600)	"	22,800	228	5,000 (already irri-gated 1,000)	"	13,500	135.0	9,000	"	22,500	157.5	520.5	2.18	1.49
1-3	Gilirang	5,000	"	10,000	100	2,000	"	5,400	54.0	3,000	"	7,500	52.5	206.5	2.14	1.39
2	Cenranae	15,000	"	30,000	300	15,000	"	40,500	405.0	-	"	-	-	705.0	1.55	1.09
3	Lawo	6,000	"	12,000	120	2,500	"	6,750	67.5	3,500	"	8,750	61.3	248.8	2.16	1.38
4	Langkemme	15,000	"	30,000	300	5,000	"	13,500	135.0	10,000	"	25,000	175.0	610.0	2.06	1.29
5	Sanrego	20,000	"	40,000	400	8,000	"	21,600	216.0	12,000	"	30,000	210.0	826.0	2.09	1.43
6	Walanae (Ludunge)	15,000	"	30,000	300	5,000	"	13,500	135.0	10,000	"	25,000	175.0	610.0	1.75	1.11
7	Walanae (Mong Dam)	*35,000*	"	*70,000*	*700*	*35,000*	"	*94,500*	945.0	-	"	-	-	1,645.0	1.59	1.04
	Total	141,000				93,000										

Notes:
(1) Yield Maize 2.5 t/ha
(2) Increased yield (Rainy season) Dry stalk paddy 4.0 t/ha - 2.0 t/ha = 2.0 t/ha (Rain-fed paddy fields) (dry fields → mean value converted into rice product)
(Dry season) Dry stalk paddy 3.2 t/ha - 0.5 t/ha = 2.7 t/ha
(3) *Dry stalk paddy* Paddy 20,000 Rp/t
Maize 20,000 Rp/t

Table 2-3-8 Project Cost Estimate

No.	Project	Construction Cost	Contingency 15%	Management Cost 10%	Total	Overall Economic Lift	Capital recovery factor Interest 6%	Capital recovery factor 12%	Annual project Cost 6%	Annual project Cost 12%	Operation & Maintenance Cost	Annual Expense 6%	Annual Expense 12%
		10^6Rp	10^6Rp	10^6Rp	10^6Rp	Years			10^6Rp	10^6Rp	10^6Rp	10^6Rp	10^6Rp
1-1	Bila	2,171	371	254	2,796	28	0.07459	0.12524	209	350	67.5	276.5	417.5
1-2	Boya	1,732	260	199	2,191	25	0.07823	0.12750	171	280	67.5	238.5	347.5
1-3	Gilirang	800	120	92	1,012	30	0.07265	0.12414	74	126	22.5	96.5	148.5
2	Cenranae	3,123	468	359	3,950	22	0.08305	0.13081	328	517	127.5	455.5	644.5
					1,200 (pump)								
					2,750 (others)								
3	Lawo	980	147	113	1,240	32	0.07100	0.12328	88	153	27.0	115.0	180.0
4	Langkemme	2,382	357	301	3,314	35	0.06897	0.12232	229	405	67.5	296.5	472.5
5	Sanrego	2,963	444	341	3,748	23	0.08128	0.12956	305	486	90.0	395.0	576.0
6	Walanae (Ludunge)	3,056	458	351	3,865	30	0.07265	0.12414	281	480	67.5	348.5	547.5
7	Walanae	8,175	1,226	1,033	10,434	32	0.07100	0.12328	741	1,286	292.0	1,033.0	1,578.0
					2,704 (dom)								
					7,730 (others)								
	Total				31,246								

Notes: (1) Economic life: Earth canal (20 years); Pump (25 years); Dam, head works (50 years)

(2) Operation & maintenance cost: Water channel 4,500 Rp/ha; Dam, pump 5% of project cost

(3) Estimate of Project Cost

1-1) Bila River (planned area: 15, 000 ha in the rainy season and 5, 000 ha in the dry season)

No.	Item	Scale of facilities	Quantity	Unit	Unit cost Rp	Construction cost x10^3Rp
0	Temporary works					40, 000
1	Headworks		100	m	5, 000, 000	500, 000
2	Primary canals	Q max = 20 m^3/s Qmean = 20 x 0. 7 = 14. 0 m^3/s	37, 500	m	17, 400	652, 500
3	Secondary canals	Qmean = 5 m^3/s	55, 000	m	10, 800	594, 000
4	Appurtenant structures	(2+3)x25%				159, 812
5	Terminal structures		15, 000	ha	15, 000	225, 000
	Estimated Total					2,171, 000

1-2) Boya River (planned area: 15, 000 ha in the dry season, of which 3, 600 ha are already irrigated, and 6, 000 ha in the dry season, of which 1, 000 ha are already irrigated).

No.	Item	Scale of facilities	Quantity	Unit	Unit cost Rp	Construction cost $x10^3$Rp
0	Temporary works					26,000
1	Headworks improvement		110	m	2,000,000	226,000
2	Primary canals (improvem't)	Q max=20 m^3/s	10,000	m	8,700	87,000
3	Primary canals (const.)	Qmean=20x 0.7=14.0 m^3/s	12,000	m	17,400	208,800
4	Secondary canals (improvem't)	Qmean=5 m^3/s	24,000	m	5,400	129,600
5	Secondary canals (const.)		60,000	m	10,800	648,000
6	Appurtenant structure (improvem't)	(2+4) x 10%				21,700
7	Appurtenant structure (const.)	(3+5)x25%				213,900
8	Terminal structures		11,400	ha	15,000	171,000
	Estimated Total					1,732,000

1-3) Gilirang River (planned area: 5,000 ha in the rainy season and 2,000 ha in the dry season)

No.	Item	Scale of facilities	Quantity	Unit	Unit cost Rp	Construction cost $\times 10^3$ Rp
0	Temporary works					15,000
1	Headworks		40	m	5,000,000	200,000
2	Primary canals	Q max =7.0 m^3/s	20,100		10,800	217,080
		Qmean= 7 x 0.7 =4.9m^3/s				
3	Secondary canals	Qmean=2m^3/s	21,300	m	9,000	191,700
4	Appurtenant structures	(2+3) x 25%				101,220
5	Terminal structures		5,000	ha	15,000	75,000
	Estimated Total					800,000

2) Cenranae River (planned area: 15, 000 ha both in the rainy season.

No.	Item	Scale of facilities	Quantity	Unit	Unit Cost Rp	Construction cost $x10^3$Rp
0	Temporary work					60, 000
1	Pumping station	Total head 10m $Qmax=18m^3/s$ $6 \times 3m^3/s$ $(=18.0m^3/sec)$ Mixed flow type ϕ1200mm PS=0. 163 x 18.0 x 10/0. 6 = 500	18	m^3/s	50,000, 000	900, 000
2	Pipe	ϕ3, 000x2 sets	100	m	1,160, 000	116, 000
3	Primary canals	Q max=18. 0 m^3/s Qmean=18. 0 x 0. 7=12. $6m^3/s$	67, 500	m	15, 000	1, 012, 500
4	Secondary canals	$Qmean=5m^3/s$	33, 800	m	10, 800	365, 040
5	Aqueduct	$Qmax=9m^3/s$	200	m	500, 000	100, 000
6	Appurtenant structure	(3+4) x 25%				344, 385
7	Terminal structure		15, 000	ha	1, 500	225, 000
	Estimated Total					3, 123, 000

Note: The present plan may be changed in the future because the irrigation for this area shall be planned on an overall basis in connection with flood control and inland fishery in Lake Tempe.

3) Lawo River (planned area: 6,000 ha in the rainy season and 2,500 ha in the dry season)

No.	Item	Scale of facilities	Quantity	Unit	Unit cost Rp	Construction cost x10^3Rp
0	Temporary work					20,000
1	Headworks		50	m	5,000,000	250,000
	Cut-off		50	m	2,000,000	100,000
	Sub total					350,000
2	Primary canals	Q max=7.0 m^3/s	15,000	m	10,800	162,000
		Qmean=7x0.7= 4.9m^3/s				
3	Secondary canals	Qmean=2m^3/s	30,000	m	9,000	270,000
4	Appurtenant structure	(2+3) x 25%				108,000
5	Terminal structure		6,000	ha	15,000	90,000
	Estimated Total					980,000

4) Langkemme River (Planned area: 15,000 ha in the rainy season and 5,000 ha in the dry season)

No.	Item	Scale of facilities	Quantity	Unit	Unit Cost Rp	Construction cost $x10^3$Rp
0	Temporary work					40,000
1	Headworks		50	m	5,000,000	250,000
2	Driving tunnel	D=4m Cross sectional area of excavation $25.0m^3$	1,000	m	480,000	540,000
3	Primary canals	Q max $=20m^3/s$ Qmean $=20x0.7$ $=14m^3/s$	30,000	m	17,400	522,000
4	Secondary canals	Qmean$=5m^3/s$	50,000	m	10,800	540,000
5	Appurtenant structure	(3+4) x 25%				265,000
6	Terminal structure		15,000	ha	15,000	225,000
	Estimated Total					2,382,000

5) Sanrego River (planned area: 20,000 ha in the rainy season and 8,000 ha in the dry season)

No.	Item	Scale of facilities	Quantity	Unit	Unit Cost Rp	Construction cost $x10^3$Rp
0	Temporary work					40,000
1	Headworks		50	m	5,000,000	250,000
2	Primary canals	$Q\ max=25m^3/s$ $Qmean=25x0.7 =17.5m^3/s$	47,600	m	20,000	952,000
3	Secondary canals	$Qmean=5m^3/s$	68,800	m	10,800	743,040
4	Appurtenant structure	(2+3) x 40%				677,960
5	Terminal structure		20,000	ha	15,000	300,000
	Estimated Total					2,963,000

6) Walanae River (Ludunge) (planned area: 15,000 ha both in the rainy and dry season)

No.	Item	Scale of facilities	Quantity	Unit	Unit Cost Rp	Construction cost $x10^3$Rp
0	Temporary work					55,000
1	Headworks		80	m	10,000,000	800,000
2	Primary canals	$Q\ max=20m^3/s$ $Qmean=20x0.7=14m^3/s$	68,000	m	17,400	1,197,120
3	Secondary canals	$Qmean=5m^3/s$	35,500	m	10,800	383,400
4	Appurtenant structure	(2+3) x 25%				395,130
5	Terminal structure		15,000	ha	15,500	225,000
	Estimated Total					3,056,000

7) Walanae River (Mong Dam) (planned area: 35, 000 ha both in the rainy and dry seasons)

No.	Item	Scale of facilities	Quantity	Unit	Unit Cost RP	Construction cost $x10^3$RP
0	Temporary (dam)					120, 000
	Temporary (canal)					100, 000
	Sub Total					220, 000
1	Dam	Height H=50m Length L=300m Embankment volume $V=1.2H^2xL$ Storage capacity $700x10^6m^3$ (of which 50% to be allocated to irrigation) Unit cost of embankment 4, 500x1/2=2, 250	900, 000	n^3	2, 250	2, 025, 000
2	Primary canals	Q max $=40m^3/s$ Qmean =40x0. 6 $=24m^3/s$	83, 000	m	27, 000	2, 262, 600
3	Secondary canals	Qmean$=7m^3/s$	146, 300	m	12, 000	1, 755, 600
4	Appurtenant structure	(2+3) x 40%				1, 607, 280
5	Terminal canals		35, 000	ha	15, 000	525, 000
	Estimated Total					8, 175, 000

Note: As for the cost of the dam mentioned here, one half is allocated simply on the basis of water volume (with the storage capacity of the dam planned at 700 million tons and the volume needed for irrigation at 350 million.) However, the cost shall be studied in detail in the future in connection with electric power generation and flood control.)

(3) Basic Data (Table of Unit prices)

1) Dam Construction Cost

a) In the case of the Way Jepara Dam

Year of estimate	:	1973
Type	:	Earth dam
Volume	:	21,500 m^3
Total cost	:	59,403,300 Rp
Cost per m^3	:	2,760 Rp/m^3

The above is direct construction cost, not including contingency.

Thus, converted cost	:	2,760 x 1.25 = 3,450 Rp/m3

b) In the case of the Karangkates Dam

Year of estimate	:	1964 to 1972
Type	:	Rockfill dam
Volume	:	6,140,000 m^3
Total cost	:	US$39,487,000

Of the engineering fee, the foreign currency portion of $10,719,000 is deducted.

Cost per m^3	:	6,431 US$/$m^3$ x 415 Rp/US$ =2,670 Rpm^3
Converted cost to present time	:	2,670 x 1.5 = 4,000 Rp/m^3

c) In the case of the Kali Konto Dam

Year of estimate	:	1964 to 1970
Type	:	Rockfill Dam
Volume	:	1,650,000 m^3
Total cost	:	US$10,922,000 (including engineering fee)
Cost per m^3	:	6,619 US$/$m^3$ x 415 Rp/US$ = 2,750 Rp/m^3
Converted cost to present time	:	2,750 x 1.5 = 4,120 Rp/m^3

d) In the case of the Sempor Dam

Year of estimate	:	?
Type	:	Rockfill Dam
Volume	:	1,100,000 m^3
Total cost	:	US$12,200,000
Cost per m^3	:	11,091 US$/$m^3$ x 415 Rp/US$=4,600 Rp/$m^3$

(including a tunnel of D = 3.5 m and l = 126 m)

e) Based on the above examples, the unit construction cost of the dams is estimated at 4,500 Rp/m^3.

2) Tunnel Construction Cost

a) In the case of Kali Konto

Year of estimate	:	1968 to 1969
Type	:	Rock, D = 2.5m, l = 397 m, Q = 14.9 m^3/s pressure tunnel, reinforced concrete
Total cost	:	US$126,720
Cost per m	:	319.2 US$/m x 415 Rp/US$ = 132,500 Rp/m
Converted cost to present time	:	132,500 x 1.5 = 198,700 Rp/m

b) Based on the examples mentioned above and corresponding examples in Japan, the unit construction cost is estimated as follows:

In the case of a non-pressure, free flow rock tunnel, the cost per m in length, and per m^2 in cross sectional area of excavation is:

D = 5m: 15,000 yen/m^2
D = 4m: 15,000 yen/m^2
D = 3m: 16,000 yen/m^2
D = 2m: 16,000 yen/m^2

3) Head Works Construction Cost

a) In the case of Way Abung Hulu

Year of estimate	:	1973
River breadth	:	23.6 m
Total cost	:	115,000,000 Rp (excluding engineering fee, etc., of 25,875,000 Rp in total)
Cost per m	:	4,873,000 Rp/m

b) With reference to the above, the unit cost is estimated at 5,000,000 Rp/m in the case of a tributary and at 10,000,000 Rp/m in the case of the main stream.

