DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT,
MINISTRY OF PUBLIC WORKS

JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)

THE FEASIBILITY STUDY ON THE GILIRANG IRRIGATION PROJECT IN THE REPUBLIC OF INDONESIA

FINAL REPORT

MAIN REPORT

JUNE 1995

NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Gilirang Irrigation Project and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to the Republic of Indonesia a study team headed by Mr. Hiroshi Yamamoto, Nippon Koei Co., Ltd., three (3) times between February 1994 to March 1995.

The team held discussions with the officials concerned of the Government of the Republic of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

June, 1995

Kimio Fujita
President
Japan International Cooperation Agency

June, 1995

Mr. Kimio Fujita
President,
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We have pleasure of submitting the study report for the Feasibility Study on the Gilirang Irrigation Project in the Republic of Indonesia, in accordance with the Scope of Work agreed upon between the Ministry of Public Works and Japan International Cooperation Agency (JICA).

The study was carried out for a total period of 17 months from February 1994 to June 1995. The project was basically formulated with principal aim of increase of agricultural production and improvement of living standard of inhabitants in the Gilirang area of 7,000 hectares through exploitation of irrigation water from the Gilirang river. In the formulation of the project, special attention was paid to environmental aspects in addition to technical and economic examination.

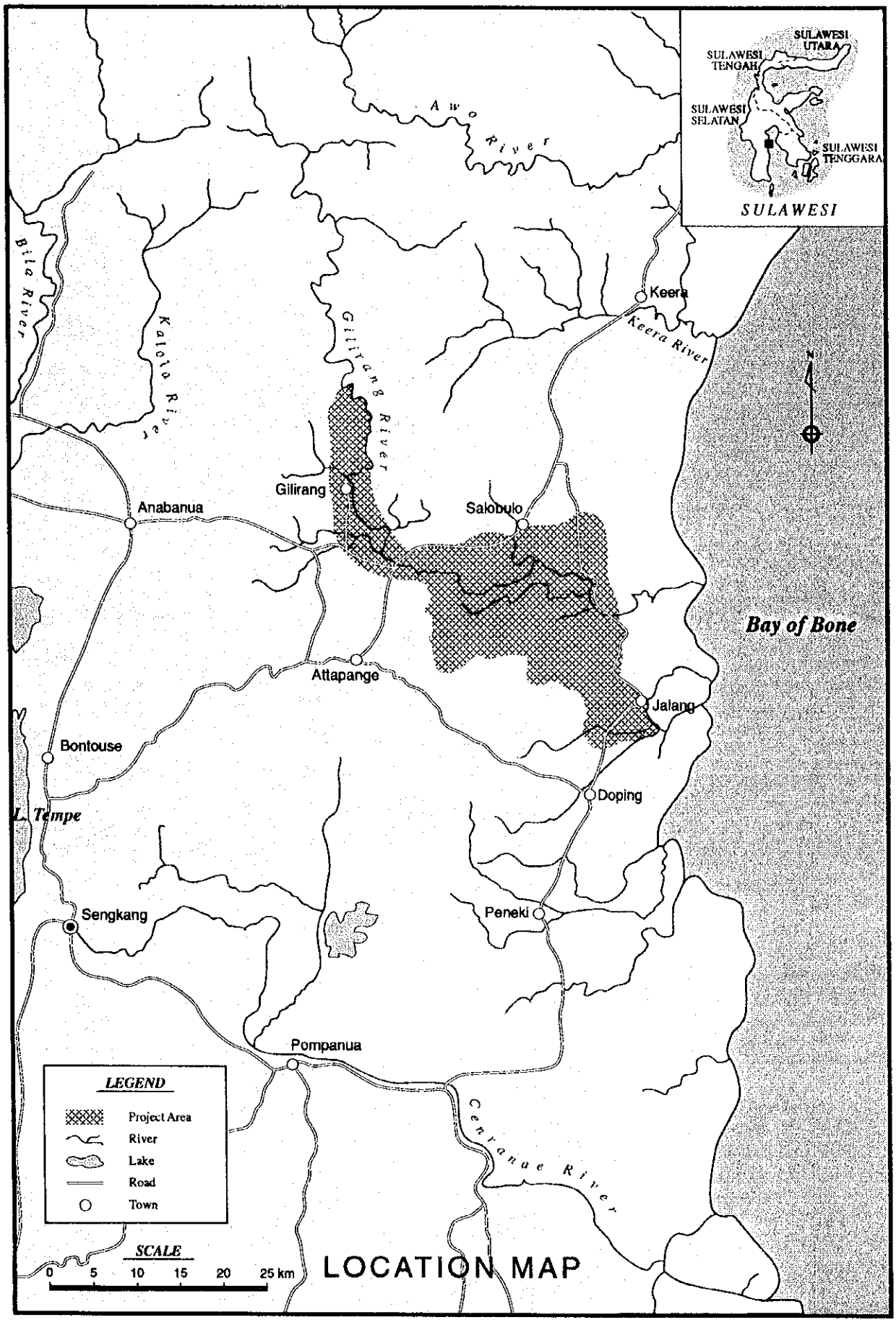
We would recommend that the project will be soon implemented in line with the conclusions presented in this report.

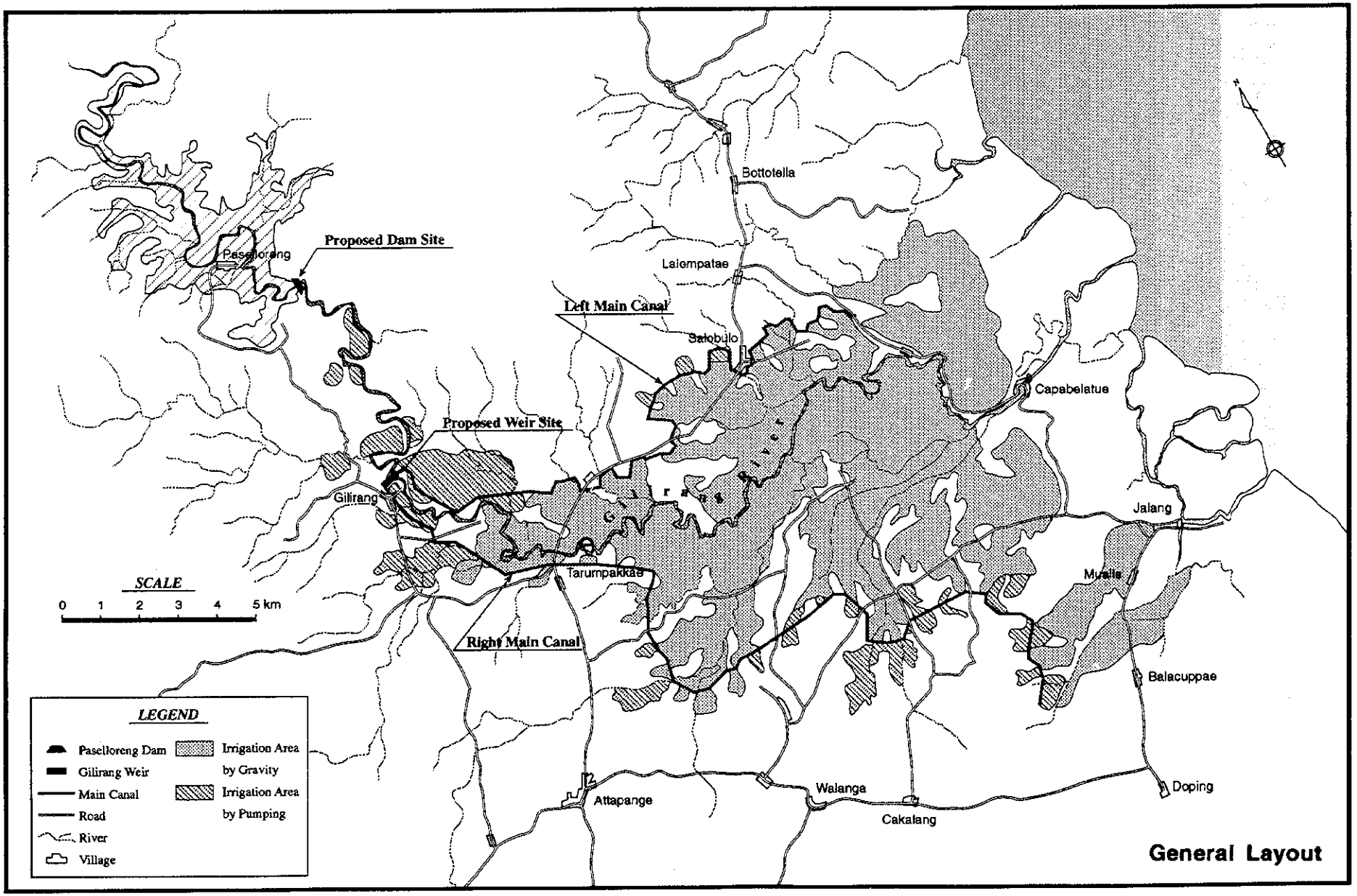
We wish to express our deep appreciation and gratitude to the personnel concerned of your and other Agencies, your Indonesia Office, the Embassy of Japan in Indonesia, and the Authorities concerned of the Government of Indonesia for the courtesies and cooperation extended to us during our field surveys and studies.

Very truly yours

Hiroshi Yamamoto

Team Leader of the Study Team for the Feasibility Study on the Gilirang Irrigation Project


SULAWESI UTARA
SULAWESI TENGAH
SULAWESI SELATAN
SULAWESI TENGGARA
SULAWESI
Awo River
Bila River
Kalola River
Gilirang River
Keera River
Keera
Gilirang
Anabanua
Salobulo
Attapange
Jalang
Bay of Bone
Bontouse
L. Tempe
Doping
Sengkang
Peneki
Pompanua
Cenranae River
N
LEGEND
Project Area
River
Lake
Road
Town
SCALE
0 5 10 15 20 25 km
LOCATION MAP


Proposed Dam Site
Paselloreng
Left Main Canal
Bottotella
Lalempatae
Salobulo
Capabelatue
Proposed Weir Site
Gilirang
Jalang
Tarumpakkae
Muralle
Right Main Canal
Balacuppae
Doping
Walanga
Attapange
Cakalang
SCALE
0 1 2 3 4 5 km
LEGEND
Paselloreng Dam
Gilirang Weir
Main Canal
Road
River
Village
Irrigation Area by Gravity
Irrigation Area by Pumping
General Layout

SUMMARY

Introduction

01. This Final Report is prepared in accordance with Clause VI of the Scope of Works for Feasibility Study on the Gilirang Irrigation Project in the Republic of Indonesia agreed upon between Japan International Cooperation Agency (referred to as JICA hereinafter) and Directorate General of Water Resources Development (referred to as DGWRD hereinafter) on March 16, 1993.

02. This report presents a feasibility study on the Gilirang Irrigation Project which was formulated through three field works and four home office works which commenced in late February, 1994 and ended in the beginning of June, 1995. It mainly deal with assessment of the present conditions in and around the study area, technical, economical and financial evaluation of the proposed Project, and ecological and environmental assessments on the implementation of the Project.

03. The Gilirang Irrigation Project is one of the priority projects identified in the "Master Plan Study for the Central South Sulawesi Water Resources Development" conducted by JICA during 1978 - 1980 period. Among nine (9) priority projects identified in the study, three (3) priority projects, i.e. the Langkeme, Bila and Sanrego irrigation projects were promoted to the further stages with assistance from OECF (Overseas Economic Cooperation Fund, Japan) and the World Bank. The former two projects are under construction at present and the latter project has been substantially completed. The Gilirang Irrigation Project is thus expected to be the fourth priority project among the nine (9) projects identified in the master plan study.

04 The necessity of this Project is clarified by the following two (2) points:

1) South Sulawesi province is one of the large rice granaries in Indonesia and plays an important role in supplying rice to other rice deficit provinces. According to the forecast made on Indonesia's rice supply and demand (the Study for Formulation of Irrigation Development Program in the Republic of Indonesia; FIDP, 1993, JICA), rice surplus from South Sulawesi province will become more important in the future.
2) In the Gilirang Project area, single cropping of paddy under rainfed conditions is widely practiced. Crop productivity is low and thus the income level and living standard of the inhabitants are low compared with those around the Project area.

In the light of the above situation, the Government of Indonesia requested the Government of Japan to extend technical assistance in conducting a feasibility study aiming at crop production increase and thus improvement of the income level and living standard of inhabitants in the Gilirang area through irrigation development.

Background of the Project

05. Agriculture is still a mainstay of Indonesia's economy. This sector represents about 20% of GDP (Gross Domestic Product) and employed 41.1 million or 54% of the labor force in 1991. The sector has an important role in non-oil merchandise trade, with major agricultural exports accounting for 48% of the value of non-oil exports in 1989/90. Food crops account for 58% of agricultural GDP followed by non-food crops at 13%, and livestock at 11% in 1991.

06. In the last decade, agricultural growth has averaged about 3% p.a. and outpaced population growth by a significant margin. Rice output has solidly contributed to the sector's impressive performance. The increase in rice production from 19.3 million tons in 1980 to 24.8 million tons in 1984 transformed the country from one of the world largest rice importers (about 2.6 million tons in 1980) to one with surpluses in 1984.

07. However, continuing self-sufficiency in rice production is still an important issue in the agricultural development policy. According to the results of FIDP study made on rice supply and demand balance in Indonesia, deficit of paddy will reach to 4.6 million tons in 2003 and 10.6 million tons in 2013, if new irrigation systems are not developed in the future.

08. In South Sulawesi Province, the agriculture sector is the largest economic sector. The sector contributes to about 42% of the provincial GRDP (Gross Regional Domestic Product) and provides employment to more than 60% of the labor force. The Province is known as one of the rice granaries in Indonesia. Its paddy production reached 4.34 million tons with a growth rate of 6.5% during 1982-1992 period. About 23% of paddy production in the province is transported to other rice deficit provinces to fulfil their local demands. The role of South Sulawesi Province in supplying rice to other provinces would become more important in the future. Again according to the FIDP study, a total of 100,500 ha of new irrigation development is required in South Sulawesi Province during Repelita VI - IX (1994/95 - 2008/09) period to maintain self-sufficiency in rice in Indonesia.

09. The Government's major objectives for the agriculture sector during Repelita VI (1994/95 - 1998/99) period are to:
    1) sustain the established self-sufficiency of food to meet domestic requirements, increase diversification of products and improve quality of production,
    2) increase production meeting the needs of industry and expanding agricultural exports,
    3) increase farmers' incomes and living standards and expand employment and business opportunities,
    4) promote a more balanced distribution of economic opportunities, regional development, land settlement, and land development including rational planning of land development to keep the prime agricultural land in the future infrastructure and industry development, and
    5) contribute to the health and better the nutritional status of the population through diversification of foodstuff.

    In relation to 1) above, sustenance of self-sufficiency in rice production is one of the most important objectives. Although Indonesia has been self-sufficient in rice since 1984, continuous efforts to increase rice production are a prerequisite to meet the increasing demand. Irrigation development is expected to play a major role to overcome this issue.

Present Condition in and around the Study Area

10. The study area is located about 240 km north-east along the national road from Ujung Pandang, the capital of South Sulawesi Province. It extends north-east of Sengkang, the capital of Kabupaten Wajo and is approximately bounded by the coastal swamp belt of Bone Bay on the east and Attapange-Doping road on the south. The northern and eastern boundaries skirt along the foot of hilly ranges.

11. The population in the 19 Desa (Village) related to the study area is about 53,400 as of 1992. The population growth in the related three Kecamatan (Sub-district) shows negative figures of -1.39 p.a. during 1988-1992 period. The number of farm households in the study area is estimated to be 6,400 with the population of 33,000 persons. The available labor force is estimated at 19,800 persons or 3.1 persons per farm household.

12. A major part of the study area is located on the alluvial flat plain created by the Gilirang river and its small tributaries, and partly lies on the undulating hilly areas near the north and the south boundaries. The land shape of the hilly areas near both boundaries are rather complicated. The altitude of the major part of the Project area ranges from EL.4 m to 18 m.

13. Climate in the study area is characterized by tropical monsoons having distinct dry and wet

seasons according to the seasonal distribution of rainfall. The cease and onset of these seasons widely vary year by year. The average annual rainfall is about 2,200 mm in the study area. The annual rainfalls widely vary from year to year ranging between approximately 1,500 mm to 2,900 mm.

14. The soils of the study area are classified into five (5) soil units, i.e. Vertisols, Eutric Cambisols, Eutoric Regosols, Thionic Fluvisols, and Lithosols. The first two (2) soil units covering a total area of 23,300 ha or 92% of the study area are suitable for irrigated crop cultivation mainly for paddy due to their general characteristics of gently undulating topography, moderate to deep surface soils, heavy texture, and easy availability of water. The last three units covers the remaining 2,000 ha.

15. The catchment area of the Gilirang river is 518 km^2 at the river mouth and 169 km^2 at the proposed dam site. At the proposed dam site, the maximum monthly mean discharge of the Gilirang river is 24.7 m^3/sec in July and the minimum 0.9 m^3/sec in December. The annual average runoff is estimated at 210 x $10^6 m^3$. According to the result of the water quality analysis (April 1994), chemical properties of water samples from the Gilirang river show that the river water seems to be acceptable for irrigation purposes.

16. There is no gravity irrigation system in the study area, even "non-technical" and/or "semi-technical" grade irrigation systems. Only small pump irrigation systems are found, being operated mainly for dry season paddy by farmers using water mostly from the Gilirang river. The pump irrigation areas are estimated at 640 ha in total in the study area. As for rural infrastructure, insufficiently arranged Desa roads and a lack of farm roads are assessed to be a constraint to agricultural development.

17. The present land use in the study area is classified as follows:

Land Use	Area (ha)	Distribution(%)
Paddy field	15,800	62.5
Upland field	1,000	4.0
Orchard	3,900	15.4
Grass land	1,400	5.5
Bush/Forest	2,000	7.9
Fish pond	200	0.8
Villages	1,000	3.9
Total	25,300	100.0

18. The wet season paddy is planted at the onset of the monsoon, from April to May, and harvested from August to September. The cultivation of palawija and wet season paddy starts in October and November. The crop yields and production fluctuate largely year by year due to wide variations of annual rainfall and unexpected damages caused mainly by drought. The average unit yield and production of major crops are estimated as follows:

	Harvested Net Area (ha)	Yields (ton/ha)	Production (ton)
1) Wet season paddy	14,250	3.0	42,800
2) Dry season paddy	640	4.0	2,600
3) Palawija*1	1,430	0.9	1,300

*1 Average yield of groundnuts, mungbeans and soybeans.

19. Paddy surplus from the study area is sold to KUDs and/or middle men through brokers. The paddy collected by KUDs is sold to Sub-DOLOG, while the paddy collected by middle men is generally transported directly to private warehouses in Ujung Pandang and Pare Pare. Most of the surplus is marketed through these two channels. The processing

and storage facilities for paddy/rice are fairly well arranged in Kab. Wajo as well as in the study area, and these capacities are estimated to be sufficient to cover the present production.

20. The average size of a paddy field is estimated at 2.34 ha per farm household. In the farm budget analysis made on this size of farm, gross income is estimated at Rp. 3.0 million (of which Rp. 2.6 million or 86% is farm income), and gross outgo is 2.8 million (of which Rp. 1.6 million or 56% is production cost). The annual net reserve of a rainfed farmer is therefore estimated at only Rp. 0.2 million.

Framework of Basic Development Concepts

21. At present, rice surplus produced in South Sulawesi province covers the rice demand of deficit provinces to a certain extent. In the FIDP study, it is forecast that about 100,500 ha of newly irrigated land is required to be developed during Repelita VI and IX period (1994/95-2013/14) in South Sulawesi province to sustain the established self-sufficiency in rice. In the Gilirang Project area, however, paddy is cultivated mostly under rainfed conditions and its productivity is still low. Consequently, income level and living standards of the inhabitants are low compared with those around the Project area. Around the Gilirang Project area, there is the Sadang Irrigation Project in which double cropping of paddy is widely practiced. In addition, Langkeme and Bila Irrigation Projects are at present at the construction stage to develop new irrigation systems for about 16,800 ha in total. After the completion of these projects, a further gap in economy will occur between the Gilirang farmers and farmers around the Project area.

22. In light of the above situation, the Gilirang Irrigation Project is needed aiming at i) sustainment of the established rice self-sufficiency, ii) improvement of the backward regional economy, iii) rectification of income levels among the regions, iv) increased job opportunities, and v) improvement of living standards.

23. The most important key factors for the development are maximum and effective use of water and land resources, and introduction of improved farming practices. With this in view, the basic concept for agricultural development would be:
    1) Stabilization of unit yield and production of wet season paddy through establishment of a new irrigation system and introduction of irrigation farming practices,
    2) Increase of dry season cropping area with year-round irrigation system through construction of a dam on the Gilirang river,
    3) Increase in irrigation area to the potential maximum area and beneficiaries, as well as for maximum total benefits,
    4) Improvement of the present drainage condition, to assure the healthy growth of paddy under irrigated conditions,
    5) Betterment of rural roads and development of farm roads,
    6) Activation of agricultural supporting services, and
    7) Project formulation paying special attention to environmental preservation in the Gilirang river basin.

Selection of Optimum Project Scale

24. The selection of an optimum project scale is carried out through a comparison of possible three (3) development alternatives which are established based on the result of assessment made on exploitable land and water resources:

Alternative	Irrigable Area	Intake Method
Alternative I	8,600 ha	Direct Diversion from the reservoir
Alternative II	5,880 ha	Diversion from intake weir at the downstream
Alternative III	7,000 ha	Provision of pumping units in addition to Alternative II

25. Alternative I aims at the maximum area development through direct diversion from the reservoir to irrigate 8,600 ha by gravity. However, this alternative's headrace construction is expected to be very expensive due to the geologic and topographic conditions. Alternative II needs to install an intake weir at the downstream. This alternative could irrigate 5,880 ha by gravity. Alternative III provides 1,120 ha of pump irrigation system in addition to the gravity irrigation system of 5,880 ha under Alternative II. According to the result of the household survey, about 75% of sample farmers intend to introduce a pump irrigation system.

26. The water balance study for each alternative is carried out based on the following conditions:
    1) Due mainly to the topographic condition of the proposed dam site, optimum scale of the dam is set at EL. 56.5 m of crest elevation (storage capacity is 132 MCM with this crest elevation),
    2) Cropping pattern applied to the water balance study is Paddy-Palawija-Paddy which is selected through comparison of three (3) possible cropping patterns.
    3) If irrigation water is not sufficient to maintain 300% of cropping intensity, the intensity of palawija is firstly reduced and that of dry season paddy is secondly reduced.