4) Water Channel Construction Cost

a) In the case of Way Abung Hulu

Q = 0 - 2 m^3/s	:	3,520 Rp/m
Q = 2 - 3 "	:	5,700 "
Q = 3 - 5 "	:	6,600 "
Q = 5 - 7 "	:	8,750 "
Q = 7 - 12 "	:	9,000 "

The above figures include direct construction cost only.

b) In the case of Way Pengubuan

Year of estimate	:	1972
Q = 2.0 m^3/s	:	10,000 Rp/m
Q = 3.0 "	:	10,833 "
Q = 4.0 "	:	11,476 "
Q = 5.0 "	:	12,180 "
Q = 6.0 "	:	12,670 "

c) With 50% added, the until cost in the case of Way Jepara becomes as follows:

Cutting	:	380 Rp/m^3
Banking	:	450 "
Wasting	:	80 "
Earth supply	:	450 "
Sodding	:	180 Rp/m^2

d) On the basis of the standard canal section in the Way Rarem Report, the estimate of unit cost is made as follows:

Q = 25.0 m^3/s	:	27,000 Rp/m
Q = 20.0 "	:	22,000 "
Q = 17.5 "	:	20,000 "
Q = 15.0 "	:	17,400 "
Q = 12.5 "	:	15,000 "
Q = 10.0 "	:	13,000 "
Q = 7.5 "	:	12,000 "
Q = 5.0 "	:	10,800 "
Q = 2.0 "	:	9,000 "
Q = 1.0 "	:	8,400 "

5) Siphon Construction Cost

The cases of Way Unpu & Pengubuan are adopted as examples.

D=0.3m, Q=0.35m^3/s	:	12,000 Rp/m
D=0.5m, Q=1.00 "	:	17,000 "

D=0.7m, Q=1.76m^3/s	:	28,000 Rp/m
D=1.0m, Q=4.00 "	:	50,000 "
D=1.3m, Q=6.76 "	:	78,000 "
D=1.6m, Q=10.24 "	:	124,000 "
D=2.0m, Q=16.00 "	:	250,000 "

6) Aqueduct: With Q = 9m^3/s, the cost is estimated at 500,000 Rp per m.

7) Construction Cost of Structures Appurtenant to Channels

In the case of ordinary topography:
25% of earth canal construction cost

In the case of undulating topography:
30 to 40% of earth canal construction cost

8) Agricultural Land Opening Cost

a) In the case of Daya Itoh

Year of estimate	:	1972
Cost per ha	:	23,731 Rp/ha (including direct cost only)
Converted cost	:	23,731 x 1.25 = 30,000 Rp/ha

b) In the case of Way Umpu & Pengubuan

Cost per ha	:	63,000 Rp/ha

c) With reference to the above examples, the unit cost is estimated as follows:

Land consolidation	:	30,000 Rp/ha
Farm roads, channels, etc.	:	48,000 Rp/ha
Total	:	78,000 Rp/ha

9) Land Clearance Cost

With reference to the cost in Japan, the cost is estimated at 120,000 Rp/ha.

10) Pumping Station

With reference to the cost in Japan, the cost is estimated at 50,000,000 Rp/m^3/s.

11) Pipeline

The unit cost of steel material is estimated at 300,000 yen/t.

2.5 Plan for Future Necessary Research and Investigation

2.5.1 Agriculture

(1) Arrangement of Data

In planning agricultural development it is important to arrange data for exact understanding of the natural conditions of the area. The area is characterized by difficulties in planned cropping which arise from occasional shift of rainy season and year variation of precipitation amount, as well as by unstable crop which arises from meteorological disasters such as drought, flood, etc.

In order to stabilize the conditions of crop production, it is first of all necessary to exactly understand regional meteorological conditions as basic data for water resources development planning.

Since water mainly governs crop in this area, precipitation amount and evaporation amount are especially important among agrometeorological observation items and it is desirable to immediately provide additional observing points and expand facilities.

The paddy rice cropping in this area does not use manure in most cases partly because of incomplete irrigation facilities. However, management practices will be required for paddy rice cropping when water resources development is carried out. This in turn requires investigation of water quality of rivers serving as natural water sources. Hence, water quality by rivers should be investigated.

Though soil condition data have been prepared, detailed investigation is required for management practices in future.

(2) Establishment of extension center and demonstration farm

Since very incomplete irrigation facilities mainly hinder the introduction of new rice-cropping techniques, the productivity in this area can be said to remain at a low level. In order to improve productivity, it is necessary to complete irrigation facilities including not only main channels but also branches. However, even if they are completed, productivity cannot be improved without introduction of corresponding paddy rice-cropping techniques.

In introducing a new technique in paddy rice culture, variety, planting density, fertilizer application, water management and control of disease and insect damage should be studied in details according to the actual conditions of a district, because unconditional application very often fails.

To avoid such failure, practical engineers to lead farmers on the front should be trained. Establishment of the extension center seems to be effective for training the practical engineers who play a very important role in extension. One extension center should preferably be provided for each kabupaten, but the scale of the center may be in accordance with the Indonesian plan within the West-Java Food Production Increase Plan. The scale is estimated as follows:

1) 3 to 5 extension workers.

2) Buildings including office, training room, warehouse.

3) Agricultural and educational materials and equipment.

4) Trial field of about 5 ha.

5) Related facilities.

The activity of the center covers:

1) Lecture in the training room and practical training in the trial field.

2) Making the round of surrounding farm household for guidance.

3) Supply and collection of information.

It is important to improve the ability of extension workers by the practical training on the trial field within the center.

One or two demonstration farms should preferably be provided for each country (Kecamatan), if possible, for demonstrating new rice-cropping techniques, thereby educating farmers and extending new techniques. In this case, the scale of the demonstration farm may be 3 ha at most.

(3) Establishment of the method for soil improvement and fertility maintenance

Since it is hot and rainfall is concentrated in the rainy season in this area, organic matter decomposes readily. In addition, the shifting cultivation by land-burning in the highland deprives soil fertility and rice straw is burnt on the paddy field. Such practices are against fertility maintenance. Consequently organic matter is consumed excessively and humus in soil lacks. This results in single grain structure of soil and low resistance of crop to drought. They aggravate drought damage. On the other hand, soil fertility level has become lower and lower because fertilizer has rarely been applied.. Even if fertilizers are applied, they are almost limited to urea and triple superphosphate, resulting in unbalanced soil nutrient composition.

Under such conditions soil nutrient deficiency will be accelerated and soil productivity is feared to become lower. In order to prevent this, rice straw and corn stem should be returned to field without burning. In addition the prevailing acid soil should be improved by applying lime, etc.

The method for soil improvement and fertility conservation ensuring proper crop growth should be established as soon as possible in order to raise crop production to high level.

(4) Covering bare land by afforestration

Bare land has resulted from no control after land burning in the valley of the Walanae River and Bila River and resulted in errosion. It should be covered as soon as possible to prevent errosion. For this purpose a suitable tree species for the area should be selected and vegetation should be restored by planned afforestration. Land burning should be re-examined because it is not desirable from a viewpoint of soil conservation.

2.5.2 Agricultural Economy

We should place emphasis on the following items in master plan formulation and feasibility study:

(1) On general view of the area

1) We grasp the state of agricultural production particularly of principal food crops, collection of population statistics, and investigate supply and demand of food crops by country, kecamatan and village (desa).

To grasp harvesting area and production of food crops such as rice, corn, etc., by kecamatan, desa and at each year. Year transition of population by kecamatan and desa.

2) Collection of data for analyzing general agricultural structure of the area

- Land use: paddy field, upland, orchard, etc.
- Agricultural production: harvesting area and production by crop.
- Land tenure: farmer's land tenure
- Capital equipment: extension of livestock, agricultural machinery, etc.
- Others

3) Investigation of the actual conditions of existing irrigation facilities.

- Provision date of irrigation facilities.
- Capacity, scale, benefited area, state of water shortage, water managing system, state of operation and maintenance, rehabilitation record, etc.
- Making ledgers and maps, classified by irrigated facilities.

4) Grasping farmers' opinion

Listenning farmers' opinion as basic data for formulating the master plan.

5) State of marketing

- Studying sales route and organization of agricultural products and purchasing route of agricultural materials.
- Analyzing and imporving the mechanisms of price formation.
- Others.

(2) For each projects

1) Grasping the state of the benefited area, such as present land use, agricultural production, farming state, etc.

- Drawing of land use map in present.
- Change in agricultural production: harvesting area and production by crops.
- Grasping state of farmer's land tenure and farmer's labour-power in connection with the benefited area and farmers.
- Farming record and listenning farmers' opinion.

2) Planning based on present-state analysis

- Study of crop to be introduced and cropping pattern.
- Guidance of group cultivation for rationalization of water use.
- Formation of organization for selling agricultural produc-

tion and purchasing agricultural materials.

- Others.

2.5.3 Irrigation

(1) Proposed head works site

1) Collection of river configuration data

a) Plan (1.5 time of upstream and downstream meandering lengths).

b) Profile and cross section of river (the same length as above).

c) Grain size analysis of river bed materials (excluding Lawo, Langkemme and Sanrego).

d) Geological investigation (boring).

2) Collection of hydrological data

a) Catchment area of the head works site.

b) Relationship between water level and river discharge at the head works site.

c) Through-year record of daily water level variation.

d) Maximum flood discharge ever recorded.

(2) Area to be benefited

1) Confirmation of irrigation area and its location

a) Drawing topographic map: general plan of 1/5,000 in scale.

b) Drawing topographic map: for the area where general plan of 1/50,000 in scale has not been drawn yet.

c) Checking and adjusting the existing B. M. network.

2) Others

a) Irrigation channel network plan.

b) Geological survey at the proposed structure construction site.

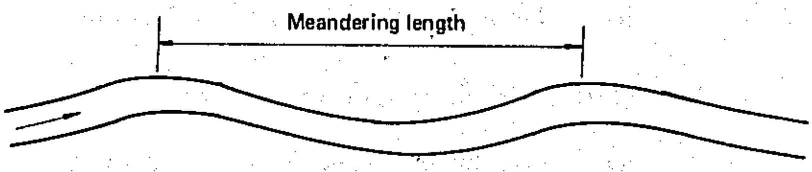
c) River water quality examination.

(3) General and supplemental data for designing water intake facilities.

1) River configuration data

a) General map (1/50, 000) covering the catchment area.

b) River plan (1/2, 000) with contour lines which covers the upstream and downstream areas within 1. 5 time of the meandering length from the weir site.



c) Cross section (ordinate; 1/100 and abscissa; 1/1,000) at an interval of 100 m or twice as long as river width.

d) Profile (ordinate; 1/100 and abscissa; 1/1, 000) with the river bed level at the deepest point, average river bed level, highest flood mark ever occurred and planned flood water level.

e) Grain size analysis of river bed materials:
Sampling at an interval of 500 m and measuring specific gravity.

f) Boring test at the weir site for clarifying the geological structure and permeability coefficient.

g) Aero-photo.

2) Hydrological data

a) Catchment area at intake site.
b) Relationship between water level and river discharge at the intake site.
c) Through-year record of daily water level variation.
d) Relation between time and water level at the time of flood.
e) Maximum flood level ever recorded (to be estimated from marks).

3) River discharge each intake site

a) Bila, Boya and Gilirang

i. Bila

An automatic river stage recorder provided about 3 Km downstream of the intake site gives river discharge. However, it is desirable to provide a staff gauge at the intake site.

ii. Boya

The already constructed Bulucenrana weir is used for measuring river discharge. A staff gauge should be provided upstream of the weir with the length 5 to 10 times as much as the maximum overflow depth. Opening extent of the regulating gate and the intake gate and the water level downstream of the intake gate as well shall be recorded at the same time.

iii. Gilirang

If observation at the intake site is impossible, a staff gauge shall be provided at the place as near as possible where water level is readily observed. In this case the river gradient 1 Km upstream and downstream of the staff gauge point shall be investigated.

b) Cenranae

The flow around this intake site is analyzed as a part of the river plan, and hence no special attention is required for taking water. However, provision of a staff gauge at the intake site for recording through-year record of daily water level variation will be useful for future analysis.

c) Lawo

Since the river flows rapidly, river discharge observation at the intake site is not always necessary. It is recommended that river discharge be observed at a suitable point downstream of the intake site.

d) Langkemme

An observation station with an automatic river stage recorder is under construction on the right bank directly upstream of the bridge located 2 Km downstream of the intake site. The instrument was due to be installed in February, 1974. Since the river is also a torrent, the river discharge can be observed at the point of the already installed staff gauge.

Note: A water level of 3.5 m was recorded on the already installed staff gauge in the recent flood.

e) Sanrego

The Keterangan staff gauge provided 500 m downstream of the intake site has been used for the river discharge observation since April, 1972. The river is also a torrent and hence the record on the already installed staff gauge can be utilized. However, the maximum flood level is said to be 3 - 4 m plus the water level at the time of investigation (February 15, 1974).

f) Ludunge

The intake site is located on the mainstream of the Walanae River and downstream of the Mong Dam site, therefore the river plan data are available. However, it is desirable to provide a staff gauge at the intake site for recording water level.

4) Others

It is unnecessary to analyze the river bed material of the weir sites of Lawo, Langkame and Sanrego.

3. Inland Fishery

3.1 Present State

South-Sulawesi faces the Bone Bay on the east and the Makassar Sea on the west and has the fourth biggest lake, Lake Tempe, in the middle. According to the Fact and Figures (1972) published by Directorate General of Fisheries, South-Sulawesi shares 10% of the Indonesian fishery production, the third, next to Riau and West Java, among the 26 provinces. The inland fishery in South Sulawesi shares only 2.9% of the total Indonesian inland fishery production but the inland fish culture shares 12.4% of the total cultured production, the third, next to West and East Java. The fish culture consists mainly of shrimp culture in the brackish water area but little of freshwater culture using pond, paddy field, etc.

The inland fishery in South-Sulawesi are practiced in lakes (Lakes Tempe, Sidenreng and Buaya), rivers, swamps and reservoirs, and the inland fish culture uses ponds, paddy fields and empangs. The area and production of each fishing ground in 1972 are, as shown in Tables 3-1 and 3-2: 15,550 ha (only Lake Tempe and its surrounding lakes, excluding other lakes where fishery is seldom practised) and 3,360 t for lakes; 11,580 ha and 1,590 t for swamps; 7,215 ha and 672 t for rivers; and 381 ha and 31 t for reservoirs. Lakes and swamps share 87.6% of the total production. On the other hand, in fish culture the area and production are 40,435 ha and 15,189 t for brackish water empangs (mainly for shrimp and milk fish); 1,388 ha and 326 t for freshwater pond; and 8,154 ha and 1,665 t for paddy field. The total inland fishery and fish culture production in weight and money amount to 22,833 t i.e. 2,478 million Rp, sharing 20.3% and 33.4% of the total fishery production including sea fishery, respectively. Thus, the inland fishery plays an important part in the fishery of South-Sulawesi.