27. As the result of the water balance study, the scale of dam and cropping pattern under each alternative are as follows:

Scale of Dam by Alternatives

Alternative	Total Storage Capacity (MCM)	Normal High Water Level (m)	Crest Elevation (m)
Alternative I	132	50.5	56.5
Alternative II	125	50.0	56.0
Alternative III	132	50.5	56.5

Cropping Area and Cropping Intensity by Alternatives

Alt.	W.S. Paddy		Palawija		D.S. Paddy		Total	
	Area (ha)	Intensity (%)	Area (ha)	Intensity (%)	Area (ha)	Intensity (%)	Area (ha)	Intensity (%)
Alt. I	8,600	(100)	0	(0)	7,400	(86)	16,000	(186)
Alt. II	5,880	(100)	5,880	(100)	5,880	(100)	17,640	(300)
Alt. III	7,000	(100)	2,000	(29)	7,000	(100)	16,000	(229)

28. For the comparison of alternatives, important indicators such as project cost, benefit, EIRR, agricultural income, project scale, and number of beneficiaries are estimated for each alternative:

Alt.	Project Cost (Rp. 1000/ha)	Economic Benefit (Rp. 1000/ha)	EIRR (%)	Agri. Net Income (Rp. 1000/ha)	Irrigation Area (ha)	Beneficiaries (Farm H.H)
Alt. I	29,281	2,294	9.3	2,017	8,600	3,800
Alt. II	26,754	3,156	13.5	2,952	5,880	2,600
Alt. III	22,955	2,680	13.3	2,368	7,000	3,100

As a result, final selection is made between Alternative II and III, because both alternatives are economically feasible with similar EIRR's. Alternative I would not be feasible, although this alternative envisages the maximum area development. Alternative II is superior to Alternative III in unit economic benefit and financial return with its maximum cropping intensity of 300%. In the meantime, Alternative III is superior to Alternative II in the project scale (irrigation area) and in the number of beneficiaries. Taking the basic concept of the Project and farmers intention into account, Alternative III is finally selected as the optimum project scale.

The Project

29. With the Project (Alternative III), the present rainfed paddy fields of 7,000 ha will be fully irrigated encouraging to more intensive use. The total beneficiaries in the Project will be 3,100 farm households. After the development, the average holding size of paddy field will decrease to 2.27 ha per farm household from the present size of 2.34 ha, because of the development of irrigation facilities.

30. The proposed cropping pattern of "wet season paddy (100%) -palawija (29%)- dry season paddy (100%)" will be introduced to all the irrigation area. The anticipated unit yield of selected crops is set at 6.0 tons/ha both for wet and dry season paddy, 1.5 tons/ha for palawija (mungbeans, soybeans and groundnuts), and 3.0 tons/ha for vegetables (as chillies). The annual crop production under with project condition is estimated as follows:

Crop	Area (ha)	Unit Yield (ton/ha)	Production (ton)
Paddy *1	14,000	6.0	84,000
Palawija *2	1,800	1.5	2,700
Vegetables (as Chillies)*3	200	3.0	600

*1 Dry grain *2 Shelled *3 Dry pods

31. The annual marketable surplus of paddy from the Project area will reach about 80,000 tons at the full development stage. Marketing of paddy surplus will be carried out through the existing marketing channels of KUD-DOLOG and the private sector. The present capacity of processing and storage facilities in and around the Project area will be possible to cover the future expected production increase. However, some expansion and/or new construction of storage facilities are proposed so as to retain the high quality of products, minimize storage losses, and activate KUD management.

32. The farm budget analysis is made on typical farms. As a result, the farm incomes under the future with project condition will increase remarkably compared with without project condition. The net reserves will also be improved from Rp. 0.23 million (rainfed without project) to Rp. 3.86 million (gravity irrigation with project) and from Rp. 1.49 million (pump irrigation without project) to Rp. 3.54 million (pump irrigation with project).

33. The institutional structure of the supporting system for agriculture development is considerably well established in Kab. Wajo as well as in South Sulawesi Province. The agricultural supporting plan is therefore programmed within the present framework of the institutional structure. From a standpoint of project sustainability and further development in farmers' living standard and regional socio-economy, the proposed plans for improvement and strengthening of the supporting services are pointed out as follows:

1) Extension services
   a) To conduct training courses for PPLs on irrigation farming,
   b) To establish and manage at least two or three demonstration farms in each village in the Project area,
   c) To periodically issue more simple and visual leaflets to the farmers together with local newspapers,
2) Agricultural cooperative
   a) To implement intensive staff training on KUD management,
   b) To involve more farmers and the younger generation in the cooperative activities,
3) Agricultural credit
   a) To adopt a system of mutual guarantee in repayment of loans by forming farmer groups, and
   b) To simplify the procedure for credit applications.

Proposed Project Works

34. The central feature of the Project is to supply irrigation water to the project area of 7,000 ha with an irrigation system by utilizing water from a storage dam to be constructed on the Gilirang river. The facilities required for the Project include Paselloreng dam, Gilirang intake weir, main and secondary irrigation canals, pumping units, drainage canal, farm roads and inspection roads, and a tertiary system.

35. The proposed site of Paselloreng dam is about 11 km upstream from the Gilirang gauging station. Gilirang intake weir is to be constructed east of Desa Gilirang, about 11 km down from the Paselloreng dam.

36. The main features of the proposed project works are summarized as follows:

(1) Paselloreng dam

a) General

- Catchment area (at dam site)	:	169 km^2
- Reservoir surface area at N.W.L.	:	11.0 km^2
- Storage capacity		
Maximum storage capacity	:	132 MCM
Effective storage capacity	:	115 MCM
Dead storage capacity	:	17 MCM
- Water level		
High water level	:	EL. 53.8 m
Normal water level	:	EL. 50.5 m
Low water level	:	EL. 34.0 m

b) Dam

- Type	:	Rockfill dam having central impervious earth core
- Crest elevation	:	EL. 56.5 m
- Dam height	:	44.5 m
- Crest length	:	230.0 m

c) Spillway

- Type	:	Non-gated side channel overflow weir
- Design flood discharge	:	1,300 m^3/sec
- Crest elevation	:	EL. 50.5 m
- Crest length	:	101.0 m

d) Diversion tunnel

- Type	:	Pressured tunnel
- Design diversion discharge	:	680 m^3/sec
- Diameter	:	6.0 m

e) Intake

- Design discharge	:	13.5 m^3/sec

(2) Gilirang intake weir

Diversion weir

a) Type of weir	:	Fixed type
b) Material of weir	:	Concrete
c) Crest elevation	:	EL. 18.20 m
d) Intake water level	:	EL. 18.00 m
e) Design flood discharge	:	570 m^3/sec
f) Diversion discharge		
- Left main canal	:	3.66 m^3/sec
- Right main canal	:	7.75 m^3/sec

g) Crest length of fixed weir including piers : 78.6 m
h) Width of scoring sluice
- Left side : 2.0 m x 2 Nos.
- Right side : 3.0 m x 2 Nos.
i) Width of intake
- Left side : 1.3 m x 2 Nos.
- Right side : 2.2 m x 2 Nos.
j) Height of weir (from stilling basin) : 6.2 m
k) Operation bridge
- Total width : 6.0 m
- Total length : 93.6 m

Closure embankment

a) Type of embankment : Homogeneous
b) Crest elevation : EL. 21.63 m
c) Crest width : 5.0 m
d) Max. height (from riverbed) : 9.63 m
e) Crest length : 740 m

(3) Main and secondary irrigation canals and related structures

Description	Left Bank	Right Bank	Total
Main Canal			
- Canal length (km)	21.0	26.5	47.5
- Related structure			
Turnout w/check for gravity (No.)	16	23	39
Turnout w/check for pump (No.)	5	23	28
Aqueduct (No.)	0	1	1
Road crossing; culvert (No.)	7	8	15
Spillway/wasteway (No.)	8	10	18
Cross drain; box culvert (No.)	8	7	15
Cross drain; pipe culvert (No.)	57	39	96
Measuring device (No.)	1	1	2
Secondary canal			
- Nos. of secondary canal (No.)	5	9	14
- Length of secondary canal (km)	8.1	29.1	37.2
- Related structures			
Turnout w/check for gravity (No.)	14	38	52
Road crossing; culvert (No.)	2	7	9
Spillway/wasteway (No.)	1	5	6
Cross drain; box culvert (No.)	0	1	1
Cross drain; pipe culvert (No.)	13	44	57
Drop (No.)	4	2	6
Syphon (No.)	0	1	1

(4) Pumping units

	Pump Area (ha)	Tertiary Block (No.)	Pump Type Type I (No.)	Type II (No.)	Type III (No.)	Total (No.)
Left main canal	75	5	1	4	0	5
Right main canal	605	23	5	15	6	26
Upstream area	440	10	0	3	7	10
Total	1,120	38	6	22	13	41

Type I : Pumping capacity of 1.4 m^3/min, 4 inches, and 10 PS of engine.
Type II : Pumping capacity of 3.5 m^3/min, 6 inches, and 18 PS of engine.
Type III : Pumping capacity of 6.0 m^3/min., 8 inches, and 27 PS of engine.

(5) Major Drainage canal

a) Length for excavation : 57.2 km

(6) Farm road and inspection road

a) Improvement of existing farm road : 27.5 km
b) Main inspection road : 47.5 km
c) Secondary inspection road : 37.2 km

(7) Tertiary system

a) Tertiary and sub-tertiary blocks : 139 Nos.

37. The project implementation schedule includes the project preparatory works and the construction works. The project preparatory works will last 24 months including the time necessary for additional photo mapping works, the detailed design works, mobilization, and construction of offices and quarters. The construction works will last 43 months for the main civil works and tertiary development works. The main civil works will be undertaken by a qualified civil work contractor/ contractors with assistance of foreign technical services which would be selected through competitive bidding, and the tertiary canals, drains and roads, by local contractors. The quaternary canal networks in the tertiary system will be constructed by the farmers under the guidance of the local government.

38. The project cost is estimated to total Rp. 160,688 million consisting of Rp. 99,625 million of foreign currency and Rp. 61,063 million of local currency, based on the current market price level in South Sulawesi as of August 1994 and the price escalation factor at 2.5% p.a. for the foreign currency portion and 6% p.a. for the local currency portion. The physical contingency includes 10% of the basic cost in the estimate.

Project Organization and Management

39. DGWRD will be the executing agency for the implementation of the Gilirang Irrigation Project. The Directorate of the East Region Implementation (DERI) under DGWRD will have direct responsibility for the project implementation. DINAS PU Pengairan, South Sulawesi will coordinate the construction of the Project at the provincial level on behalf of the Ministry of Public Works. The Gilirang Project Office would be established in or near the Project site. The proposed Project Office would have almost the same organizational structure with that of the on-going projects.

40. After completion of the project works, all project facilities constructed by the Gilirang Project Office will be handed over to DINAS PU Pengairan, South Sulawesi. DINAS PU Pengairan with its branch offices would be responsible for O&M of all the project facilities from dam to inlets of tertiary blocks. The O&M Office of the Project with a service area of 7,000 ha would be ranked as the Ranting Office. Four (4) Sub-Ranting Offices would be established by dividing the service area into four (4); one is for the upstream area including dam and intake weir, the other is for the left bank area, and the remaining two are for the right bank area. Before completion of the construction works of the Project, water users' association (P3A) would be established in each tertiary block. P3A would be responsible for O&M of the tertiary blocks down to the terminal facilities. A total of 139 P3As would be newly established in the Project area. Each P3A would have its own command area of about 50 ha on an average.

Project Evaluation

41. On the basis of the project cost and benefit, EIRR is calculated. The annual net direct benefit derived from the crop production amounts to Rp. 18,760 million at the full development stage. The negative benefit derived from the submerged area of Paselloreng dam is estimated to be Rp. 368 million. The economic cost is estimated at Rp. 98,645 million. The annual O&M cost for project facilities is to be Rp. 643 million. The calculation of EIRR is made based on 50 years of the project life. The result of the economic evaluation indicates that the Project is feasible with EIRR of 13.3 %.