Table 3-1 Area of Inland Fish Culture and Fishery in South Sulawesi

Unit: ha

Year	Fish Culture				Fishery					Total
	Culture farm	Pond	Rice field	Total	Lake	Swamp	River	Reservoir	Total	
1969	37,147	2,414	10,698	50,259	15,550	11,569	7,310	730	35,159	86,418
1970	37,677	2,017	9,038	48,732	15,550	11,830	7,214	730	35,324	84,056
1971	38,716	2,079	9,646	50,441	15,550	11,580	7,214	579	34,923	85,364
1972	40,438	1,388	8,154	49,981	15,550	11,580	7,215	381	34,726	84,707
Aver-age	38,494	1,974	9,384	49,853	15,550	11,639	7,238	605	35,033	84,886

Fishery Service South Sulawesi

Table 3-2 Production of Inland Fish Culture and Inland Fishery in South Sulawesi

Unit: ton

	Fishing ground	1969	1970	1971	1972	Ave.
Inland fish culture	Culture farm	12,061	14,347	15,102	15,189	14,319
	Pond	1,813	439	468	326	429
	Rice field	466	2,114	2,081	1,665	1,925
	Total (A)	14,340	16,930	18,229	17,180	16,669
	Sub total* (B)	1,008	1,022	1,032	655	929
	Ratio (B)/(A)	7.0%	6.0%	5.7%	3.8%	5.6%
Inland fishery	Lake	5,705	5,100	5,609	3,360	4,943
	Swamp	2,504	1,654	1,647	1,590	1,848
	River	1,366	749	708	672	873
	Reservoir	190	104	62	31	96
	Total (A)	9,765	7,607	8,026	6,653	7,762
	Sub Total* (B)	7,342	5,939	6,550	4,505	6,084
	Ratio (B)/(A)	75.2%	78.1%	81.6%	79.7%	78.4%
Total	Culture & fishing (A)	24,105	24,530	26,255	22,833	24,432
	Sub total* (B)	8,350	6,961	7,582	5,160	7,013
	Ratio (B)/(A)	34.6%	28.3%	28.9%	22.6%	28.7%

Note: * The Sub total of three Kabupaten around Lake Tempe, Kabupaten Wajo, Soppeng, Sidrap.

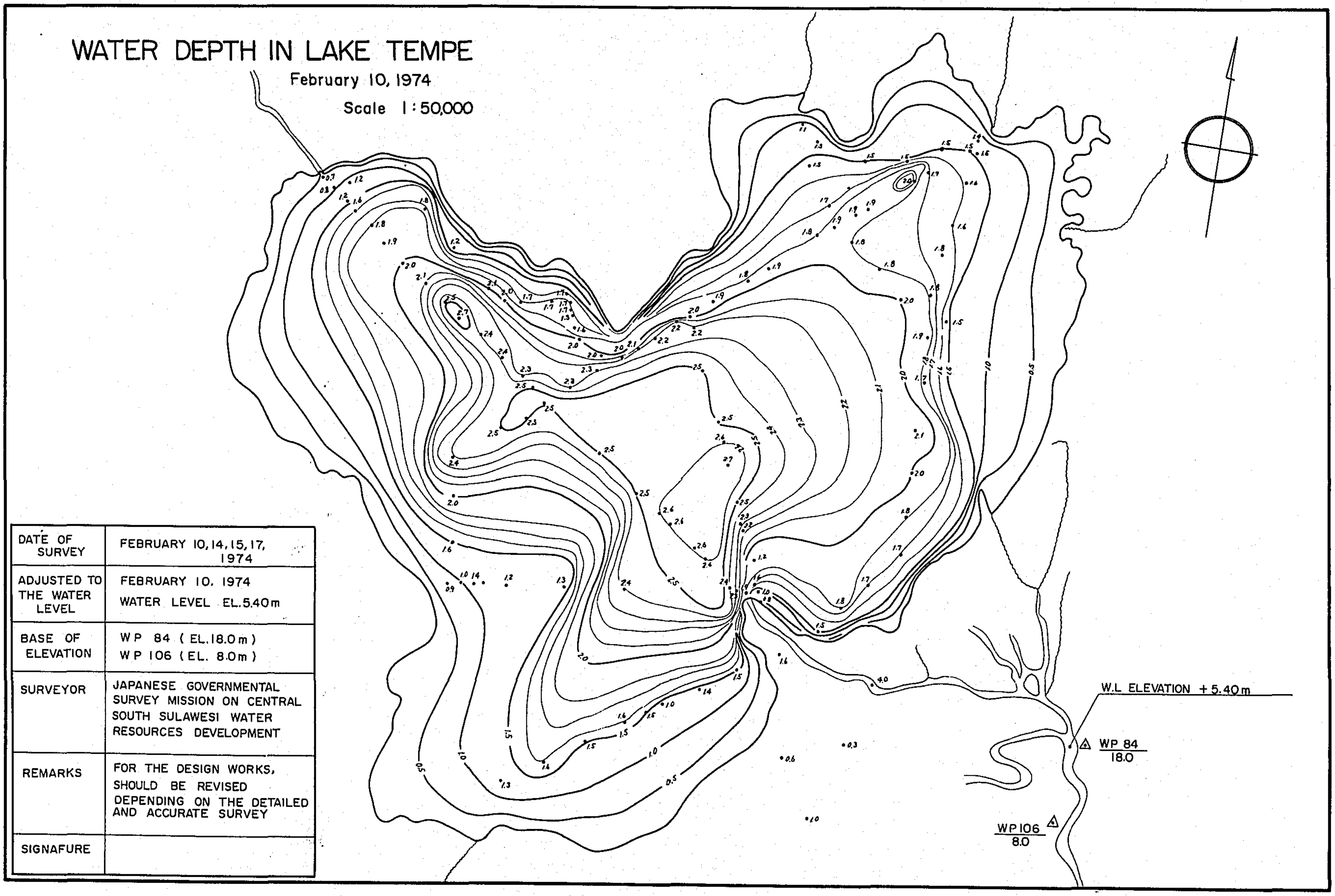
Fishery Service South Sulawesi

(1) Since one of the purposes of this survey is to re-develop the inland fishery around Lake Tempe, the fishery on Lake Tempe will be discussed below.

1) Topological conditions

As shown in Fig. 3-1, 3-2 and 3-3, Lake Tempe of an approximate triangular shape, from the south-west side to the north-east side about 15 Km and from the south-east side to the north-west side about 10 Km, has a surface area of about 9, 000 ha at the time of survey with water level of about 5.4 m. The maximum depth is about 2.70 m at around the center of the lake and is a very shallow dish-shaped lake. Therefore, in the dry season from the end of September to the beginning of December the lake has a water depth of 30 to 50 cm and an area of 10, 000 to 20, 000 ha. It sometimes leaves only a small water area at the center which is disconnected from the inflowing streams and the remaining area is dried up. Part of it is used for growing upland crops such as corn. On the other hand, at a flood occurring at the peak of the rainy season from June to July, the lake has a depth reaching 6 to 7 m and becomes a big lake of 30, 000 to 35, 000 ha which consists of Lake Sidenreng locating about 7 Km north-west of the lake, Lake Buaya locating about 5 Km north-east of the lake, and the wide swampy area surrounding the three lakes.

From the end of December to the end of May, though floods occasionally occur, the water level is stable maintaining an average level: the lake is 2.5 to 3.0 m deep and about 9, 000 to 10, 000 ha wide. As shown in Fig. 3-4, the main inflowing rivers to Lake Tempe are the Bila River flowing from the north, and the Walanae River flowing from the south through the Menraleng River. The Watta River and the Cenranae River flow in from Lakes Sidenreng and Buaya, respectively. Small rivers such as the Lalirompowe River



DATE OF SURVEY	FEBRUARY 10, 14, 15, 17, 1974
ADJUSTED TO THE WATER LEVEL	FEBRUARY 10. 1974 WATER LEVEL EL.5.40m
BASE OF ELEVATION	WP 84 (EL.18.0m) WP 106 (EL. 8.0m)
SURVEYOR	JAPANESE GOVERNMENTAL SURVEY MISSION ON CENTRAL SOUTH SULAWESI WATER RESOURCES DEVELOPMENT
REMARKS	FOR THE DESIGN WORKS, SHOULD BE REVISED DEPENDING ON THE DETAILED AND ACCURATE SURVEY
SIGNAFURE	

Fig. 3-1 Water Depth in LakeTempe

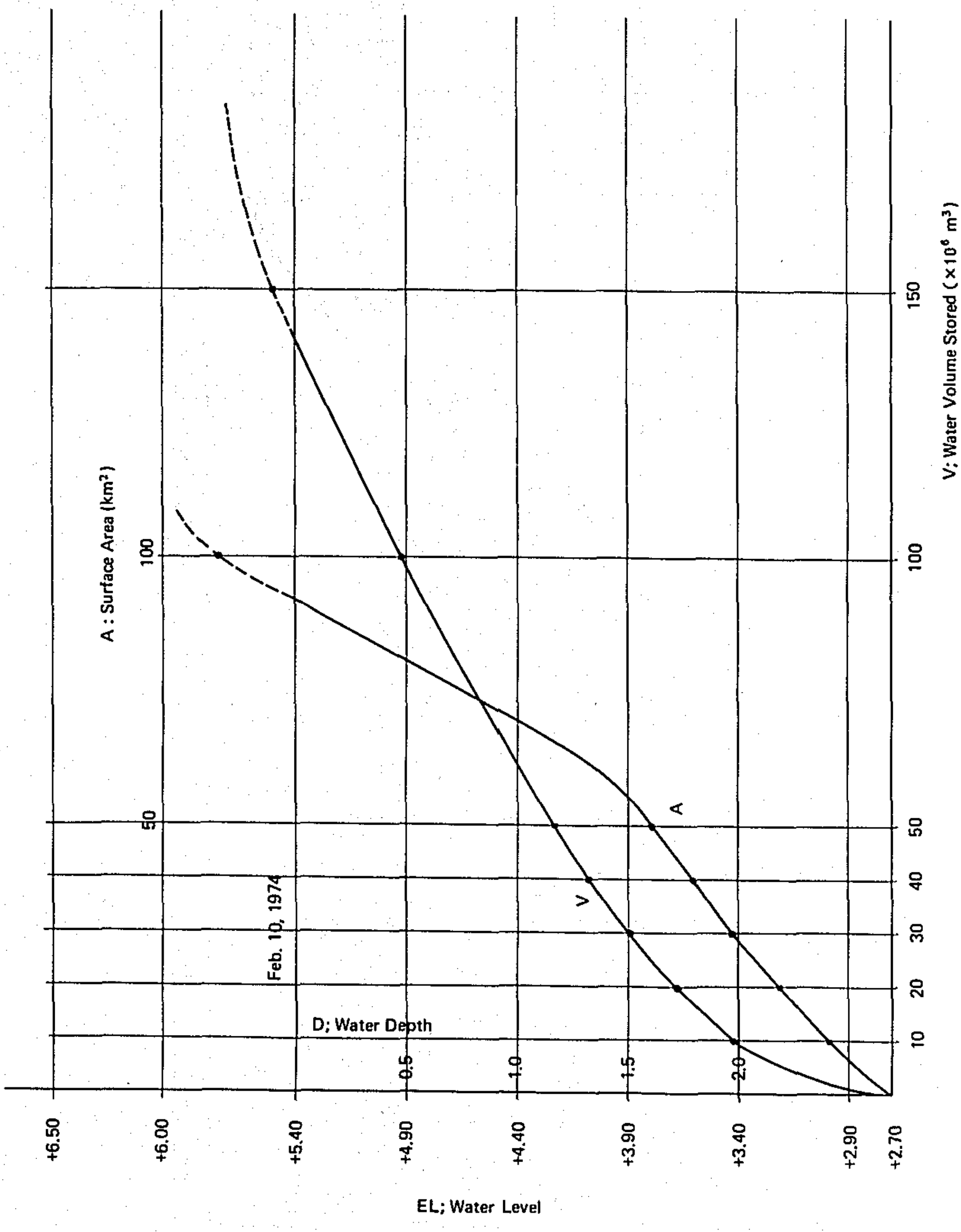


Fig. 3-2 Lake Tempe
Water Level vs
Water Volume & Surface Area

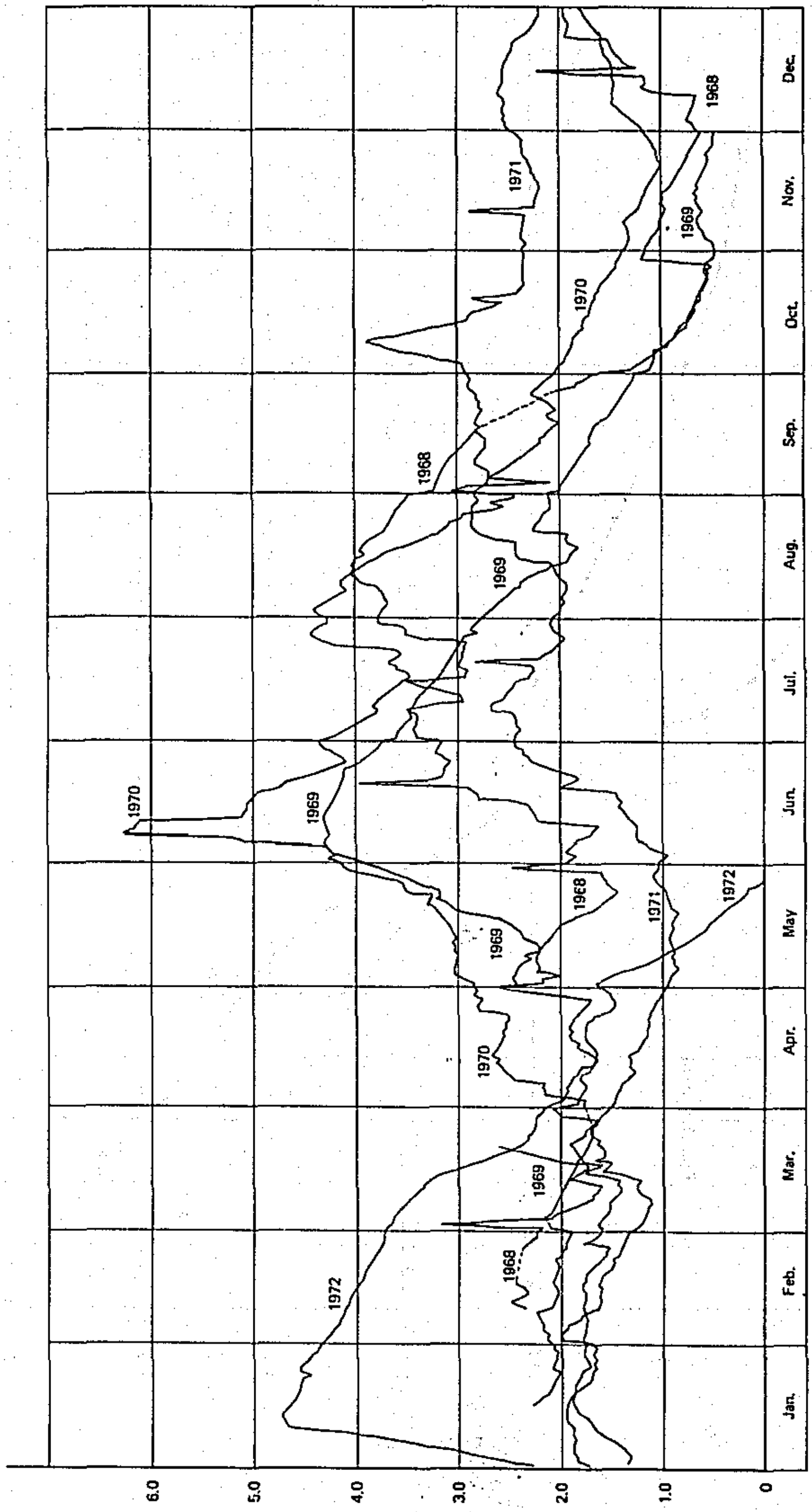


Fig. 3-3 Water Depth Record in Lake Tempe
(at Laringgi)

from the south, the Batubatu River from the west and the Jancung River from the east flow in. The outflowing river is the Cenranae River flowing through the Menraleng River to the east into the Bone Bay at Palima which is located north of Watampone. Lake Buaya sometimes dries up in the dry season. On the other hand Lake Sidenreng is relatively deep, 5 m in depth in the rainy season and 2 m in depth in the dry season according to an interview, and shore is rather steep. The Wattae River connecting Lakes Sidenreng and Tempe joins to Biloka River at Wattae where the river bed is raised by sedimentation. When the water level of Lakes Sidenreng and Tempe is lowered in the dry season, the lakes are disconnected at this point and Lake Sidenreng becomes an isolated lake of about 3,000 ha.

Lake Tempe belongs mostly to the Wajo but partly to the Sopping.

2) Inland fishery around Lake Tempe

The inland fishery around Lake Tempe is important because it shares about 78.4% of the average inland fishery production of South-Sulawesi from 1969 to 1972, i.e. 6,084 t estimated to amount to about 600 million Rp, as shown in Table 3-2. Catch in weight by fishing ground around Lake Tempe is shown in Table 3-3: 4,943 t, i.e. about 81% for lakes, indicating the importance of the lakes. Lake Tempe and Buaya shares 78% of the catch from lakes, while Lake Sidenreng shares only 21%.

30 to 50% of the fish caught in Lake Tempe and around is processed to dry salted fish and exported from Pare-Pare or Ujung pandang Port to Java. Kalimantan, etc. The dry salted fish processing, one of the most important industries of Wajo, is prosperous especially around Singkang.

Cold storages and ice-making plants for storing fish are not found and fish paste processing is seldom practised around Lake Tempe. Hence, all fish except dry salted fish are sold as fresh fish for domestic consumption purpose.

The species of the fish caught on Lake Tempe is relatively limited. As shown in Fig. 3-5, and Table 3-4, the species consist mainly of Tawes (Puntius Juvanicus (Bikr)), Sepat Siam (Trichogaster Pectoralis (Regan)), Ikan Tambakan (Helostoma Temminckii C. V.) and Ikan Mas (Cyprinus Carpio ..... common carp) these species were introduced from Jave Kalimantan, and Jabus (Ophicephalus Striatus B. L.), domestic species of Lake Tempe.

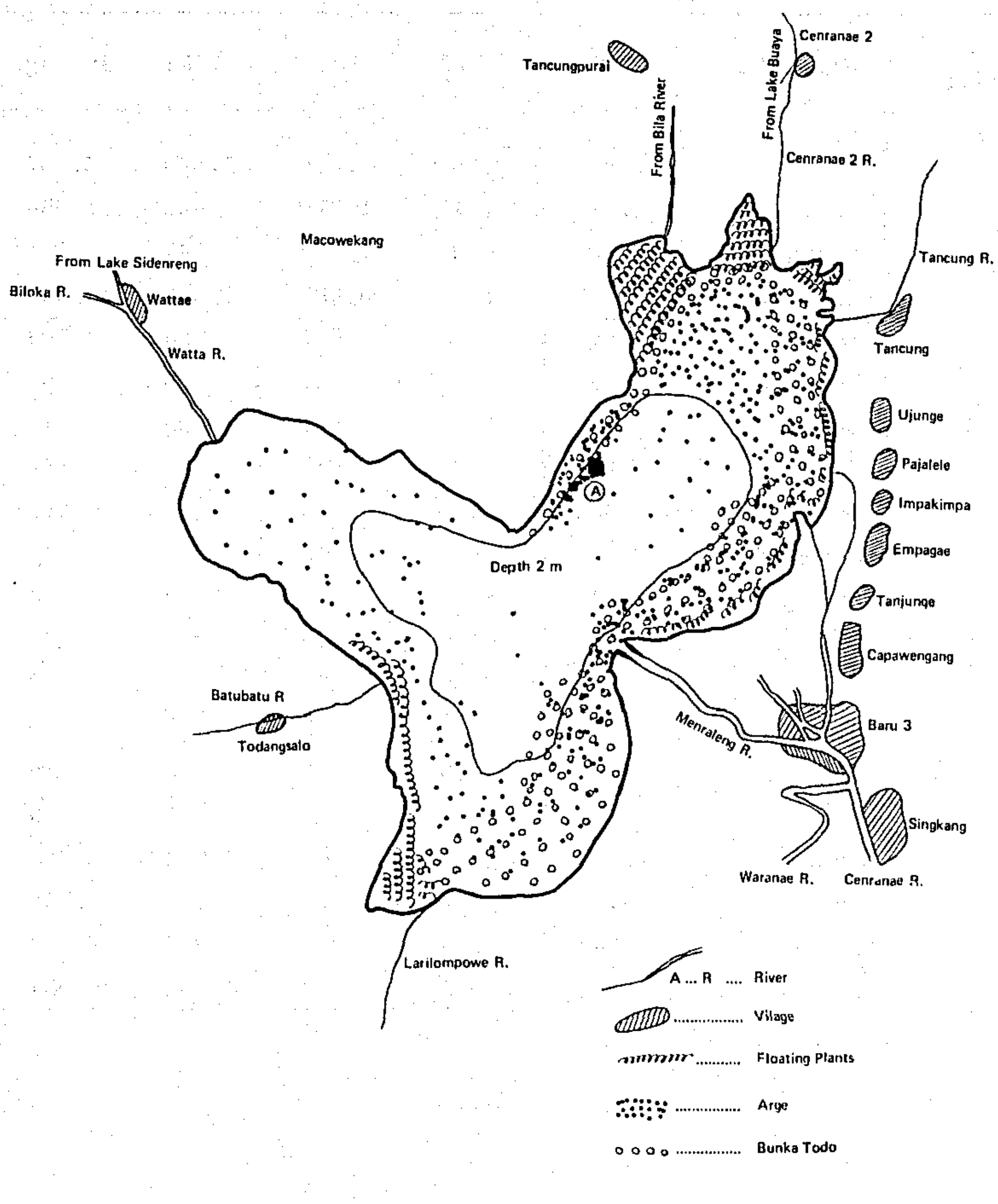


Fig. 3-4 Outline Drawing of Lake Tempe and Distribution of Water Plant

Table 3-3 Production of Fish Around Lake Tempe by Fishing and Kabupaten

Unit: ton

Fishing ground	Kabupaten	1969	1970	1971	1972	Average
Lake	Wajo	2,524	2,261	2,516	1,649	2,237
	Soppeng	2,073	1,812	1,870	864	1,654
	Sidrap	1,108	1,027	1,223	847	1,051
	Sub total	5,705	5,100	5,609	3,360	4,943
Swamp	Wajo	962	438	647	786	708
	Soppeng	80	87	22	30	54
	Sidrap	9	22	21	26	19
	Sub total	1,051	547	690	842	782
River	Wajo	355	170	170	173	217
	Soppeng	4	8	25	24	15
	Sidrap	45	48	4	89	46
	Sub total	404	226	199	286	278
Reservoir	Wajo	180	38	31	4	63
	Soppeng	0	0	0	0	0
	Sidrap	2	28	21	13	16
	Sub total	182	66	52	17	79
Total	Wajo	4,021	2,907	3,364	2,612	3,225
	Soppeng	2,157	1,907	1,917	918	1,723
	Sidrap	1,164	1,125	1,269	975	1,132
	Sub total	7,342	5,939	6,550	4,505	6,084

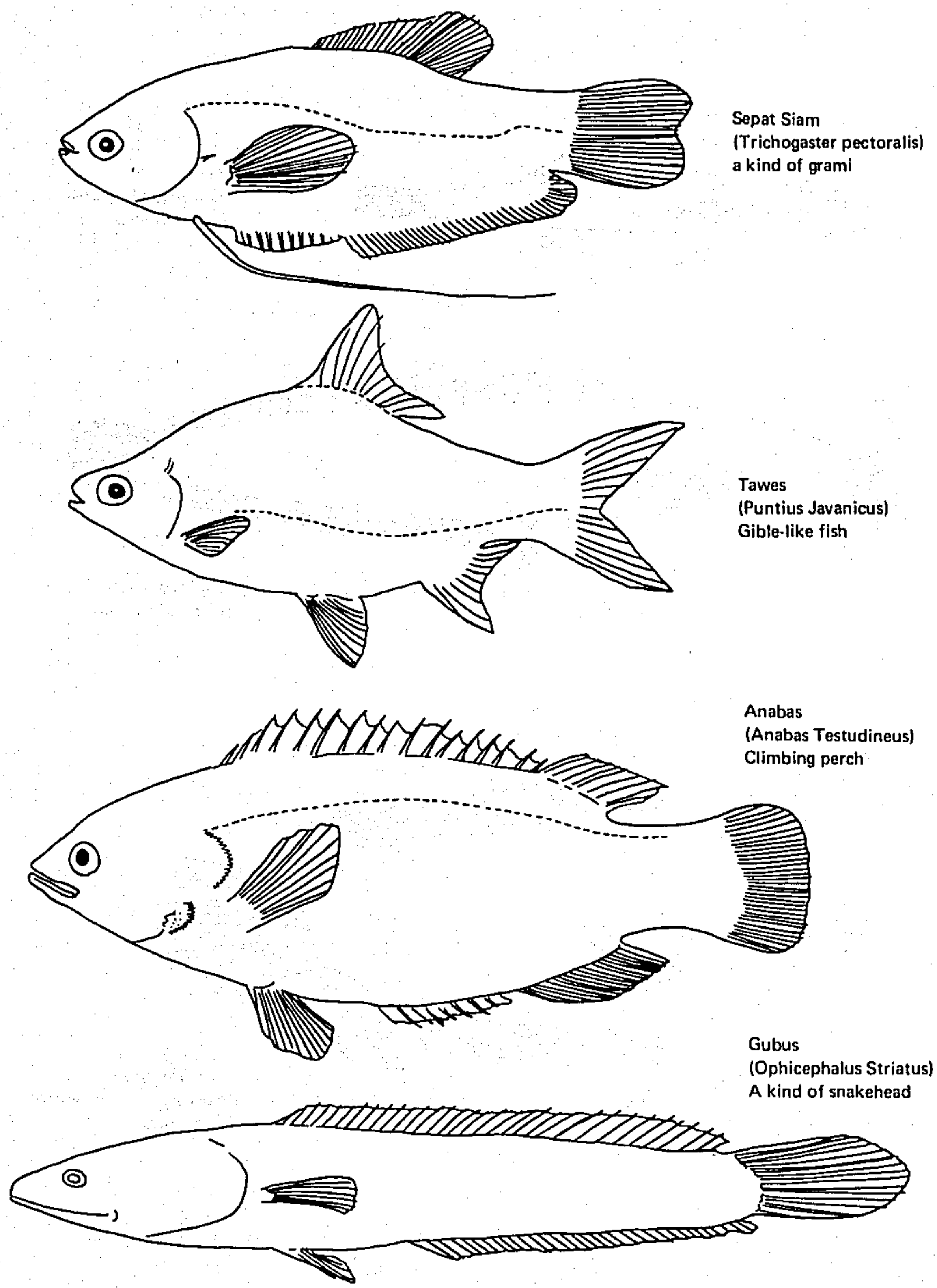
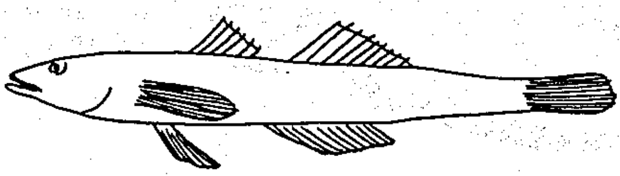
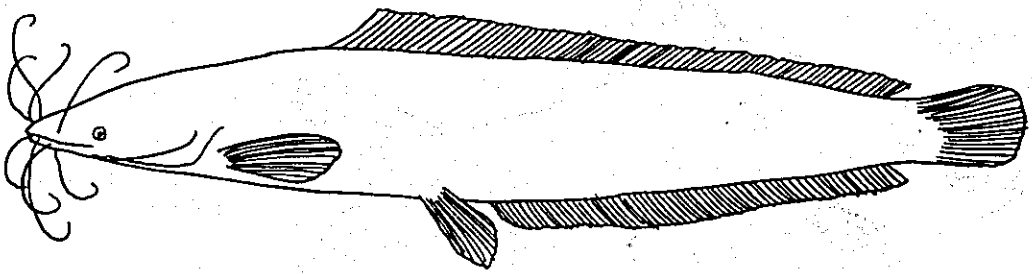