42. The financial viability of the Project is evaluated with respect to farm economy. Under with project condition, annual net reserve or capacity to pay of a typical farmer would increase from Rp. 0.2 million at present to Rp. 3.9 million. While the amount of irrigation service fees is estimated to be about Rp. 218,000 for 2.27 ha of farm based on the government regulations. This amount corresponds to only about 6% of the increased amount of net reserve. Accordingly, it could be concluded that the increase in net reserve under with project condition would enable farmers to pay the irrigation service fee, if it is imposed on them.

43. With the implementation of the Project, the following socio-economic impacts are expected:

    1) Increase of employment opportunities due to the introduction of intensive farming and the project construction works.
    2) Accelerate of development of the regional economy due to an increase of farmers' income.
    3) Expansion of marketing scale in and around the Project area mainly in the marketing of farm input and output.
    4) Increase in rice surplus from the Project to fulfil demand in the rice deficit regions.
    5) Improvement of rural socio-economic activities as a result of construction of inspection roads.

Environmental Impacts

44. The Project is formulated paying much attention to minimizing the expected adverse impacts on the environment by employing mitigation measures, e.g. determination of river maintenance flow considering the water demand in the downstream reach of the Gilirang river, drainage planning taking the existing brackish water ponds in the downstream area into account, and introduction of farming practices which utilize small amount of agro-chemicals. However, it is predicted that the Project would cause various impacts on environmental components due mainly to the construction of the dam with 132 MCM of maximum storage capacity and conversion of 7,000 ha of rainfed paddy field into irrigated paddy fields. The result of the environmental impact assessment is summarized as follows:

    1) Pre-construction Stage; Environmental impacts related to the involuntary resettlement of inhabitants in the submerged area of Paselloreng dam are predicted to be significant. Inhabitants would have expectation and anxiety about the new resettlement site, resettlement and compensation. They would lose their present job.
    2) Construction Stage; The construction works would cause significant impacts on topography, soil erosion, water quality, etc. These would further cause changes to the mangrove forest in downstream areas.
    3) Operation Stage; Significant impacts are predicted on changes in surface water hydrology due to the construction of dam, water quality, sedimentation in the downstream area, and groundwater level. These impacts would further cause impacts on mangrove forests and fish. A positive impact is expected on the water supply to the inhabitants in the Project area after operation of the irrigation system.

Contamination of the water quality is predicted due to the introduction of 229% of cropping intensity.

45. The environmental management plan is thus formulated to minimize the expected adverse impacts as far as possible. For instance, in the pre-construction stage, compensation procedures and amounts should be agreed with inhabitants and the new resettlement site should be arranged before land acquisition. At the construction stage, training and guidance for safety, health, and sanitation should be provided, and proper construction works should be introduced. At the operation stage, replanting of trees should be carried out around the reservoir and in the upstream area, and proper guidance should be provided to the farmers in use of agro-chemical and irrigation water. The environmental monitoring plan is also formulated in the course of the environmental study and clarifies the source of impact, monitoring objectives, monitoring methodology and the monitoring execution agency.

46. All the results of the environmental impact assessment including all environmental management and monitoring plans were handed over to DGWRD in the middle of December 1994. Based on this result, DGWRD is going to prepare a report on environmental impact assessment according to the Indonesian laws and regulations through explanation and discussion with the committee for environmental assessment, both at provincial and national levels.

Recommendations

47. Through the investigation and studies on the Gilirang Irrigation Project, it has been shown that the implementation of irrigation and drainage systems on the Gilirang river basin of over 7,000 ha, together with construction of the Paselloreng dam is technically sound, economically feasible, and financially viable. The Project will contribute to i) stabilizing supply of agricultural production, particularly of rice, ii) achieving rural development and better balanced regional development, iii) creating and stabilizing employment opportunities, and iv) ensuring an increase in farmers' income and living standards. It is recommended, therefore, to implement the Project as early as possible.

48. DGWRD will be responsible for the finalization of the environmental impact assessment on the Gilirang Irrigation Project in accordance with Indonesian laws and regulations. In the implementation of the Project, however, it is recommended to consider the environmental management and monitoring plans formulated by the JICA Study Team. Important items in monitoring are changes in water quantity and quality due to dam construction and in mangrove forests and fishes in the downstream areas.

49. With regard to the resettlement of inhabitants in the submerged area of Paselloreng dam, the government's explanation is required to mitigate their anxiety on resettlement, as programmed in the resettlement program prepared by the Government. In addition, it is recommended to obtain the inhabitants' consent on resettlement before commencement of the land acquisition. Construction of the new site for inhabitants is also recommended to be arranged before land acquisition. Moreover, it is recommended to arrange the required funds for execution of resettlement as soon as possible.

50. Watershed management in the Gilirang river basin is of vital significance for rational land and water resources development in the basin. Through the reconnaissance survey made in the catchment area of the Gilirang river, it was confirmed that a certain part of its forest areas are now grass land due mainly to the unrestricted cutting of trees. Since the forests play an important role in conservation of soil and water resources, it is recommended to restrict the cutting of trees in the basin. In addition, it is recommended to strengthen the replanting of trees undertaken by the forest office in Kab. Wajo. Countermeasures on soil erosion in the basin are also required to be examined.

51. Through the study, it was confirmed that the agricultural supporting services are considerably well established in Kab. Wajo as well as in South Sulawesi Province. However, these should be further activated to ensure the sustainability of the Project and further development of farmers living standards and the regional socio-economy. The activation of supporting services is required to be arranged in a comprehensive and co-ordinated manner under the leadership of BUPATI Office, Kab. Wajo.

FEASIBILITY STUDY ON
THE GILIRANG IRRIGATION PROJECT

FINAL REPORT

Table of Contents

List of Tables

List of Figures

List of Attachments

CURRENCY EQUIVALENT

(As of August 1994)

Currency Unit	=	Rupiah (Rp.)
US$ 1.00	=	Rp. 2,160
Rp. 1 million	=	US$ 463

GOVERNMENT OF INDONESIA PHYSICAL YEAR

April 1 - March 31

WEIGHTS AND MEASURES

1) Length

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer

2) Area

cm^2	:	square centimeter
m^2	:	square meter
km^2	:	square kilometer
ha	:	hectare

3) Volume

cm^3	:	cubic centimeter
m^3	:	cubic meter
ml	:	milliliter (=1.0cm^3)
lit.	:	liter
MCM	:	million cubic meter

4) Weight

mg	:	milligram
g	:	gram
kg	:	kilogram
t	:	ton (=1,000 kg)

5) Time

sec	:	second
min	:	minute
hr	:	hour
d	:	day
yr	:	year

6) Currency

US$	:	US Dollar
Rp.	:	Indonesian Rupiah
¥	:	Japanese Yen

7) Other Measures

%	:	percent
PS	:	horse power
pH	:	scale for acidity
°C	:	centigrade degree
kgf/cm^2	:	kilogram force per square centimeter
m^3/sec	:	cubic meter per second
$m^3/sec/year$	:	cubic meter per second per year
t / ha	:	ton per hectare
ppm	:	part per million
EC	:	electric conductivity
CEC	:	caution exchange capacity
No.(Nos.)	:	number(s)
pc(s)	:	piece(s)
kWh	:	kilowatt hour
kVA	:	kilovoltampere
kV	:	kilovolt
M-D	:	man-day

8) Technical terms

EL	:	elevation
MSL	:	mean sea water level
Lu	:	lugeon
N.W.L	:	nomal water level
L.W.L	:	low water level
H.W.L	:	high water level

GLOSSARY OF ABBREVIATION

ADB	:	Asian Development Bank
Agraria/Pertanahan	:	Directorate General of Land Affairs
BANGDES	:	Rural (Village) Development in General
BAPPEDA	:	Badan Perencanaan Pembangunan Daerah -- Provincial Development Planning Agency
BAPPENUS	:	Badan Perencanaan Pembangunan Nasional -- National Development Planning Agency
BIMAS	:	Bimbingan Massal -- Mass guidance for self sufficiency in food stuffs
BPH	:	Brown Plant Hopper
BPP	:	Balai Penyuluh Pertanian -- Rural Agricultural Extension Centre (REC)
BPPDSA	:	Bagian Proyek Pengembangan Data Sumber Air
BRI	:	Bank Rakyat Indonesia -- Indonesian People's Bank
BULOG	:	Badan Urusan Logistik -- National Food Logistics Agency
Bupati	:	Head of Kabupaten
BUUD	:	Badan Usaha Unit Desa -- Village Unit Executive Body
Cabang Dinas	:	Division of Dinas PU Pengairan (previously called Seksi Pengairan)
Camat	:	Head of Sub District (Kecamatan)
CRIA	:	Central Research Institute of Agriculture
Dati I	:	Daerah Tingkat I (Provincial level)
Dati II	:	Daerah Tingkat II (District (Kabupaten) level)
Desa	:	Village
DGFCA	:	Directorate General of Food Crops Agriculture
DGWRD	:	Directorate General of Water Resources Development
Dinas	:	Provincial government services agencies/Official
DOI	:	Directorate of Irrigation
DOLOG	:	Depot Logistik - Food Procurement Agency
DPMA	:	Directorate General of Penyelidikan Masalah -- Directorate of Hydraulic Engineering
DPU	:	Department Pekerjaan Umum -- Ministry of Public Works
Dusun	:	A village administrative sub-area
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
FAO	:	Food and Agriculture Organization of the United Nations
GDP	:	Gross Domestic Product
GOI	:	Government of Indonesia
Golongan	:	"A class/division, as in a subdivision of irrigation area for rotating and spreading planting dates"
GRDP	:	Gross Regional Domestic Product
HHS	:	Household Survey
IBRD	:	International Bank for Reconstruction and Development
IEE	:	Initial Environmental Examination
IMP	:	Pengendalian Mama Terpadu -- Integrated Pest Management
INMAS	:	Intensifikasi Massal -- Mass Intensification Program
INMUM	:	General Intensification Program
INSUS	:	Intensifikasi Khusus -- Special Intensification Program
IPEDA/PBB	:	Land taxes
JICA	:	Japan International Cooperation Agency
Juru Pengairan	:	Irrigation Overseer/Inspector
Kabupaten (Kab.)	:	Administrative district within a province
Kantor Wilaya	:	Provincial office of a Ministry
Kanwil	:	Kantor Wilaya -- Provincial office of a Ministry
Kecamatan (Kec.)	:	Administrative sub-district within a Kabupaten
Kepala	:	Head of an organization
Kepala Desa	:	Head of village
KIK	:	Small Investment Credit
KIOSK	:	Small shop
Kontak Tani	:	Key farmer or leading farmer
KUD	:	Koperasi Unit Desa -- Village unit cooperative
LKMD	:	Village community Resilience Board (Lembaga Ketahanan Masyarakat Desa)
Mantri	:	Local official in charge of a specific service in Kecamatan
Mantri Pengairan	:	Juru Pengairan

O&M	:	Operation and Maintenance
OECF	:	Overseas Economic Cooperation Fund
P3A	:	Water User's Association (Pengkumpulan Pertani Pemakai Air)
P3SA	:	Proyek Peren Canaan Pengembangan Sumber - Sumber Air -- Water Resources Planning and Development Program
Palawija	:	Second crop planted after harvest of wet season paddy
PEMDA	:	Local government (Pemerintah Daera)
Pengairan	:	Water resources
Pengamat	:	"Irrigation inspector, head of Ranting Dinas"
PMF	:	Probable Maximum Flood
PPA	:	Gate Keeper/Operator (Penjaga Pintu Air)
PPL	:	Penyuluh Pertanian Lapangan -- Agricultural Field Extension Worker
PPM	:	Penyuluh Petanian Madya -- Agricultural Extension Officer
PPS	:	Penyuluh Pertanian Spesialis -- Agricultural Extension Specialist
PRIS	:	Provincial Irrigation Service
PU	:	Ministry of Public Works
Ranting Dinas	:	Sub-Branch within Cabang Dinas (previously called cabang Seksi)
Repelita	:	Five-year development plan (Rencana Pembangunan Lima Tahun)
Rural Irrigation	:	Irrigation system with or without headworks in which the flows can not be controlled/measured by permanent structures
Sawah	:	Paddy field
SB	:	Stem Borer
SD	:	Sekolah dasar (Elementary school)
Sub Dinas	:	Sub division of provincial public works
SUPRA INSUS	:	Supra Intensifikasi Khusus -- Super Group Guidance Intensification Program
T.S.P.	:	Triple Super phosphate
T&V or TV	:	A system of agricultural extension (Latihan dan Kunjungan)
Ulu-Ulu	:	Water master/Water distribution supervisor of P3A of village
UNDP	:	United Nations Development Program
UNESCO	:	"United Nations Educational, Scientific, and Cultural Organization"
WKPP	:	PPL working area (Wilayah Kerja Penyuluhan Pertanian)

DEFINITION OF STUDY AREA

Agricultural, soil and land use studies	:	25,300 ha in which all possible development area is included.
Socio-economic study	:	531 km^2 which cover 19 village areas related to the study area.
Hydrological and environmental studies	:	518 km^2 which cover a catchment area of the Gilirang river basin.