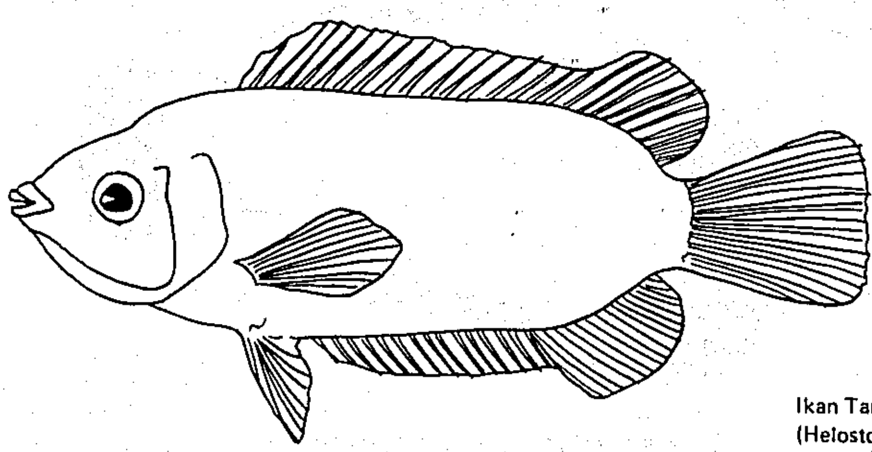
Fig. 3-5 Fish in Lake Tempe



Bugo
(Glossogobius giuris)
A kind of goby



(Clarias Batrachus)
A kind of Cat fish



Ikan Tambukan
(Helostoma Temminckii)
Kissing grami

Fig. 3-5 (Cont'd)

Table 3-4 Species Composition of Fish Caught in Wajo

Local Name	Specientific Name	Catch Composition	Remarks
Tawes	Puntius Javanicus	50%	
Sepat Siam	Trichogaster Pectoralis	20%	
Ikan Mas	Cyprinus Carpio	10%	
Tambakan/ Samarinda/ Biawa		5%	Including Gabus, Lele Belanak, Udang Sungai, Bungo, etc.
Others		15%	

Published by Wajo Fishery Service on August 2, 1973

As shown in Table 3-4, species composition of the fish caught in Wajo in 1972, Tawes and Sepat Siam share 70% of the total catch, indicating that they are the most important species. As shown in Table 3-5, 40 to 70% of the Tawes and Sepat Siam caught in Wajo, is processed to dry salted fish and the remainder is sold for domestic consumption purpose. Ikan Mas, which was introduced from Java in 1948, hardly propagates in the lakes, so most of its resources seems to grow out of the stocked fry which is produced in hatcheries, three in Soppeng and two in Sidrap. No hatchery is provided in Wajo. Stocking record of Ikan Mas fry is shown in Table 3-6, about 1,100 thousand in 1972.

The fish price ranges from 50 to 150 Rp/Kg as shown in Table 3-7, according to the research carried out at the Pasar Sentral in February, 1974. Gabus is the most expensive because it suits inhabitants' taste and the catch is small. As mentioned above, Ikan Mas has relatively recently introduced but it is important because not only it is expensive next to Gabus because of suiting the taste of inhabitants but also it shares 14.8% of the catch excluding raw fish for processing. The most caught fishes, Tawes and Sepat Siam, are the cheapest and most of them are processed to dry salted fish. The raw fish price calculated from the price of dry salted product (the yield recovery from raw fish is estimated to be 62.5%) are very low, 31 Rp/Kg for Sepat Siam and 44 Rp/Kg for Tawes.

Table 3-5 Fishery Production and Exported Fish in Wajo

Unit: ton

Year	Lake Tempe	All Grounds	Exported Fish (in raw fish weight)	Ratio (A)/(B)
1961	11,749	14,090	5,631	41 %
1962	9,060	12,010	4,398	37
1963	5,847	7,955	3,108	39
1964	6,851	9,993	3,792	38
1965	3,393	4,492	2,607	58
1966	1,350	2,314	1,769	76
1967	1,248	1,935	975	50
1968	2,676	4,810	1,989	41
1969	2,177	3,212	1,683	52
1970	1,539	2,748	1,534	56
1971	1,987	2,707	872	32
1972	1,454	1,939	635	33
Average	44,111	5,659	2,416	42

Notes:
1) The exported fish are caught within Wajo and exported out of it.
2) Fish are mostly exported in the form of dry salted fish. The above quantities are expressed in weight of the raw fish.
3) The raw fish consists of Tawes, 60% and Sepat Siam, 40%.

Fishing Service Wajo

Table 3-6 Stocking Record of Ikan Mas Fry to Lake Tempe (in thousand)

Year / Kabupaten	1968	1969	1970	1971	1972	1973
Soppeng	50	100	200	250	350	1,000
Sidrap	0	0	0	0	0	75
Total	50	100	200	250	350	1,075

The Fishery Service Soppeng & Sidrap

Table 3-7 Market Price in Singkang, Kabupaten Wajo

As of Feb., 1974

Species	Size	Price Rp/Kg	Remarks
Fresh fish			
Gubus	Large	150	Price at the Pasar Sentral
	Small	90	
Tawes	Large	100	
	Small	50	
Sepat Siam		50 - 70	
Ikan Mas		100 - 150	
Anabas		150	
Shrimp	Large	50 - 20	
	Small	2	
Bugo (a kind of goby)		100	
Dry Salted Fish			
Sepat Siam		50	Price of raw fish 31
Tawes		70	44

According to the interview at Pasar Sentral Singkang

The fishing gears shown in Fig. 3-6 are mostly primitive and are made of bamboo by the fishermen themselves. Fishing nets and guts are made of nylon. No activt fishing method such as towing net, purse seine, etc., are generally found. However, Bunka to do is noteworthy because it is an active fishing method taking advantage of the habit of fish gathering under floating plants. All fishing boats are non-power canoes which use only a simple sail for utilizing wind as auxiliary power of man power. So-called sailing boats are not found.

According to this survey, fishermen around Lake Tempe was 22,300 in number in Wajo. According to the Waskita Karya's Report, the numbers of fishermen and their families are 21,000 fishermen and about 4,200 families, in Wajo, and 7,000 fishermen and about 200 families, in Soppeng, totalling 22,000 fishermen and 4,400 families. In addition, there are fishermen in Sidrap operating on Lake Sidenreng. 1,300 families, 30% of the above-mentioned fishermen around Lake Tempe, which constitute about 300 houses, are full-time fishermen. Their living level is low and they have been made increasingly poorer by the recent catch reduction. 60%, 2,460 families, are seasonal/semi full time fishermen living on mainly farming. Their living level is higher than the full-time fishermen. They have basic education and are influenced by town life, so the traditional way of thinking has been gradually changed. 10%, about 440 families, are amateur fishermen who catch fish for the purpose of sport and recreation.

As for the excercise of the fishing ground, the Plawang system to give an exclusive right of using for three years, to a particular person who has won at the auction has been established for the area near the east shore of Lake Tempe around the mouth of the Menraleng River. Regulations of fishing gear and methods on period and location are applied under the authorities of the adat law and administrative guidance and control of the local government, in order to maintain the order of fishing grounds.

According to this survey, when the water level of Lake Tempe is about 5.4 m (considered to be an average level) indicated in Fig. 3-4, a lot of Characeae sp. colonies are found on the bottom shallower than 2 m, especially in the east part of the lake. Floating plants of Alternanthera sp. grow 500 m to 1 Km off the shore, especially the northern bays of the lake around the mouths of the Bila and Cenranae-Cenranae Rivers are almost covered with floating plants. Very many Bunka toddos making use of the floating plants are often found in the eastern part of the lake particularly in the area with the depth less than 2m, 2 to 2.5 Km off the shore. Floating plants and arge grow less in the bay at the mouth of the Watta River in the north-western part of the lake. Floating plants do not grow and arge grows less in the middle of the lake.

The water of the lake at the time of the survey should pH 6.7 and a temperature from 29 to 30°C (in the surface). It was made so turbid by silt that a dish 20 cm in diameter was visible to the depth of only a few to some ten cm. However, the water where arge grow densely on the bottom was generally clear. A very clear water was found around the middle of the lake off the northern shore ((a) point shown in Fig. 3-4) but the reason was not clarified by this survey.

The biggest fishing ground in the lake is the area around the mouth of the Menraleng River, where a lot of fixed fishing gears such as Julu, Bubu Konde, Bubu Udang, etc., are placed. More than ten Palawangs are established around there, making the center of the Lake Tempe fishing ground. Off the eastern shore, north of the mouth of the Menraleng River, many Bunka Toddoes are set and virages covering Tanjunge, Empagae Ujunge and Tancung locate near the shore, so this area makes the next biggest fishing ground to the area around the mouth of the Menraleng River. The northern part of the lake is not so much used for fishing because there are few villages which are far from the lake by wide swampty area. Particularly the north-western bay in which the Watta River flows is seldom used. Many Panambes (a kind of long line) for Gabus are placed in the north-eastern part of the lake where arge grows densely and the water is relatively clear.

The local government provides a prohibited fishing area of about 250 ha in the middle of the lake through the year in order to preserve fishery resources.

Though Lake Buaya was not explored according to an interview it seems to be under simular conditions to those of Lake Tempe.

At the time of this survey Lake Sidenreng was more turbid than Lake Tempe. Only a few colonies of floating plants are found around the mouths of inflowing rivers along the western and eastern shores of the lake. Arge was hardly found throughout the lake. The flora of Lake Sidenreng was very poorer than that of Lake Tempe.

Summing up the above discussion the water is very turbid but rich in nutrient and water plants grow well in Lake Tempe. The lake is shallow and supplied with sufficient amount of oxygen. The water has the pH of 6.8, almost neutral, and a high temperature of 29 to 30°C. Various feeding habit fishes such as plankton feeder, aquatic plants feeder, omunivorous fish, carnivorous fish, etc., are bred in the lake. The shallow area near the shore forms a good littoral zone. From the results of this survey Lake Tempe has high potential to produce or reproduce fishery resources if it has sufficient surface area and water volume. Though Lake Sidenreng has larger surface area and water volume than Lake Tempe in the dry season, the former has less potential than the latter.

In addition to lakes, swamps and rivers are used for fishing. Swamps are important because they share about 13% of the total catch as shown in Table 3-3. However, analysis and discussion could'nt be carried out because this survey offered few available data.

(2) One of the purposes of this survey is to give basic data for developing the inland fishery (including fish culture) within the central South-Sulawesi Water Resources Development Plan area. Since the inland fishery development is mainly directed to fish culture, the present state of fish culture around Lake Tempe will be discussed below.

Indonesian inland fish culture has been practised over the middle and eastern part of Java Island since the period of the Dutch rule. As shown in Table 3-8, the paddy field fish culture shares 82% of the fish culture around Lake Tempe. It should be practised under the conditions that water is sufficiently controlled by technical irrigation and that seedling to be stocked is available. Around Lake Tempe paddy field fish culture is practised in technically irrigated paddy field in Soppeng and Sidrap. In 1972 Soppeng produced 57 t on the culture area of about 300 ha and Sirap produced about 26 t on the culture area of about 100 ha. Since Wajo has no technical irrigation, paddy field fish culture is not practised. The seedling to be stocked is extensively produced in a small yield per area unit, but the production technique has been established. The seedling is supplied from three hatcheries in Soppeng and two in Sidrap.

An example of seedling production is shown by Lajoa Hatchery which is the biggest in Soppeng. The hatchery has about ten ponds of the area totaling 1.5 ha and two 1m x 5m x 1m concrete ponds, keeps 200 female and male spawning fish, respectively (collecting eggs five times per month), and is managed by three members (personnel of the local government). As shown in Table

Table 3-8 Fish Culture Around Lake Tempe

Unit: ton

Ground	Kabupaten	1969	1970	1971	1972	Average
Pond	Wajo	45	8	9	0	15
	Soppeng	13	4	3	2	5
	Sidrap	1	1	3	5	2
	Sub Total	59	13	15	7	23
Rice field	Wajo	0	0	1	0	0
	Soppeng	120	115	76	57	92
	Sidrap	18	18	13	26	18
	Sub Total	138	133	89	83	110
Total	Wajo	45	8	9	0	15
	Soppeng	133	119	79	59	97
	Sidrap	19	19	16	31	21
	Sub Total	197	146	104	90	134

Fishery Service South Sulawesi

3-9, the seedlings produced in 1972 were 1,130 thousand in total in number, of which one million were stocked in Lake Tempe and 130 thousand were sold to 60 to 70 farmers at a price of 1 Rp per each fry.

Paddy field fish culture is mainly practised with Ikan Mas in the following three ways:

1) As shown in Fig. 3-7, a ditch 20 cm in width and 30 cm in depth is provided in a paddy field. 2,000 fries of 5 to 8 cm in body length are stocked for each one ha of a field at the time of trans-planting. The fries grown to 15 to 18 cm in body length are caught after 4 to 5 months at the time of harvest.

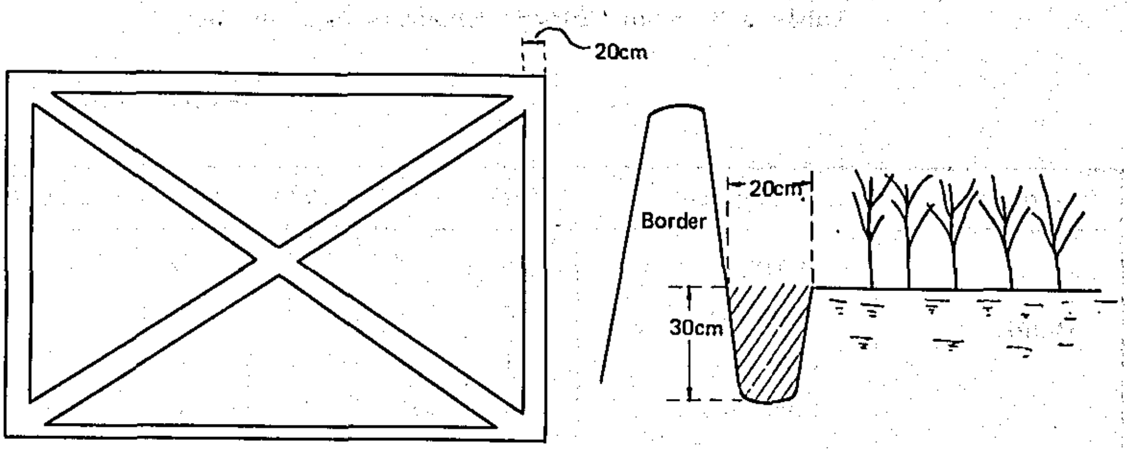


Fig. 3-7

2) One month before rice-planting 10,000 fries of 2 to 3 cm in body length are stocked for each one ha of about one third of paddy field. After nursing for one month, 7,000 fries of 5 to 8 cm in body length are obtained. The fries thus obtained are cultured in the same way as 1).

3) Rice nursery beds are used as a culturing pond after transplanting, and culture is done in the same way as 1).