ANNEXES
(Separate Volume)

ANNEX VOLUME I

Annex 1	Geology and Soil Mechanics
Annex 2	Meteorology, Hydrology and Water Balance Study
Annex 3	Dam and Weir
Annex 4	Irrigation and Drainage

ANNEX VOLUME II

Annex 5	Soil and Land Use
Annex 6	Agriculture and Agro-economy
Annex 7	Construction Plan and Cost Estimate
Annex 8	Organization and Management
Annex 9	Environmental Study
Annex 10	Project Evaluation

ANNEX VOLUME III

Annex 11	Drawings

CHAPTER 1 INTRODUCTION

1.1 Authority of the Report

This Final Report is prepared in accordance with Clause VI of the Scope of Works agreed upon between Japan International Cooperation Agency (referred to as JICA hereinafter) and Directorate General of Water Resources Development (referred to as DGWRD hereinafter). The Scope of Works is incorporated in this report as Attachment -2.

This report presents a feasibility study on the Gilirang Irrigation Project which was formulated through three field works and four home office works which commenced in late February, 1994 and ended in the beginning of June, 1995. It mainly deals with assessment of the present conditions in around the study area, technical, economical, and financial evaluation of the proposed project, and ecological and environmental assessment on the implementation of the project.

The Final Report consists of the following four (4) separate volumes:

1. MAIN REPORT

2. ANNEX VOLUME I
   - Annex 1 Geology and Soil Mechanics
   - Annex 2 Meteorology, Hydrology and Water Balance Study
   - Annex 3 Dam and Weir
   - Annex 4 Irrigation and Drainage

3. ANNEX VOLUME II
   - Annex 5 Soil and Land Use
   - Annex 6 Agriculture and Agro-economy
   - Annex 7 Construction Plan and Cost Estimate
   - Annex 8 Organization and Management
   - Annex 9 Environmental Study
   - Annex 10 Project Evaluation

4. ANNEX VOLUME III
   - Annex 11 Drawings

1.2 History of the Project

In early 1970s, the Government of Indonesia focused on the comprehensive regional development in Central South Sulawesi. To realize the development concept, the Government of Indonesia requested the Government of Japan to extend technical assistance for the formulation of the master plan for comprehensive development in this region.

In compliance with the request from the Government of Indonesia, the Government of Japan conducted the master plan study through JICA by the following steps:

1) 1973 : Dispatch of preliminary survey team

2) 1976 : Dispatch of JICA experts to collect hydrological data required for the master plan study

3) 1978 : Preparation of topographic maps on a scale of 1:25,000

4) 1978 - 1980 : Master plan study for the Central South Sulawesi Water Resources Development Project

In the master plan study, nine (9) priority projects including the Gilirang Irrigation Project were identified for the regional economic development to increase the public welfare of local inhabitants in the Central South Sulawesi. Among the priority projects, three priority projects, i.e. the Langkeme, Bila and Sanrego irrigation projects were promoted to the further stages with assistance from the OECF and the World Bank. The former two projects are under construction at present and the latter project has been substantially completed. The Gilirang Irrigation Project is thus expected to be the fourth priority project among the nine projects identified in the master plan study.

On the basis of the above background, the Government of Indonesia requested the Government of Japan on January 1992 to extend technical assistance in conducting a feasibility study on the Gilirang Irrigation Project. In response to the request, JICA sent a preparatory study team to Indonesia on March 1993 and agreed to the Scope of Work for the feasibility study with the Directorate General of Water Resources Development, Ministry of Public Works on March 16, 1993. Based on the agreed Scope of Works, the Feasibility Study on the Gilirang Irrigation Project commenced in late February 1994 upon arrival of the first group of the Study Team in Jakarta

1.3 Needs of the Project

The necessity of this Project is clarified by the following two (2) points:

1) South Sulawesi province is one of the large rice granaries in Indonesia and plays an important role in supplying rice to other rice deficit provinces. According to the forecast made on Indonesia's rice supply and demand in the recent study (the Study for Formulation of Irrigation Development Program in the Republic of Indonesia; FIDP, 1993, JICA), rice surplus from South Sulawesi province will become more important in the future in fulfilling the expected rice deficit in other provinces.

2) In the Gilirang Project area, on the other hand, single cropping of paddy under rainfed conditions is widely practiced. Crop productivity is low and thus the income level and living standards of the inhabitants are low compared with those around the Project area.

In the light of the above situation, the Project is needed to improve crop productivity and increase crop production through irrigation and drainage development in the Gilirang Project area, elevate the income level and living standards of the inhabitants, and achieve balanced regional development.

1.4 Previous Studies

The following surveys and studies relevant to the Gilirang Irrigation Project were carried out with Japanese technical cooperation:

1) Preliminary Study on the Water Resources Development in the Central South Sulawesi, OTCA, June 1974,

2) Hydrological Data Collection and Guidance for Data Collection on the Central South Sulawesi Water Resources Development Project, JICA, March 1977,

3) Topographic Mapping on a scale of 1:25,000, JICA, September 1978,

4) Master Plan on the Central South Sulawesi Water Resources Development, JICA, March 1980, and

5) Preliminary Survey Report on the Gilirang Irrigation Project, JICA, April 1993.

The Government also undertook independent activities for the Project. The major activities made so far are as follows:

1) 1978 : Installation of a water level gauging station on the Gilirang river at Desa Gilirang,

2) 1988 : Geological investigation of the dam site proposed in the Master Plan, and

3) 1994 : Installation of a water level gauging station on the Gilirang river at Desa Arajang

1.5 Scope of Works

(1) Objectives of the Study

The objectives of the study consist of the following two aspects:

1) To conduct a feasibility study on the Gilirang Irrigation Project, and

2) To carry out technology transfer to the Indonesian counterpart personnel through on-the-job training in the course of the study.

(2) Study Area

The study area stipulated in the Scope of Works is about 16,000 ha along the Gilirang river in Central South Sulawesi. The agricultural study including soil and land use study, however, extends to 25,300 ha which includes the above 16,000 ha. The socio-economic study also covers 19 related villages within 531 km^2 in three Kecamatan (Kec. Sajoanging, Majauleng and Maniangpajo) in Kab. Wajo. Hydrological and environmental studies are concentrated into a catchment area of Gilirang river basin with a total coverage of 518 km^2.

(3) Scope of Works

The study undertook Work II of the two works agreed in the Scope of Works; Work I (preparation of topographic map covering the study area at a scale 1:5,000) and Work II (Feasibility Study). The study was carried out in the two stages covering the following work items:

1) Preparatory Works in Japan
   - Examination of available data
   - Preparation of a plan of operation
   - Preparation of the Inception Report

2) Field Survey in the First Stage Study
   - Explanation and discussion on the Inception Report
   - Data collection and field survey
   - Contracts with sub-contractors and their supervision
   - Preliminary study on development potential and constraints
   - Preparation of a draft on basic development strategy
   - Preparation, explanation, and discussion on the Progress Report (I)

3) Home Office Work in the First Stage Study
   - Analysis of results of the field survey in the First Stage Study
   - Evaluation of development potential and constraints
   - Formulation of basic strategy for the development
   - Examination of contents and methods of the Second Stage Study
   - Preparation of the Interim Report

4) Field Survey in the Second Stage Study
   - Explanation and discussion on the Interim Report
   - Supplemental filed survey
   - Contracts with sub-contractors and their supervision
   - Preparation of the Progress Report (II)

5) Home Office Work in the Second Stage Study
   - Analysis of results of the field survey in the Second Stage Study
   - Formulation of an irrigated agricultural development plan
   - Preparation of the Draft Final Report

6) Explanation and discussion on the Draft Final Report

7) Preparation of the Final Report

1.6 Activities of the Study Team

Until completion of this report, the JICA Study Team of 10 experts had cumulatively consumed 62.1 man-months during the period from late February, 1994 to the beginning of June, 1995. A total of 9 Indonesian counterparts were also involved in the execution of the field survey together with the JICA Study Team. Table 1.5.1 shows the list of members of the JICA Study Team and the Indonesian counterparts.

(1) Preparatory works

The JICA Study Team carried out preparatory works prior to the commencement of the field survey and compiled the Inception Report based on the available data and information collected in Japan.

(2) First Stage Study

The first group of the Study Team arrived in Jakarta on February 20, 1994. The kick-off meeting was held at DGWRD, Jakarta on February 21, 1994 and the Inception Meeting, at the Public Works of South Sulawesi, Ujung Pandang, on February 22, 1994. Immediately after these meetings, the Study Team proceeded to the Project site and substantially started the field survey and investigation following the approved plan of operation stated in the Inception Report. The Team continued the survey, investigation, and study for just three (3) months until May 19, 1994. At the end of field survey, the JICA Study Team prepared the Progress Report (I) based on the findings obtained through the field survey. Contents of the Progress Report (I) were discussed on May 4, 1994 with the Steering Committee established at the provincial level by the Indonesian Government.

The JICA Study Team started the home office work in early July 1994 and it lasted for one and a half (1.5) months until the middle of August 1994. During this period, the major works of the Team were analysis of the field survey, evaluation of the development potential and constraints, and formulation of a basic agricultural development strategy. At the end of the home office work, the Team compiled the Interim Report involving all the study results of the First Stage Study.

(3) Second Stage Study

For the execution of the field survey under the Second Stage Study, the first group of the JICA Study Team arrived in Jakarta on August 30, 1994. A meeting on the Interim Report was held at Ujung Pandang between the Steering Committee and the Team on September 1, 1994. Through the discussion, the basic agricultural development strategy described in the Interim Report was basically accepted by the Steering Committee. Immediately after the meeting, the Team proceeded to the Project site and substantially started a field survey and investigation. The Team executed the survey, investigation, and study for three and a half (3.5) months until December 11, 1994. At the end of the field survey, the Team analyzed the field survey results and studied the comments of the steering committee. Based on these, the Team prepared the Progress Report (II) which outlined the proposed development plan. Contents of the Progress Report (II) were discussed with the Steering Committee on December 5, 1994 and were basically accepted by the Steering Committee.

The Team started the home office work in the middle of December 1994 and it lasted for two (2) months until the middle of February 1995. During this period, the Team prepared the Draft Final Report which presents the proposed plan of the Gilirang Irrigation Project.

(4) Explanation and discussion on Draft Final Report and preparation of Final Report

On March 20, 1995, technical meeting on the Draft Final Report took place at Ujung Pandang between the Steering Committee and the JICA Study Team. In the meeting, the JICA Study Team confirmed comments and requests of the Steering Committee on the Draft Final Report.

The JICA Study Team prepared the Final Report of the present study based on the comments and requests of the Steering Committee, and submitted it herewith in accordance with the Scope of Works.

1.7 Steering Committee

The Government of Indonesia especially established a steering committee at the provincial level for the present study on May 16, 1994 aiming at the promotion of the Gilirang Irrigation Project. The Committee comprised the Head of BAPPEDA as chairman, Head of KANWIL Public Works as vice-chairman, Head of DPUP as secretary, and Heads of KANWIL BPN, Agriculture, Mining and Energy, Forest, Transmigration and Chief of DINAS Food Crops, Secretary of Kab. Wajo and Chief of Sub. Dit. Planning and Design, Dit. Irrigation II, DGWRD (Chief of Sub. Dit. Irrigation, Dit. Technical Engineering at present after a change in the organization of DGWRD) as members. The committee meetings were held four times in Ujung Pandang; the first meeting was on the Progress Report (I), the second was on the Interim Report, the third was on the Progress Report (II) and the fourth was on the Draft Final Report.

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 National and Regional Economies

Since 1969 when the first five-year development plan (Repelita I) started, the Indonesian economy has grown steadily with an average annual growth rate of around 7%, although it experienced a lower growth rate for a certain period due to the collapse of the oil price. In 1991, the Gross Domestic Product (GDP) totaled Rp. 227,160 billion at current market prices. In the same year, the per capita GDP was approximately Rp. 1.25 million or US$ 641. GDP in real terms increased at the rate of 6.7% p.a. during the past four years from 1987 to 1991. Of the GDP in 1991, about 21% is derived from the manufacturing sector followed by 20% from the agricultural sector, and 17% from the trade (wholesale and retail trade and restaurants) sector. The share of the agriculture sector in GDP declined from about 45% in 1970. This is because of the considerably high growth in other sectors.

A distortion arises in Indonesia's economy, due mainly to the recent rapid growth in other sectors, particularly in the manufacturing sector. For instance, labor productivity in the agriculture sector is lower than other sectors, reflecting the agriculture sector's small share in GDP and large share in employment. As of 1990, labor productivity is Rp. 0.52 million/labor/year in the agriculture sector, and Rp. 1.37 million/labor/year in all other sectors.

The Gross Regional Domestic Product (GRDP) in South Sulawesi Province was Rp. 5,282 billion in 1991 at current market prices. This amount of GRDP accounts for about 2.3% of Indonesia's GDP, while the provincial population accounts for 3.9% of Indonesia's total population. The per capita GRDP in the province is about Rp. 0.75 million or US$ 383 which is only about 60% of the Indonesian average. GRDP in real terms increased by a rate of 9% p.a. during the past four years from 1987 to 1991. The agriculture sector accounts for about 42% of GRDP followed by 19% for the trade sector, and 8% for the manufacturing sector.

2.2 Agriculture Sector in Indonesia

Agriculture is still a mainstay of Indonesia's economy. This sector represented about 20% of GDP and employed 41.1 million or 54% of the labor force in 1991. The sector has an important role in non-oil merchandise trade, with major agricultural exports accounting for 48% of the value of non-oil exports in 1989/90. Food crops accounted for 58% of agricultural GDP followed by non-food crops of 13% and livestock of 11% in 1991.

Production is dominated by small farmers. The average farm size of small farmers varies from 0.5 to 0.7 ha in Java and 1 to 3 ha outside Java. The important food crops grown by small farmers are rice, maize, cassava, sweet potatoes, groundnuts, and soybeans. Livestock is usually raised with food crops and secondary crops (palawija in Indonesian term). Poultry, beef cattle, and dairy cattle are commonly raised by small farmers.

In the last decade, agricultural growth has averaged about 3% p.a. and outpaced population growth by a significant margin. Rice output has solidly contributed to the sector's impressive performance. The increase in rice production from 19.3 million tons in 1980 to 24.8 million tons in 1984 transformed the country from one of the world largest rice importers (about 2.6 million tons in 1980) to one with a surplus in 1984. However, as mentioned in Section 2.4, sustenance of the established self-sufficiency in rice production is still an important issue of the agricultural development policy. According to the results of recent study made on rice supply and demand balance (The Study for Formulation of

Irrigation Development Program in the Republic of Indonesia: FIDP, 1993, JICA), the deficit of paddy will reach 4.6 million tons in 2003 and 10.6 million tons in 2013 if new irrigation systems are not developed.

2.3 Agriculture Sector in South Sulawesi Province

The agriculture sector is the largest economic sector in South Sulawesi province. The sector contributes to about 42% of the provincial GRDP and provides employment to more than 60% of the labor force. Food crops account for 42% of agricultural GRDP followed by fisheries (20%), non-food crops (13%), and livestock (10%). The share of the fisheries subsector is considerably larger in the provincial GRDP compared with Indonesia's GDP, while the shares of estate crops and forestry are smaller.

In the provincial agriculture sector, paddy is the most important commodity. Paddy harvested area is about 856,000 ha or nearly 60% of the total harvested area of major annual crops in the province in 1992. Paddy production reached 4.34 million tons with a growth rate of 6.5% during 1982-1992. According to the results of FIDP study, rice surplus in South Sulawesi Province was about 643,000 tons (989,000 tons in paddy equivalent) in 1990. These figures show that about 23% of paddy production in the province is transported to other rice deficit provinces to fulfill their local demands. Major provinces receiving rice from South Sulawesi Province are Jakarta, East Kalimantan, West Kalimantan, and other provinces on Sulawesi island.

The role South Sulawesi Province plays in supplying rice to other provinces will become more important in the future. Again according to the FIDP study, a total of 100,500 ha of new irrigation development is proposed in South Sulawesi Province during Repelita VI - IX (1994/95 - 2008/09) period to maintain the self-sufficiency in rice in Indonesia, as shown below:

Target Development Area in South Sulawesi Province for Paddy Production

(Unit: 1000ha)

	Repelita VI	Repelita VII	Repelita VIII	Repelita IX	Total
New Construction	12.5	53.8	34.2	0.0	100.5
Extension	0.2	2.5	0.0	0.0	2.7
Rehabilitation	15.2	0.0	0.0	0.0	15.2
Ground Water	2.5	3.0	3.0	2.0	10.5
Small Scale	37.5	37.5	0.0	0.0	75

Repelita VI (1994/95-1998/99), Repelita VII (1999/00 - 2003/04), Repelita VIII (2004/05 - 2008/09), Repelita IX (2009/10 - 2013/14)

2.4 Agricultural Development Policy

The Government's major objectives for the agriculture sector during Repelita VI (1994/95 - 1998/99) period are to:

1) sustain the established self-sufficiency of food to meet domestic requirements, increase diversification of products, and improve quality of production,

2) increase production meeting the needs of industry and expanding agricultural exports,

3) increase farmers' incomes and living standards and expand employment and business opportunities,

4) promote a more balanced distribution of economic opportunities, regional

development, land settlement, and land development including rational planning of land development to retain prime agricultural land for the future infrastructure and industry development, and

5) contribute to the health and better nutritional status of the population through diversification of foodstuff.

In relation to 1) above, sustenance of self-sufficiency in rice production is one of the most important targets. Although Indonesia has been self-sufficient in rice in 1984, continuous efforts to increase rice production are a prerequisite to meet the increasing demand. Irrigation development is expected to play a major role in overcoming this issue.

For development of the irrigation subsector, major objectives during Repelita VI are to:

1) expand the irrigation schemes so as to get a more balanced water use and ensure water conservation, protect production areas, and prevent devastation by floods and drought, and to support the utilization of new agricultural fields,

2) increase irrigated agriculture so as to maintain the water resources and irrigation schemes,

3) promote a more harmonized development in coordination with other water-consuming-sectors such as settlement and industry, river maintenance, hydro-electric power, and tourism, and

4) strengthen maintenance and rehabilitation in the irrigation schemes through heightening farmer's ability and participation.

CHAPTER 3 PRESENT CONDITION IN AND AROUND THE STUDY AREA

3.1 Location

The study area is located at about 240 km north-east along the national road from Ujung Pandang, the capital of South Sulawesi Province. It extends north-east of Sengkang, the capital of Kabupaten Wajo and is approximately bounded by the coastal swamp belt of Bone bay on the east and Attapange-Doping road on the south. The northern and eastern boundaries skirt along the foot of hilly ranges.

Administratively, the study area comes under Kabupaten Wajo, and extends over three Kecamatan, i.e. Sajoanging, Majauleng and Maniangpajo. These are 19 Desa related to the study area with an area of 531 km^2 comprising nine (9) Desa in Kec. Sajoanging, five (5) Desa in Kec. Majauleng and the remaining five (5) Desa in Kec. Maniangpajo. These administrative boundaries are illustrated in Figure 3.1.1.

3.2 Human Resources

The population in the 19 Desa was about 53,400 in 1992 within a total territory of 531 km^2 according to statistic data obtained from the relevant Kecamatan. The average population density is estimated to be 101 persons/km^2. The population growth in the related three Kecamatans shows negative figures of -1.39% p.a. on an average during 1988-1992 period. The total households in the study area are about 11,000. Average family size is 4.86 persons of which 2.85 persons or about 58% are estimated to be workable.

On the other hand, the estimated farm population based on the primary data from the result of the household survey (250 sample farmers) is about 32,000 persons with 6,300 households in the study area. The primary data also shows that the average family size is 5.14 persons per farm family. The family labor force per farm household is estimated to be 3.1 persons based on the age distribution pattern as shown below:

Labor Force per Farm Household

1)	Study area	(ha)	25,300
2)	Total paddy field (net area)*1	(ha)	15,000
3)	Average holding size of paddy field	(ha/household)	2.37
4)	Number of farm household	(household)	6,300
5)	Average family size	(person/household)	5.14
6)	Number of farm population	(person)	32,000
7)	Age distribution		
	65 and over	(%)	2.6
	50 - 64	(%)	12.9
	15 - 49	(%)	53.1
	0 - 14	(%)	31.4
	Total	(%)	100.0
8)	Labor force per household*2	(person/household)	3.1

*1 Gross paddy field x 95% = 15,800 ha x 0.95 = 15,000 ha (excluding roads, etc.)

*2 Average family size x (age distribution between 15 and 49 + 50% of age distribution between 50 and 60)
= 5.14 persons x (53.1% + 6.5%) = 3.1 persons/household

3.3 Natural Resources

3.3.1 Topography

The study area extends both sides of the lower Gilirang river basin from the west to the east, bounded by the undulating hilly ranges on the north and the south. The Gilirang river runs from the north to the south near the junction of a provincial road and turns to the east, and then flows directly into the Bay of Bone. Numerous small tributaries, which originate the in hilly ranges outside of the study area flow into the Gilirang river in the study area.

A major part of the study area is located on the alluvial flat plain created by the Gilirang river and its small tributaries, and partly lies in the undulating hilly areas near the north and the south boundaries. The topography of the hilly areas near both boundaries are rather complicated. The alluvial plains are mainly covered with rainfed paddy fields.