In either wayabout 150 Kg per ha can be produced. Cultured fish are sold in the near market for the purpose of domestic consumption, at a price of 100 to 150 Rp/Kg.

Table 3-9 Fry Production in Lajoa Hatchery

Unit: thousand

Month	Production in number	Month	Production in number	Month	Production in number	Month	Production in number
1	75	4	90	7	95	10	95
2	90	5	100	8	100	11	100
3	95	6	100	9	90	12	100

Total: 1,130 thousand

Balai Bench Ikan Lajoa Soppeng

3.2 Present Problems

The development of inland fishery (including fish culture) under the central South-Sulawesi Water Resources Development Plan should be discussed from the following two viewpoints:

(1) Recoverying the fish productivity on Lake Tempe which is the most productive in the plan area.

(2) Developing production of fish which is one of the important animal protain sources in the entire plan area, especially paddy field fish culture in technically irrigated paddy fields because artificially water-controlled paddy fields will increase with the expansion of irrigation facilities under the plan.

1) In and around Lake Tempe

According to the Waskita Karya's Report, average catch in Lake Tempe from 1950 to 1956 was about 16,500 t. The data collected in this survey disclosed that the average catch from 1966 to 1972 was reduced to about one third, 5,000 t. However, the accuracy of the data is not good from the method of the estimate, therefore the reduction rate is not accurate. Never the less, the great catch reduction in Lake Tempe which occurred for the last about twenty years has become a serious social and economic problem in Wajo where many people engage in fishery. The Waskita Karya's Report has ascribed the cause of this reduction to fact that the lake was made shallow by the sedimentation caused by mud from rivers flowing into the lake, resulting in very small water surface and volume especially in the dry season.

This survey also revealed that the lake became shallower year by year and the surface area in dry season decreased. However, as mentioned above, the lake has an excellent high primary productivity which is used well for the producting fishery resources. From the fact that the life cycle of freshwater fish in tropical area usually completes in one year from the beginning of the rainy season to the end of the dry season, surface area and water volume which extremely decrease in the dry season can be considered to be one of the greatest factors which determine the amount of fishery resources of the entire lake.

In the dry season the lake sometimes has a depth of 30 to 50 cm, a surface area of 1,000 to 2,000 ha, and a water volume of 2 to 5 million m^3. Taking this into account and judging from the fish species composition, mean body weight and monthly catch, the inhabiting density of fish is too high, which supports the above estimate.

Extremely decreased depth, surface area and water volume control the amount of inhabitable fish and increase inhabiting density so much as to facilitate catching fish, resulting in over fishing: Thus, the fishery resources will be damaged. On the other hand, decreased depth raises water temperature so much that the lake becomes unsuitable for inhabitation of Tawes and Ikan Mas and hence air breather such as Anabas, Gabus, etc., will relatively increase in number. These fishes are carnivorous, so they can easily catch the other fishes in a reduced water. Since the carnivorous fish is superior, in food chain, such an increase will reduce the productivity of the entire lake. This will cause a serious problem in Wajo, because Tawes of a plants feeder, and Sepat Siam of a plankton feeder are important as raw fishes of dry salted fish for export.

The dry salted fish processing is an important industry around Lake Tempe, especially around Singkang in Wajo. The processing is done by co-operatives, simple processing mills or fishermen themselves. The process comprises first cutting the head off and dorsally opening (Tawes) or removing the head and the entrails, next immersing fish in a brine containing salt in weight as much as about 30% of the fish body weight for 12 to 24 hours, and finally drying by sunshine for 3 days. The quality of products is bad because fish are incompletely treated: especially the entrails of Sepat Siam are not perfectly removed. The low-quality salt being used, which contains a large amount of Ca and Mg, not only spoil the taste of products but also makes it impossible to perfectly dry fish up because of deliquescence, resulting in further worsening the quality.

The fishing gear used on Lake Tempe is relatively unefficient as mentioned earlier. However since the resources amount itself directly controls catch, introduction of efficient gear does not always increase catch and may adversely promote overfishing resulting in less fishery resources. Therefore, the introduction should be done carefully.

2) General view of planed area

The area of the Water Resources Development Plan is distant from the sea except the downstream area of the Cenranae River and has undeveloped transportation means. Therefore, inland fish is predominant in this area. The inhabitants like fish and as domestic animal or fowl are not consumed much, inland fish is the most important animal protein source. The average daily intake per capita is estimated to be 10 to 20 g which is far smaller than the required amount. Hence, it is very important to make efforts to improve fishery production all over the area. Though fishery practised even on undeveloped swamps and ponds, fish culture in technically irrigated paddy fields in predominant all over the area excluding Lake Tempe. The tropical water which is relatively eutrophy and high temperature has high potential in fish production. The fish culture in paddy fields can achieve relatively high production extensive way without labor and care.

The fish culture little affects flood control and agricultural development at present and can be developed in harmony with other projects in the Water Resources Development Plan.

Three Kabupatens (Soppeng, Sidrap and Bone) except Wajo have technically irrigated paddy fields. As mentioned earlier, however, fish culture is practised only in Soppeng and Sidrap, in only about 15% and 0.6% of the technically irrigated fields, respectively. It is not practised in Bone which has technically irrigated paddy fields of 7,000 ha. This is partly because water control in these area is not sufficient and partly because the possibility and importance of fish culture are not so appreciated and technical introduction is insufficient. Therefore only five hatcheries to produce seedling have so far been provided in Soppeng and Sidrap and the seedling production in 1972 was estimated not to exceed one million in number excluding those stocked in lakes. These quantities are very small judging from the area of the existing technically irrigated fields.

Though the seedling producing technique has been established, the production per area unit remains at a low level, for the extensive production. It is possible to increase production by introducing a more intensively nursing technique.

The problem in paddy field fish culture of Ikan Mas is that a processing technique of the fish for preservation has not yet been developed. Since the demand exceeds the supply presently, entire catch may be used for the domestic consumption, but in future when paddy field fish culture will be extended supply exceeds demand because cultured fish is caught for marketing almost at the same time of a year. Since transportation facilities are not developed, fish should be propossed to preservable products.

3.3 Direction of the Development

(1) Around Lake Tempe

In planning the fishery development around Lake Tempe, attention should be paid to securing animal protein sources for the inhabitants as well as to promotion of the industry. However, it is necessary to keep sufficient surface area and water volume of the lake in the dry season in order to basically restore catch, because reduction of surface area and water volume mainly causes reduction of the catch on Lake Tempe as mentioned in section 3.2. To what extent surface area and water volume should be kept cannot be determined before investigating to what extent catch increase is expected by the keeping. However, to keep the average production in normal condition it is estimated that a surface area of about 6,000 to 7,000 ha and a depth of about 4.0 to 4.5 m should be secured. However, in order to maintain a constant water level in the dry season, water level controlling facilities should be established along the Menraleng River. The establishment of the facilities should be studied from the viewpoint of not only technology and economy but also future meteorology, hydrology and flood control in the plan area as wide as 7,000 Km^2. It should be also studied as a part of the Water Resources Development Plan. Therefore, it is difficult to study it only from the viewpoint of fishery resources restoration. Though the establishment is a basic solution, it should be studied under a future master plan. A concrete solution cannot be immediately found.

If the inhabiting quantity of fish in the dry season and consequently that of fry in the beginning of the rainy season determine the amount of fishery resources in Lake Tempe (most of the fish spawn in the beginning of the rainy season), the lake which has a high productivity of fish in seasons except the dry season, can be used as a large-scale fish culturing pond by stocking artificially produced fry. In this case surface area reduction in the dry season favors catching the stocked fish. Presently Ikan Mas is said to be difficult to reproduce in the lake. If so, most of the Ikan Mas sharing 10% of the total fish catch have grown from stocked fry produced in Soppeng and Sidrap. This demonstrates the effectiveness of fry stocking.

The fishery resources in Lake Tempe should be restored first by stocking with fry. Ikan Mas is considered most suitable for stocking because of its marketing price, growth rate, inhabitants' taste and the present fry producing technique. Though production increase of Ikan Mas is effective in supplying the animal protein for inhabitants, Tawes or Sepat Siam as raw fish of dry salted fish should be increased for promotion of the local industries. Fry production technique of these fishes and processing technique of Ikan Mas should be studied well in the next survey. The ecosystem of the lake should be preliminarily investigated for clarifying the effect of stocking much a particular species of fish, and thus an optimum stocking amount will be estimated. Hatchery equipments and engineers are indispensable for stocking. Suitable personnel should be trained for a definite period in a hatchery of the Java Island or so where fish culture has long been practised, in order to master practical knoweldged for fry production requiring close attention. The indispensable condition for hatcheries is to be available necessary amount of water throughout a year. A technically irrigated paddy field where rice can be cropped even in the dry season is most suitable for it. Soppeng around Lake Tempe, which is technically irrigated, has already had three hatcheries and is now practising fry stocking. In future, hatchery should be increased in number and engineers be trained. Wajo which is most dependent on Lake Tempe has no hatchery at present. Therefore, a suitable site should be found for constructing hatcheries and engineer be immediately trained. The hatcheries should be constructed first of all because, as mentioned later, they will be used as a seedling supply center for paddy field fish culture when technically irrigated paddy fields are completed and expanded under the Development Plan.

Though swamps have the next biggest total area to lakes among lakes, rivers and swamps, the productivity is at a low level. The swamps, if positively utilized by installing simple facilities meeting the topological condition and by stocking with and introducing an appropriate fish species, will achieve an appreciable production. If the fishery resources of Lake Sidenreng are developed, it will be utilized effectively. However, since a few data are available from this survey, the swamps cannot be discussed. They must be investigated in the next survey.

As for the processing the quality of salt used for dry salted fish should be improved. High quality salt should be obtained by joint purchasing.

2) General view of the area

Paddy field cultured fish will be primary animal protein source of the whole inhabitants of the area. Under the Development Plan 93,000 ha in the dry season and 141,000 ha in the rainy season of paddy fields will be technically irrigated successively. These paddy fields together with the already irrigated about 9,000 ha paddy fields, will be usable for fish culture. According to the fishery service, Sidrap has about 17,000 ha irrigated paddy fields, but fish culture is seldom practised and the hatchery capacity is insufficient. Therefore, in the area where paddy fields are technically irrigated, hatcheries should be provided first of all and fish culture be introduced to farmers. It should be especially promoted in Bone which has a vast area of technically irrigated paddy fields. As mentioned above, in Wajo hatcheries should be established as soon as possible for restoration of fishery in Lake Tempe and provision of future paddy field fish culture.

Fish culture should be introduced to farmers by demonstrating the advantages on model farms which are also provided for demonstrating the advantages of improved agricultural techniques. When paddy fields are technically irrigated and rice cropping technique guided under the Development Plan, fish culture should be studied and planned as a part of the food production increase plan of the area. In this case, fry is to be supplied from the hatcheries of the local government, but farmers should be guided so that they can supply necessary amount of seedling for themselves.

Though Ikan Mas is a suitable species for paddy field fish culture at present, more suitable species including introducing new ones should be searched. For culturing Ikan Mas, processing technique for preservation should also be developed. After the extension of fish culture, agricultural chemicals application, poultry farming and water control (intermediate drying, etc.) for rice cropping which accompany the development of agricultural technique will probably cause trouble with the existing fish culture. However, the fish culture which can supply animal protein most lacking in the plan area should be developed and extended at present by effective utilization of the natural productivity.

3.4 Future Necessary Investigation

(1) Investigation around Lake Tempe

It is necessary to survey the environment and ecology of the fish inhibiting in Lake Tempe whether the fishery productivity is restored by water level control in the dry season or by stocking with fry. Survey on the following items are necessary:

1) the behabiour and life cycle of main fish inhibiting in the lake

2) fish composition by species and by season

3) change of littoral zone with water level change of the lake and

4) water quality change with water level change of the lake.

In addition to the above basic survey items the following items should also be surveyed.

5) The conditions of the swamps and rivers and the actual conditions of the fishery in them

6) the actual conditions of Lake Sidenreng and

7) the factor and the conditions under which Ikan Mas is reproductive in Lake Tempe.

(2) The conditions for producing fry to be stocked with in Lake Tempe

1) Suitable hatchery sites in Wajo and Soppeng. The construction of a hatchery is especially urgent in Wajo.

(3) Survey on the following items is necessary for culturing fish in technically irrigated paddy field:

1) the possibility to culture fish in the existing technically irrigated paddy fields

2) the possibility to culture fish in the paddy fields to be irrigated under the Development Plan

3) the suitable site of hatcheries to produce seedlings for fish culture

4) improvement of seedling producing techniques

5) processing techniques for perseving Ikan Mas

6) the possibility to introduce fish species other than Ikan Mas

(4) Besides these items, the following general items should be investigated:

1) the actual circumstances of domestic fish consumption and

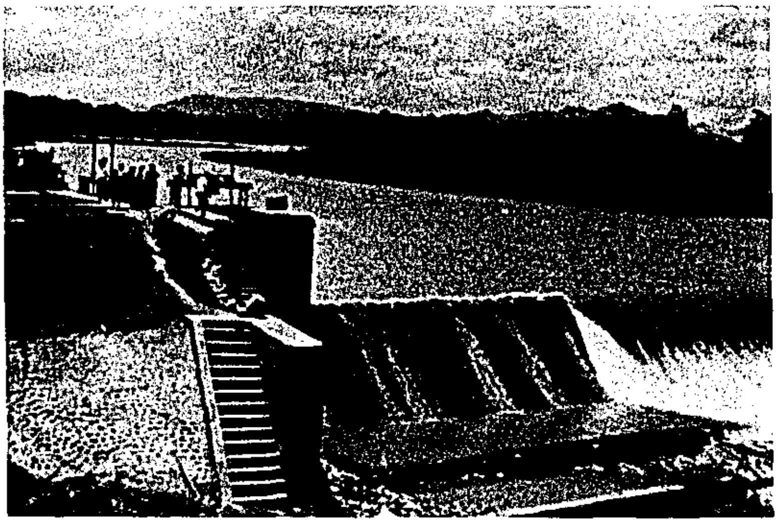
2) the actual circumstances, of the marketing of fresh fish and processed fish products.

The basic investigation for formulating the master plan requires at least two investigators for 12 months.