The north-eastern part of the study area scatters in the hilly areas along the Gilirang river with an altitude range of EL. 18 m to 27 m above MSL. The south-western part of the study area extends on the flat plain with gentle slopes and its altitude ranges from EL. 1.5 m to 4 m. The brackish water ponds extends in the low lands between the southern border of the study area and sea coast. The altitude of the major part of the project area ranges from EL. 4 m to 18 m.

3.3.2 Climate

Climate in the study area is characterized by tropical monsoons having distinct dry and wet seasons according to the seasonal distribution of rainfall. The cease and onset of these seasons vary widely year by year. This variation is one of the climatic constraints for agriculture in the study area. The wet season usually commences in March and lasts about five months until July and is followed by unstable dry season from August through February.

There is a marked difference in the yearly rainfalls, although there is a clear trend in the rainfall pattern. The average yearly rainfall is about 2,200 mm in the study area. The yearly rainfalls vary widely from year to year ranging between approximately 1,500 mm to 2,900 mm.

Mean monthly temperature varies from 26 °C to 28 °C with a narrow seasonal variation. From October to November, it is the hottest season having a mean maximum temperature higher than 32 °C. From June to August, it is the coolest season having a mean minimum temperature less than 23 °C. The average daily fluctuation is only about 4 °C throughout the year.

The mean monthly relative humidity ranges from about 72 % to 84 %. The highest relative humidity occurs in May and June, and the lowest occurs in October.

Annual average sunshine percentage is 53 % at Sengkang. The mean monthly sunshine duration widely varies from 5.2 hr/day at the minimum in December to 8.1 hr/day at the maximum in September.

The monthly average of wind velocity is generally low, in a range of 1.0 m/sec to 1.5 m/sec.

The annual evaporation from the Class A-pan at Sengkang varied from 1,840 mm (5.0 mm/day) in 1978 to 2,290 mm (6.3 mm/day) in 1987, and the average annual evaporation is 2,080 mm (5.7 mm/day). The mean monthly evaporation is in the range of 4.6 mm/day in June to 7.1 mm/day in October.

3.3.3 Geology

The upper Gilirang river basin is entirely covered with a layer of Conglomerate with a thickness of about 100 m to 400 m, including a little glauconic sandstone with shale, coquina and molluscs. Foraminifers thereabouts range in age from "late middle the Miocene to the Pliocene". Meanwhile, the lower Gilirang river basin is mostly covered with Alluvium with a thickness of about 100 m including clay, silt, sand, gravel and reef limestone. (see Figure 3.3.1).

(1) Geological condition of dam site

The bedrocks of the proposed dam site are composed of semi-consolidated soft conglomerate, sandstone and mud stone of Tertiary Pliocene formation which dip slightly to the upstream. The sandstone is gray colored, massive, and soft; it generally consists of medium grain sand, and is predominant at the Gilirang dam site. The conglomerate is also gray colored, massive, and soft with partial intercalation of well consolidated semi-hard faces; this rock is dominant at the upstream and the right bank of the dam site; the thickness is assumed to be around 20 to 50 m. The mud stone is seen in the form of thin intercalation in the dam foundation and is a gray to dark gray soft rock; this rock is cracky and of low bearing capacity due to its shrinkage and slaking.

Strikes and dips of the basement rocks around the proposed dam site are estimated to be N60°E-N55°W of strike with 5 - 25°W of dip. There is no large scale faults near the proposed dam site. Several faults are however observed near the proposed dam site; they have displacement of 5 cm to 60 cm and fractured zones from 1.0 cm to 20.0 cm in width. These faults are observed at remote areas more than 900 m from the proposed dam site.

The bedrock at the dam site generally shows a tendency that the larger in diameter, the weaker in consolidation. This rock is divided into three zones, highly weathered rock, moderately weathered rock, and slightly weathered to fresh rock zone.

Terrace deposit is brown to gray, soft and loose, and unconsolidated, This deposit consists of clayed silt to sand layer and gravel layer, having a thickness of about five (5) meters from surface to flood terrace. The N-values for soft silt and sandy clay layer are observed to be lower than 10. Talus deposit is brown, soft, loose, and unconsolidated. This deposit is distributed in the narrow area on foot of slope, the thickness of which may rang from 1 to 5 m. In accordance with the above geological consideration, it was concluded that this site would be ideal for the foundation of the filldam.

(2) Geology of proposed weir site

The proposed weir site is geologically composed of Tertiary Pliocene sedimentary rocks and Quaternary deposits, such as terrace, talus, and river bed deposits. At this site, the outcrop of the bedrocks is observed in the river course with EL. 12.0 m. It is therefore assumed for this site to have enough bearing capacity for a foundation for a fixed type concrete gravity weir.

(3) Geology along the canal routes

The irrigation canal routes are covered mainly with softly consolidated rocks such as conglomerates, sandstones and mudstones of the Pliocene age and unconsolidated weak deposits in the Quaternary age. The embankment of canals and related structures would be executed by the maximum use of the in-situ materials which are excavated for the construction of canals and related structures. Judging from the field reconnaissance survey, the suitable embankment materials for canal and related structures would be available along the canal routes.

3.3.4 Soils

The soils in the study area are classified into five (5) soil units according to the FAO/ UNESCO soil classification system, i.e. Vertisols (V), Eutric Cambisols (Ce), Eutoric Regosols (Re), Thionic Fluvisols (Jt) and Lithosols (L).

Vertisols (V) extend mainly over the flat low land and lower terrace of the alluvial plain developed along the Gilirang river. These soils are developed on recent and semi-recent alluvial deposits and the generally immature with no predominant morphological characteristics. The effective soil depth is generally deep, more than 50 cm. The soil texture is very fine and the constituency is very sticky and plastic. The soil structure is generally angular blocky. Most of these soils are put under cultivation of rainfed paddy. These soils are suitable not only for irrigated rice but also for a wide range of crops, and they occupy about 9,600 ha or 37.9 % of the study area.

Eutric Cambisols (Ce) occur on the higher terrace of old alluvium extending widely over the northern and southern parts of the study area. These soils are generally mature with a predominant B2 horizon. The soil texture is fine silty clay. The soil structure is blocky to granular, and the constituency is sticky and plastic. These soils are also suitable for a wide range of crops. Most of land covered with these soils is presently used for paddy cultivation. These soils occupy 13,710 ha or 54.2% of the study area.

Eutric Regosols (Re) extend sporadically over the higher terrace of old alluvium. These soils are composed of the weathering materials of the mother gravel rock. The surface layers of these soils are very thin and the water holding avidity is very poor. These soils occupy about 490 ha or 1.9% of the study area.

Thionic Fluvisols (Jt) extend over the coastal swamp belt of the flat alluvial plain along the eastern border of the study area. In the lower layer of these soils, acidic sulfur compounds such as pyrite and jarosite are developed. These soils are generally not suitable for crop cultivation. The majority of the area with these soils is used as fish ponds. These soils occupy 1,200 ha or 4.7% of the study area.

Lithosols (L) cover the dissected foot hills of north-western part of the study area to a small extent of 300 ha or about 1.2% of the study area. As the effective soil depth is very thin, these soils have almost no agricultural value.

The soil map is given in Figure 3.3.2.

3.3.5 Water Resources

(1) General

The Gilirang river is the only surface water source in the study area. The river originates from the mountainous zone between the Bila and Awo river basins. The river meanders from the north to the south near the junction of a provincial road and turns to the east, and then flows directly into the Bay of Bone traversing through the alluvial plain in the lower Gilirang river basin.

Its total reach is about 100 km. The catchment area of the river is 518 km^2 at the river mouth, 230 km^2 at the Gilirang gauging station, and 169 km^2 at the proposed dam site. The proposed dam site is located at about 11 km upstream of the Gilirang gauging station. In the upstream of the station, the river basin is classified into three categories by its coverage. About 70 % of the basin is mountainous area with forest, 20 % is hilly covered with shrub, and the remaining is grass land. The average gradient is very steep in the first 10 km from river origin and gradually becomes gentle toward the river mouth. The average gradient between proposed dam site and the river mouth is very gentle, or about 1:2,500.

There are three (3) water-level gauging stations in the Gilirang river. They are Arajang, Tarunpakkae, and Gilirang station. In the Arajang station, however, no data is available, because its observation started in February 1994. The observation at Tarunpakkae station started in 1975 and terminated in 1978, and accordingly data is available only for the short period in of this station. The Gilirang station has continuous data from 1979 up to date, although there are some interruptions.

Following the above evaluation, data from the Gilirang station are applied to the hydrological analysis. The Gilirang station also has discharge data measured directly using a current meter. These data are useful to know the relation between the water level and the discharge in the river by formulation of a so called rating curve.

(2) Stream flow

Daily discharge at the Gilirang gauging station is estimated using the rating curve. Then, the half-monthly discharge is calculated for 15 years from 1979 through 1993. The interrupted period of the data is filled in by an estimated discharge using the co-relationships of discharge between the Gilirang gauging station and Bila Upstream or Bila Downstream gauging stations in the Bila river basin. The table below shows the seasonal patterns of the stream flow of the Gilirang river at the proposed dam site and the Gilirang gauging station:

Seasonal Patterns of the Stream Flow of the Gilirang River

(Unit : m^3/sec)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Proposed dam site	1.4	3.1	1.2	8.4	13.7	15.4	18.2	8.4	5.9	2.4	1.6	0.7	6.7
Proposed weir site	1.9	4.2	1.6	11.4	18.6	20.9	24.7	11.4	8.0	3.3	2.2	0.9	9.1

The flood discharge at the proposed dam site and weir site is estimated as follows based on the unit hydrograph analysis:

Flood Discharge

(Unit : m^3/sec)

Probable Peak Flood	Return Period (Year)						
	10	25	50	100	200	1,000	PMF
Proposed dam site	677	802	896	987	1,081	1,293	1,760
Proposed weir site (before dam construction)	836	991	1,107	1,219	1,335	1,598	2,175
Proposed weir site (after dam construction)	362	444	508	570	637	792	1,152

(3) Water quality

In this study, the water quality analysis was carried out for water samples taken from the Gilirang river. Study results of the chemical properties of water samples show that the river water seems to be acceptable for irrigation purpose.

3.4 Infrastructures

3.4.1 Irrigation and Drainage System

(1) Existing pump irrigation system

There is no gravity irrigation system in the study area, or even a "non-technical" and/or "semi-technical" grade of irrigation system. Only small pump irrigation systems are operated by the farmers themselves. Water source for the systems depends mostly on the Gilirang river. Pumping lift from the river is estimated at about 5 to 15 m depending on the topographic conditions. Pump bores vary 3 to 8 inches with 12 to 24 HP engine covering about 40 ha of irrigation area per unit on an average.

All the pumps are operated only for the dry season paddy cultivation. Pumping operation periods and hours vary from 60 to 80 days per crop season and 12 to 24 hours per day respectively, depending on climate conditions and farmers' experiences. Canal networks are very primitive and only on-farm ditches are aligned to distribute irrigation water to plots. These ditches are maintained by the farmers themselves. The pumps are generally owned by farmers; some are hired from private companies on contract bases and the others are supported by the government. In the 1993/94 crop season, there were 20 units of pump irrigation facilities in the study area, irrigating about 640 ha of dry season paddy.

The pump irrigation systems in the upper Gilirang river basin such as Paseiloreng and Arajang provide water for 165 ha and 105 ha, respectively. These systems have been operated for 8 to 12 years. In the downstream areas such as Akotengeng and Bottobenteng, pump irrigation systems have been operating for only a few years and are still at the trial stage.