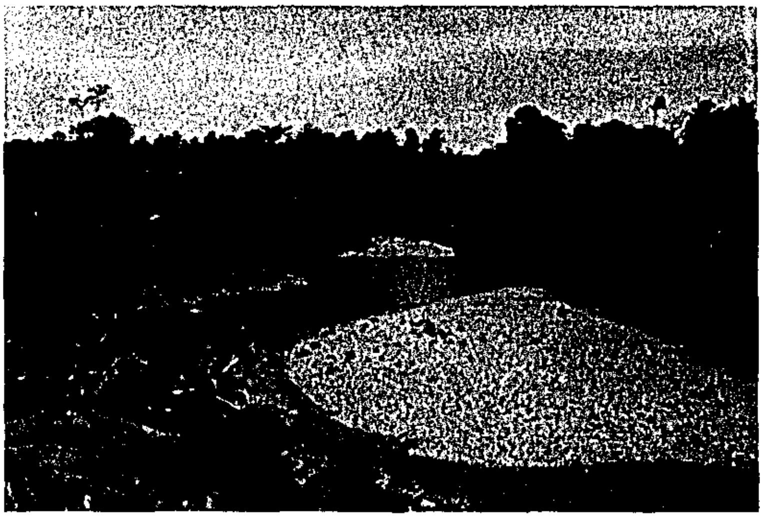
APPENDICES

1. Field Photographs

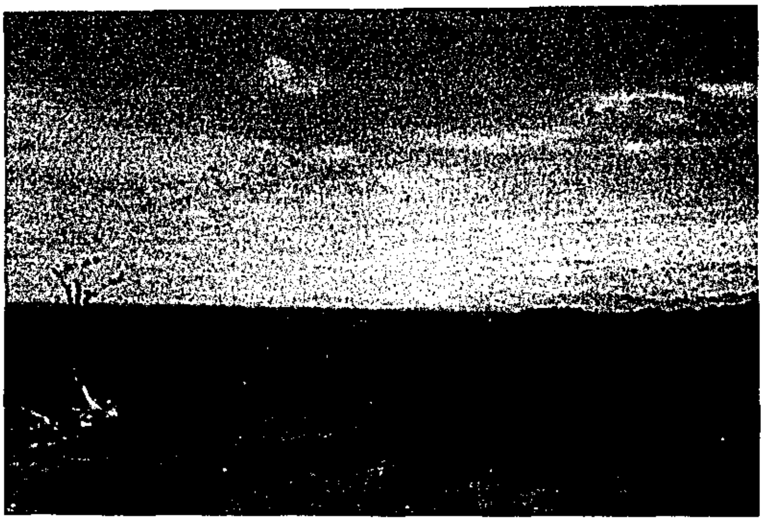
No. 1. A downstream point of the Bila near the proposed construction site of intake facilities.



No. 2. Existing Bulucenrana weir on the Boja (built in 1930).

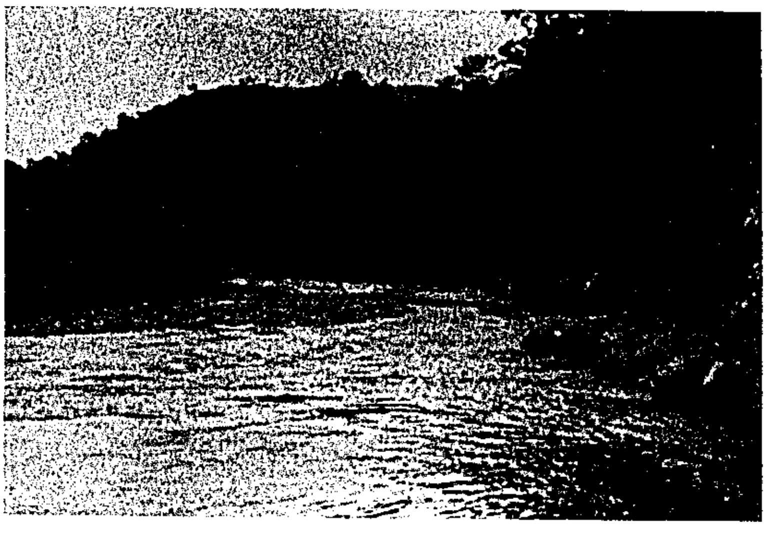


No.3. A point around 1 km downstream of the proposed construction site of intake facilities on the Gilirang.



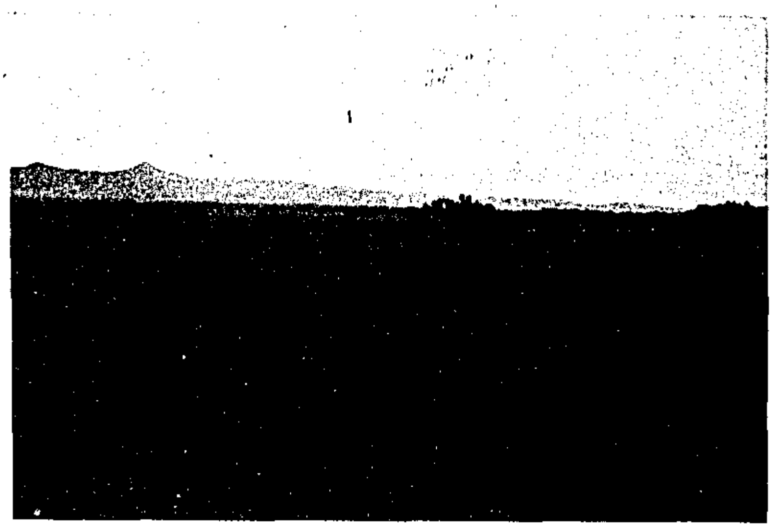
No.4. Hilly area extending in the basin of Gilirang.

NO.5. An upstream point of the Langkame near the proposed construction site of intake facilities.

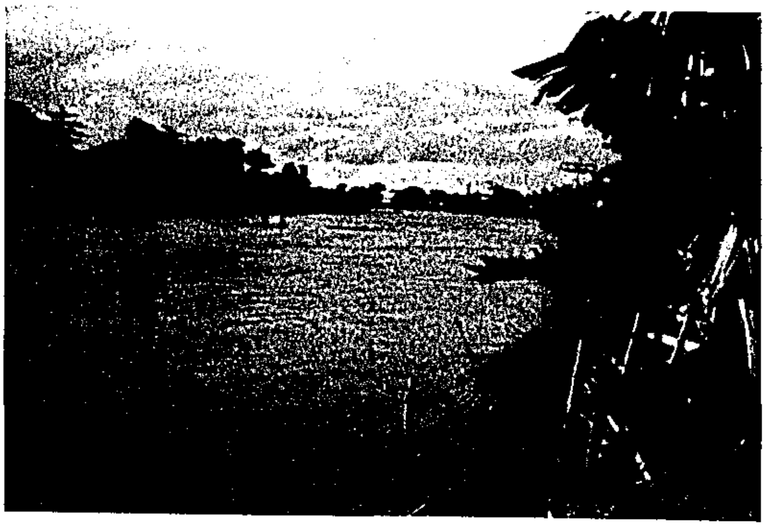


No.6. An upstream point of the Lawo near the proposed construction site of intake facilities.

No. 7. An upstream point of the Sanrego near the proposed construction site of intake facilities.



No. 8. A view of Sanrego irrigation area.



No. 9. The proposed construction site of a regulating gate on the Cenranae viewed from the confluence with the Walanae in the direction of Lake Tempe.

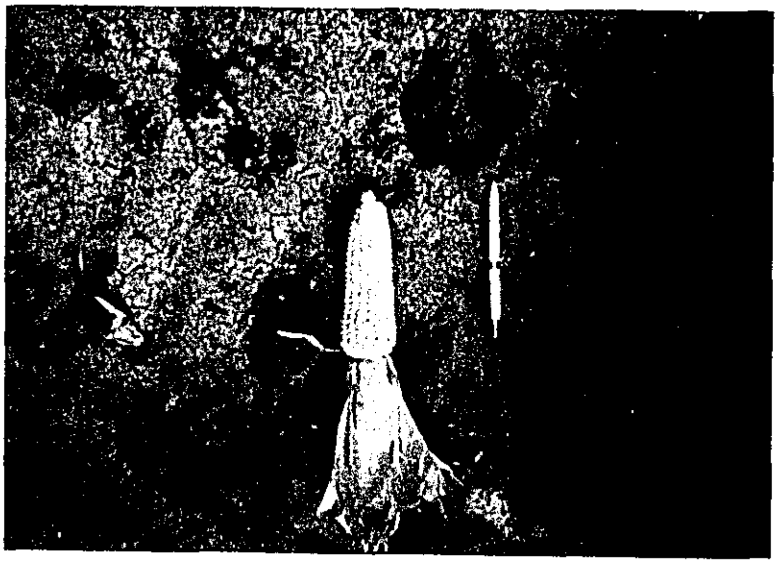
No.10. A view of the proposed construction site of Ludunge intake facilities on the Walanae.

No. 11. Transplanting of rice

No. 12. Harvesting of rice

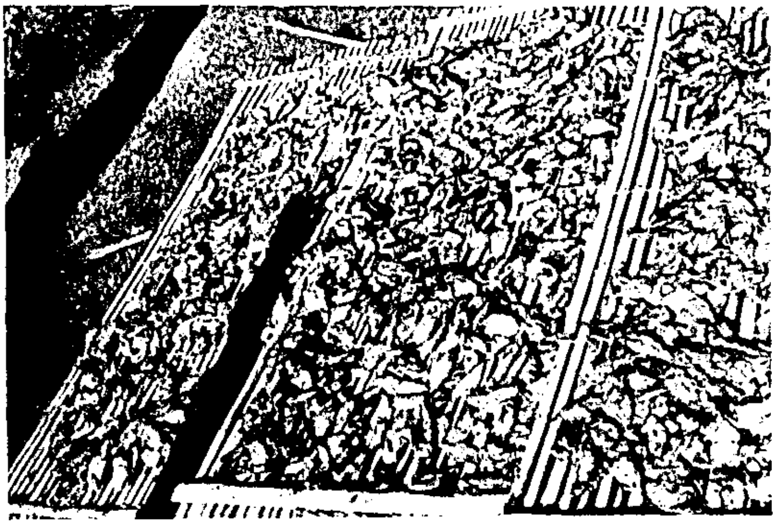
No. 13. Husking and polishing.

No. 14. Seeding of maize.

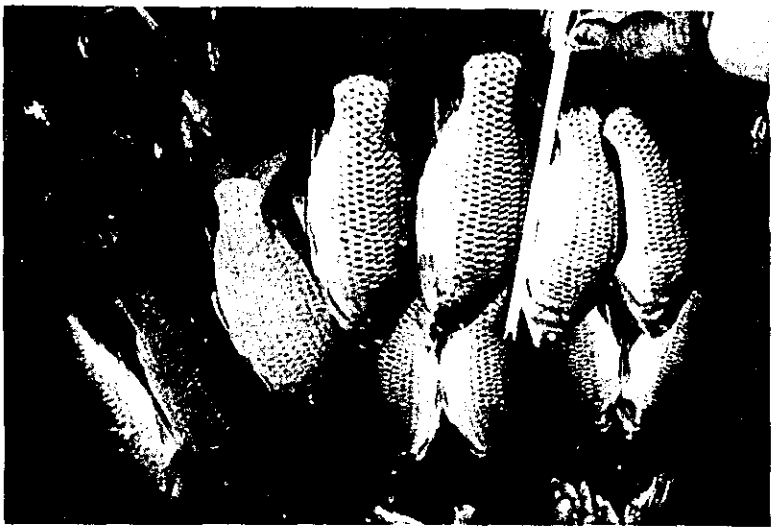


No. 15. Kernel of maize.

No. 16 Arge growing on the bottom of Lake Tempe
Characeae SP

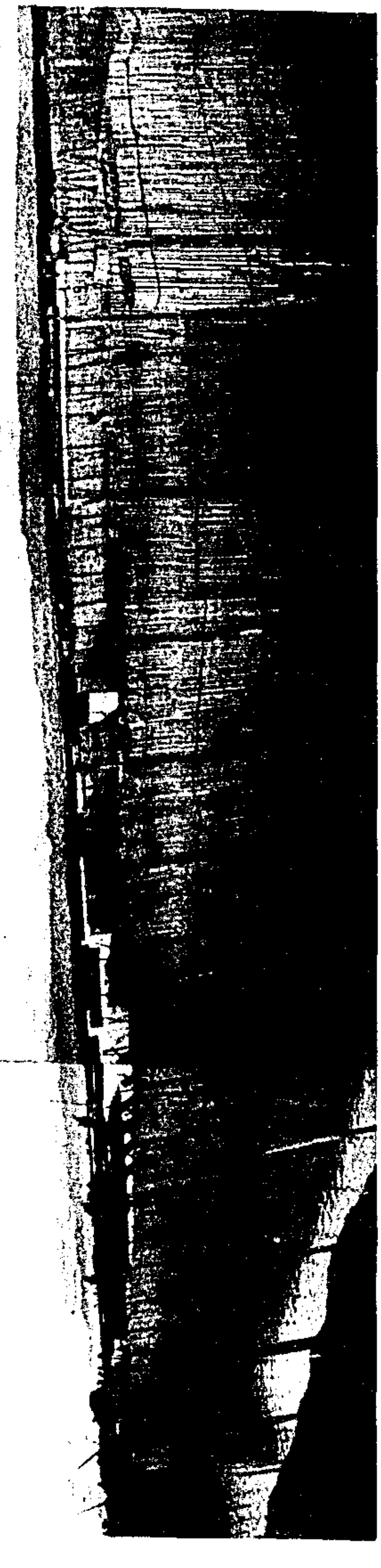


No. 17 Sun-dryed sepat siam after immersing a brine



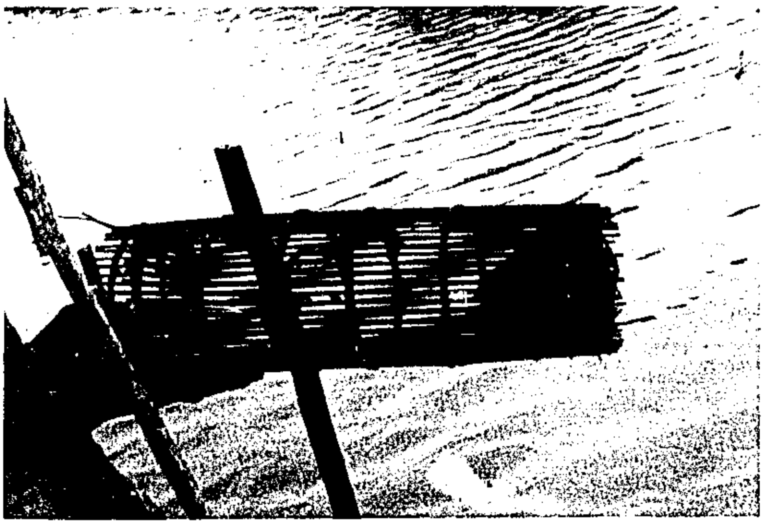
No. 18 Ikan Mas Fishes Caught in Lake Anabas
Tempe

No. 19 Fishes Caught in Lake Sidenreng

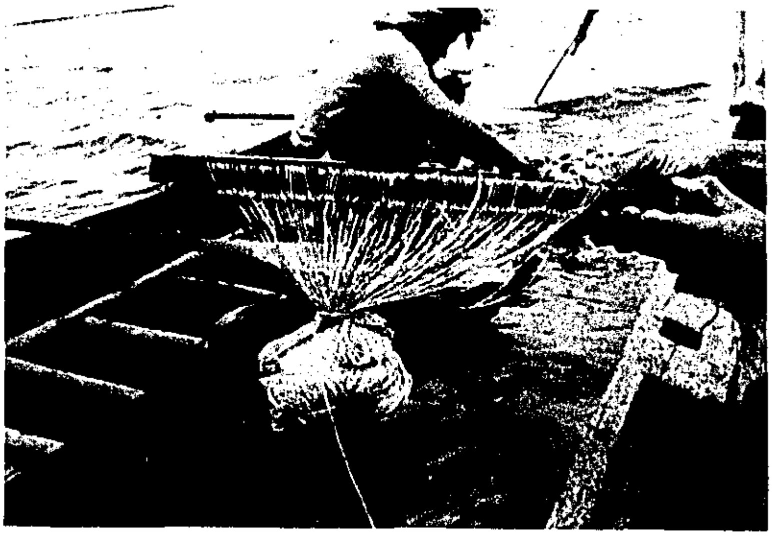


No. 20 Bubu Konde

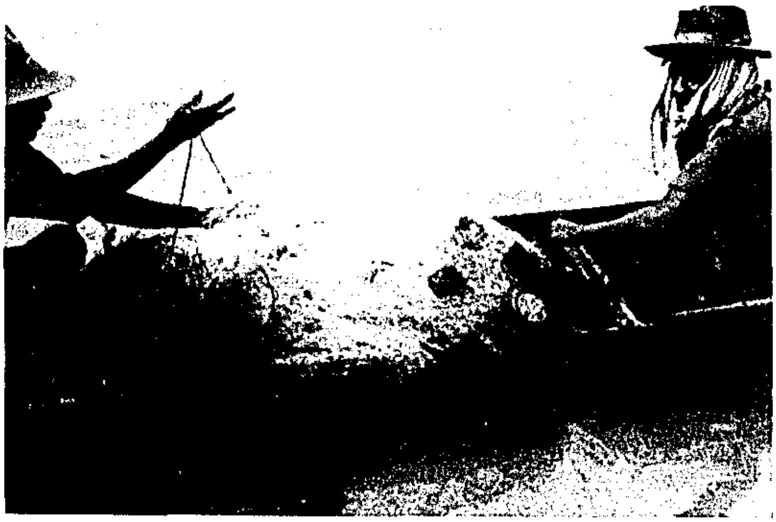
No. 21 Julu



No. 22 Bubu Udang

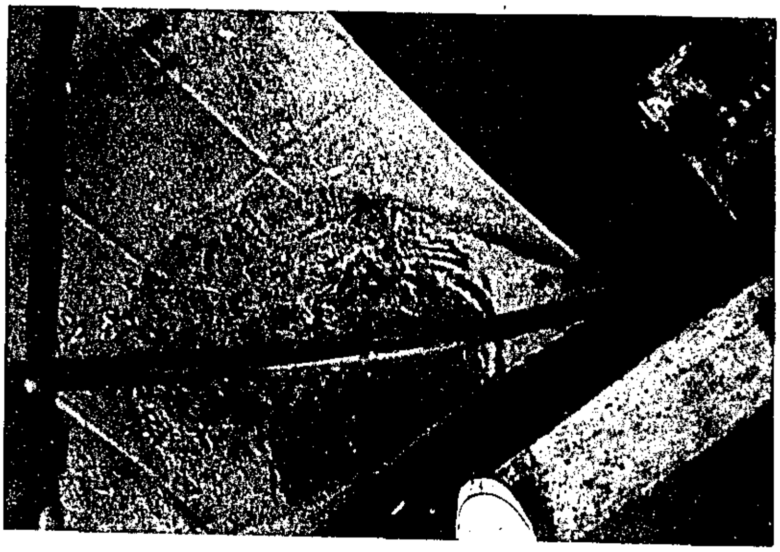


No. 23 Panambe



No. 24 Lanra

No. 25 Hatchery in Lajoa Soppeng Spawning Pond



No. 26 Fries of Ikan Mas

2. The List of Data Collected

Since the survey team arrived in Indonesia on 30th January 1974, the following data have been collected by each expert in cooperation with Indonesian Counterparts.

These data will be used for the further study.

1. Maps
   (1) Topographical Map in Central South Sulawesi Area 1 : 125.000
   (2) Topographical Map in Central South Sulawesi Area 1 : 50.000
   (3) Map on Project Outline for the Regional Development of the Walanae - Bila - Cenranae, with Tempe Sidenreng Lake, and Saadang Watershed, South Sulawesi Province Indonesia 1 : 250.000

2. River
   (1) P.T. Waskita Karya Report on Hydro-Morphometric Measurements
       Danau Tempe, October 1973 (Directorate of Planning and Programming, Jakarta)
   (2) Institute of Hydraulic Engineering: Bendungan, Krueng LJreue No. P. 212, No. P. 212A, Aug. 1969 (LPMA, Bandung)

3. Irrigation
   (1) Survey Dasar; Pembangunan Pertanian Sulawesi Selatan, Djilid IIA, IIB, III & IV.
       By Lembaga Penelitian Tanah, Bogor in 1967.
   (2) Laporan Bidang Planologi; Proyek Irigasi Sanrego
       By Irigasi Bandung in December 1973
   (3) Agricultural Data; Proyek Irigasi Sanrego
       By Irigasi Bandung in 1974
   (4) Skema Saluran Irigasi pada Daerah Irigasi
       By Irigasi Bendung in 1973
   (5) Outline Proposals for the Improvement of the Conditions of the Lake Tempe Region, South Sulawesi
       By P.N. Waskita Karya in December 1970.

4. Agriculture

Source: Dinas Pertanian Rakyat Propinsi Sulawesi Selatan, Agriculture Kabupaten and anthens

(1) Population (men, women, total)

1973 each Kabupaten

1972 Whole South Sulawesi

(2) Irrigated Area (technics, semi-technics, total)

1973 each Kabupaten and Whole South Sulawesi

(3) Cultivated land and production of main crops

1971 - 1973 each Kabupaten

1968 - 1973 whole South Sulawesi

(4) Land Use 1973 each Kabupaten and whole South Sulawesi

(5) Price of Main Crops

1971 - 1973 each Kabupaten and whole South Sulawesi

(6) Cropping pattern 1973 each Kabupaten

(7) Damaged area 1973- each Kabupaten

1968 - 1972 whole South Sulawesi

(8) Live stock 1971 - 1973 each Kabupaten

1972 whole South Sulawesi

(9) Bimas Area 1973 each Kabupaten

(10) Agricultural tools 1973 each Kabupaten

(11) Size of farmer's Holding 1973 whole South Sulawesi

(12) Rain fall 1969 - 1972 whole Sulawesi

(13) Climate table 1972 Kabupaten Sidurup

(14) Organization structure of Agricultural Office
1973 Kabupaten Soppeng

(15) Interviewed farmers group
1973 Kabupaten Bone

(16) Maps of Soil condition (One set) Institute of Soil Research, Bogor

(17) Data of forestry Forest service in South Sulawesi

5. Inland Fishery

(1) FACT AND FIGURES 1971 Directorate General of Fisheries

(2) Fisheries STATISTICS OF INDONESIA 1972
Directorate General of Fisheries

(3) STATISTICAL DATA ON INLAND FISHERIES OF SOUTH SULAWESI (Based on "Progress Report of Fisheries Services of South Sulawesi")

(4) LEMBAGA PENELITIAN PERIKAMAN DARAT (BOGOR)
L A P O R A N No. 34

(5) PERIKAMAN DAERAH SULAWESI SELATAN DALAM ANGKA 1968-1973
Dinas Perikanan Daerah Sulawesi Selatan, Ujung Pandang, 1973

(6) Hasil Usaha Pemeliharaan/Penagkapan Perikanan Darat Propinsi Sulawesi Selatan untuk Tahun 1972
Innas Perikanan Daerah Sulawesi Selatan.

(7) The Numbers of The Fishing Gears of Danau Tempe, 1971
Dinas Perikenan Daerah Kabupaten Wajo, Singkang.

(8) Department Pertanian Republik Indonesia Direktorat Jenderal Perikanan Dinas Perikanan Daerah Kabupaten Wajo

(9) Daftar Tinggi Air Laringgi dalam Tabun 1970 - 1972

Dinas Perikanan Daerah Kabupaten Wajo

(10) Daftar Tinggi Air di Danau Tempe dan Sungai Monraleng di Kabupaten Wajo

Dinas Perikanan Darat Daerah Propinsi Sulawesi Selatan

(11) PETA DANAU TEMPE

Dinas Perikanan Darat Propinsi Sulawesi Selatan

(12) Inland Fishery Sidenreng Rappang

Dinas Perikanan Darat Daerah Sidenreng Rappang.

3. Memorandum for Japanese Preliminary Survey Team on Central South Sulawesi Water Resources Development

I. INTRODUCTION

The Japanese Government has decided to make available to the Government of Indonesia the service of a team of experts (hereinafter called the "Team") for the preliminary survey on Central South Sulawesi Water Resources Development Project (hereinafter called the "Project") as listed in the Technical Assistance Proposal for 1973/74 code number BTA-33.

The present document sets forth a memorandum for preliminary survey and study of the project to be performed within the framework of Technical Cooperation Program of the Government of Japan.

II. DESCRIPTION OF PROJECT

The project area is estimated to be the basins of Walanae River, Bila River, Lake Tempe and Cenranae River.

The project is planned to study the water resources potential and all possibilities of agricultural development in conjunction with the preparation of the region for food production center and make assessment of other resources development, and to investigate the possibility of maintaining the lake surface of Lake Tempe, which decreases very much in the dry season.

III. OBJECTIVE OF SURVEY WORKS

The survey will be carried out to review the existing reports and data, especially, the project finding survey report by OECF, Japan made in April 1973, to indentify urgent projects for early feasibility studies plan study for water resources development of the basins mentioned above.

IV. SCOPE OF SURVEY

The Team will undertake the followings:

1. Survey in Indonesia

   1) The areas to be surveyed are
      - (i) The basin of Walanae River
      - (ii) The basin of Bila River
      - (iii) The basin of Lake Tempe
      - (iv) The basin of Cenranae River

   2) The items of the survey are:
      - (i) Data collection on hydrology, meteorology, geology, soil, land use, agriculture, inland fishery and lake sedimentation.
      - (ii) Examination of existing map.
      - (iii) Investigation of sedimentation of Lake Tempe and inland fishery.
      - (iv) Investigation of the condition of the rivers concerned and flood problems.
      - (v) Investigation of the site for intake stuructures and irrigation canal networks, etc.
      - (vi) Investigation for agricultural development in the area.

2. Survey and studies in Japan

   1) To analyse the obtained above, to make the frame work of the Development Projects, and to identify the Projects.

   2) To make a priority list of all the individual projects surveyed and studied.

   3) To make suggestions on the measures to improve the soil conservation.

   4) To make suggestions on the measures to be taken to control the flood.

5) To make the preliminary survey report on the Project.

6) To recommend terms of reference for the next studies to be undertaken.

V. REPORTING

1. Ten copies of the draft reports in English "Preliminary studies of Central South Sulawesi Water Resources Development Project" will be presented to the Government of Indonesia in May 1974 for comments.

2. Fifty copies of the final reports in English will be presented to the Government of Indonesia in July 1974, provided the comments from the Government of Indonesia will be received not later than one month.

VI. UNDERTAKING OF GOVERNMENT OF JAPAN

The Government of Japan will undertake for the contribution to the survey, the following items:

1. To provide the technical assistance through a Japanese Survey Team consisting of 10 experts for 30 days from January 30, 1974, as shown in the working schedule (in Appendix, A) for the execution of the survey works in Article IV.

2. To provide the expenses of accomodations for the Team, fuel for the vehicle, small maintenance and overtime work of the drivers.

3. To provide funds for other expenditure necessary for the survey team in carrying out the works in a satisfactory way, which are not covered by the expenses in the above items and also not by the contribution of the Government of Indonesia.

VII. UNDERTAKING OF GOVERNMENT OF INDONESIA

The Government of Indonesia will undertake the following arrangement for the Japanese Survey Team.

1. Data collection

All available documents, drawings, maps, statistic data and information related to the Project, in which,

1) One copy of coloured topographical map of 1/50,000 covering the objective area.

2) One copy of topographical map of /1125,000 covering the objective area.

3) Some copies of other available maps.

4) One set of agricultural survey report in South Sulawesi by the Institute of Soil Research, Bogor.

2. Indonesian counterpart personnel

The following number of Indonesian Engineers will be provided to assist the experts of the Team and to receive transfer of knowledge from the experts.

1) one planning engineer as team leader
2) one irrigation engineer
3) one river engineer
4) one hydrologist
5) one inland fishery engineer
6) one agronomist
7) one agro-economist
8) Three Japanese Colombo Plan Experts for site survey (The travelling allowance will be borne by the Team)
   i) One irrigation expert
   ii) One river engineering expert

iii) One agronomist

3. Vehicle and drivers

Four jeeps and one motor boat will be prepared at the Project site for experts of the Team counterparts.

4. Instrument

The measuring instrument necessary for the survey shall be made available by the Japanese Colombo Plan Experts in Indonesia.

1) Echo sounder
2) Level
3) Compass
4) Currentmeter and accessories
5) Hand level
6) Altitude meter
7) Distance meter
8) Staffs and poles
9) Stop watch
10) Cloth tape and measuring rope
11) Binocular
12) Hand auger and shovel
13) Others

5. Lodgings

Arrangement of lodgings at the site according to the Team's schedule.

VIII. MISCELLANEOUS

The Japanese experts who are engaged in the Project shall be entitled to such privileges as are normally extended by the Government of Indonesia to the Colombo Plan Experts.

Transfer of knowledge from the Japanese experts to the Indonesian counterparts will be exercised to a large extent.

IX. SIGNATURE

The undersigned agreed on the foregoing on behalf of the Parties concerned on this date, February 1, 1974

Ir. Busono Budidarmo Director of Planning & Programming, Directorate General of Water Resources Development, Ministry of Public Works & Electric Power, Indonesia	Mr. Seiichiro Nakamoto Leader of Japanese Preliminary Survey Team on Central South Sulawesi Water Resources Development Project.