To operate the pump irrigation system, the owner/farmer of pumping the facilities organizes an average number of 42 farmers per system. Water charge is collected at a rate of 20% of the harvest. Operation costs (fuel and lubricant cost) vary depending on the capacity of the pump, pump lift, rainfall distribution, and operation techniques. Costs are estimated at Rp. 42,000 ha/season according to information from farmers.

A lease contract of pumping facilities is commonly made between the owner and a representative of farmers such as a village chief or a farmer leader, charging Rp. 1,500,000/unit/crop season in 1993. An inventory of pump irrigation facilities and their distributions in the study area are summarized in Table 3.4.1 and Figure 3.4.1.

(2) Drainage condition

There are poor drainage tracts scattered in the study area, since a drainage system has not been developed up to date. The poor drainage tracts are generally located around the confluence of the Gilirang river and its tributaries. Because of the gentle gradient of the Gilirang river, the drainage conditions along the riparian tracts of its tributaries are greatly affected by the water level of the Gilirang river; the conveyance capacity of the tributaries themselves are extremely insufficient, and may cause flooding in the surrounding tracts.

In addition to excess runoff from upper basins, low-lying coastal belts near the sea such as Akkajeng and Doping are greatly influenced by tide when peak runoff meets high tide. According to the farmers interview, the frequency of flood which causes one-day inundation occurs once a year, and 2-3 days continuous inundation happens once every 2-3 years. The damages to crops by inundation depend on the kinds of crops, their growing stage, and depth and duration of inundation. In order to minimize the depth and duration of inundation, an improvement of the drainage system is essential in this coastal area. There are six (6) typical poor drainage areas with a total area of 810 ha in the study area; details and their locations are summarized in Table 3.4.2 and Figure 3.4.1.

3.4.2 Transportation

There are three (3) categories of road in the study area, i.e. Provincial, Kabupaten, and Desa road. The provincial road is maintained by DINAS PU Binamarga and the Kabupaten road by PUD (Pekerjaan Umum Daerah), and the Desa road is the responsibility of each Desa authority.

(1) Provincial roads

Three (3) provincial roads are networked in the study area. The first one is Paria-Attapange-Sakkoli road which is connected to Sengkang with a total length of 20.5 km within the study area (the distance from Sengkang to Paria is 23.5 km). The second one starts at Sengkang and extends to Tarunppakkae in the study area through Anabanua and Poleonro. The length of the road totals about 3.8 km within the study area. These two (2) roads are asphalt-paved and well maintained. The third one runs from north to south along the eastern border of the study area via Jalang and Doping with a total length of 22.0 km in the study area. This road was recently promoted to provincial road and is now under going up-grading works.

(2) Kabupaten roads

There are three (3) Kabupaten roads in the study area. The first one connects Attapange to Doping traversing the southern boarder of the study area; its length totals 16 km. The second one connects Jalang to Tobulelle through Allopporeng; its length totals about 13.7 km. The third one originates at Paria and extends to Gilirang via Laerung and Poleonro with a total length of 10.5 km. All Kabupaten roads have low grade paved and are poorly maintained, so they are nearly all weathered. According to Kantor PUD, all the Kabupaten roads mentioned above are included in the maintenance program in 1994/1995.

(3) Desa road

There are five (5) main Desa roads in the study area as summarized below:

List of Desa Roads in the Study Area

	Passage Village	Length (km)
1.	Gilirang - Arajang	5.5
2.	Pantoe - Sarammae - Allapporeng	8.3
3.	Bottodonga - Benceng-2 - Padewakeng	9.5
4.	Sarammae - Bacubacue	5.5
5.	Laerung - Bottodonga	3.5
	Total length	32.3

All the above Desa roads are unpaved and in poor condition, passable only by 4WD vehicle in the wet season. However, their importance is very high at present for the local farmers. The details of the road conditions and locations are shown in Figure 3.4.2.

3.4.3 Electrification

PLN distribution lines of 20 Kv are networked in and around the study area. As shown in Figure 3.4.2, PLN electricity supply service covers almost all the villages along the Provincial and Kabupaten roads in the study area. The user's percentage of PLN service among total families in the study area is only 32% at present. The PLN service for the remaining villages along Desa roads is programmed as to be supplied in 1994/95 fiscal year.

Besides the PLN electricity service, there are small scale private electricity supply services at

the village level. They supply electricity to about 20 to 40 households usually at night. Including the village electricity services, the electrification rate in the study area is estimated at about 50%, based on the results of the household survey.

3.4.4 Water Supply

The people in the study area generally depend on wells and rainfall for their drinking and domestic water. Almost all houses have concrete storage water tanks with a capacity of one (1) m^3, together with a roof catch for water harvesting. However, the people are faced with difficulties in obtaining clean water, particularly in draught years. In the eastern area along the coast such as Doping and Akkajeng, the water has a high content of salt forcing people to buy drinking water at cost of Rp. 150/20 liters for their daily use. The people in the upper stream of the Gilirang river obtain their domestic water by digging holes at riparian sites.

(1) Piped water supply

A piped water supply system has been in operation since 1985 in the study area at Ciptakarya. There are five (5) systems at present; the system at Attapange is operated by PDAM collecting a water charge of Rp. 250/m^3; the other four (4) systems are operated by respective Desa authorities without collecting water charges, but they have ceased operation at present due to a lack of operation and management techniques. It is therefore scheduled that the operation and management for the remaining four (4) systems will be transferred to PDAM in the near future. The system in Attapange was constructed in 1985 and serves 250 families; it is equipped with 5 lit./sec. of pumping capacity and two (2) to four (4) inches diameter pipe line for a total length of six (6) km. The water source of the system is a spring with a check dam in Tengnga. The pumping unit is operated for five (5) hours per day. The PDAM has an extension plan for the system, targeting a further 200 beneficiary families by providing 10 km of pipe line and an additional deep well. Figure 3.4.2 illustrates the location of the present supply system.

(2) Well

There are 36 wells supported by DINAS Kesehatan (Public Health) and 13 wells by Bangdes (village office). They are deep tube wells with hand a pump and shallow dug wells with or without hand a pump depending on the hydro-geological conditions. According to an Public Health officer, clean drinking water is very important for reducing diarrhea which is very common in the study area, and the least requirement is one well per 10 families. Because of budgetary constraints, however, the total number of wells in the study area is far below this minimum requirement.

3.5 Present Condition of Agriculture

3.5.1 Present Land Use

The lands in the study area are classified into seven (7) land use categories, comprising paddy field, upland field, orchard, grass land, bush/forest, fish pond, and villages. The present land use in the study area is summarized as shown below:

Present Land Use in the Study Area

Land Use	Area (ha)	Distribution(%)
Paddy field	15,800	62.5
Upland field	1,000	4.0
Orchard	2,900	11.5
Grass land	1,400	5.5
Bush/Forest	2,000	7.9
Fish pond	1,200	4.7
Villages	1,000	3.9
Total	25,300	100.0

Paddy fields totaling 15,800 ha are developed on the alluvial plain and riverine terraces along the Gilirang river and its tributaries. Upland fields of about 1,000 ha extend mainly around the village areas, relatively elevated lands, and slopes. These are presently used for the cultivation of maize, cassava, sweet potatoes, etc. Orchard of 2,900 ha are sporadically located around the village areas and isolated hills, and are cultivated with coconuts, banana, mango, cashew nut, etc. The remaining 5,600 ha are grass land, bush/forest, fish ponds, and villages. The present land use in the study area is illustrated in Figure 3.5.1.

3.5.2 Present Cropping Pattern

The present cropping patterns in the paddy fields (15,000 ha in net)[1] in the study area are illustrated in Figure 3.5.2 based on data and information obtained from the agricultural services in Kab. Wajo and the three related Kecamatans, and farmers.

Cultivation of paddy is predominant in the study area. Nearly 100% of wet season paddy is cultivated under rainfed conditions even in the pump irrigation schemes. Palawija crops are usually cultivated in the dry season, although the extent of the area is small. Major palawija crops in the study area are groundnuts, mungbeans, maize, and soybeans. The extent of these cropping patterns and cropping area, by each crop are estimated as follows:

Extent of Cropping Pattern in the Study Area

Type I	:	Single cropping of Paddy	12,180 ha
Type II	:	Paddy - Paddy	640 ha
Type III	:	Paddy - Palawija	1,430 ha
		Total	14,250 ha

Note: An assumed 5% of damaged area due to drought, flood, and pest/diseases is deducted from the above figures.

Cropping Area for Major Crops in the Study Area

1) Wet season paddy	14,250	ha
2) Dry season paddy	640	ha
3) Dry season palawija	1,430	ha
Total	16,320	ha
(Multi-cropping intensity: 115%)		

[1] Gross paddy field x 95% = 15,800 ha x 0.95 = 15,000 ha (excluding roads, etc.)

3.5.3 Farming Practices

Based on the data from Kabupaten and Kecamatan Agricultural Services, BPP offices, and the results of the household survey, farming practices for paddy and palawija grown in the study area are estimated as follows:

Farm Inputs by Crops in the Study Area

		Paddy					
		Wet*1	Dry*2	Maize	Mung-beans	Soy-beans	Ground-nuts
1) Seed	(kg)	30	30	20	20	40	120
2) Fertilizers							
- Urea	(kg)	183	183	-	-	25	40
- TSP	(kg)	32	32	-	-	100	60
- KCl	(kg)	3	3	-	-	25	-
- ZA	(kg)	54	54	-	-	-	-
3) Agro-chemicals*3							
- Liquid type	(lit.)	0.48	0.48	-	-	1.5	-
- Powder type	(kg)	1.1	1.1	-	-	-	-
4) Labor	(man-day)						
- Family Labor		57.3	60.3	76.0	36.0	45.0	49.0
- Hired Labor		24.9	24.9	-	19.6	24.5	32.0
6) Animal Power	(day)	2.04	2.04	4.35	5.22	5.22	12.43
7) Mech. Power	(day)	2.03	2.03	-	-	-	-

*1 Rainfed paddy *2 Irrigated by pump *3 Mainly insecticides
Source: 1) Household Survey, JICA Study Team, 1994
2) Laporan Analisa Usahatani Padi, Palawija dan Hortikultura 1993/94, DINAS Pertanian Tanaman Pangan, Propinsi Sulawesi Sulatan.

Farm inputs for paddy are examined to be advanced with the application of considerable amounts of fertilizers and agro-chemicals. Input supplies for palawija cultivation are generally small compared with those for paddy. For the paddy cultivation, exchange of labor among the farmers is common for transplanting, and harvesting is carried out on a contract basis. Use of a two-wheel tractor is common for land preparation together with animal power. Since the farm road network is not sufficiently available in the study area, transportation of harvested paddy from field to home yard is one of constraints to the present farming. The farmers usually hire animal power (horses) for this with a considerable amount of cost estimated to be Rp. 13,000/ton.

3.5.4 Crop Yield and Production

The present crop yield and production in the study area are estimated on the basis of the result of the household survey as follows:

Crop Production in the Study Area

	Harvested Area (ha)	Yields (ton/ha)	Production (ton)
1) Wet season paddy	14,250	3.0	42,800
2) Dry season paddy	640	4.0	2,600
3) Palawija*1	1,430	0.9	1,300

*1 Average yield of groundnuts, mungbeans, and soybeans.

Crop production in the study area often suffers serious damage from drought. For instance, the drought in the 1992/93 crop season inflicted considerable damage on the paddy cultivation in three Kecamatans related to the study area. As shown in Table 3.5.1, about 20% of total planted area of paddy was not harvested due to drought damage in 1992/93. In the same crop season, palawija crops also sustained a great deal of damage from drought.

3.5.5 Livestock Production

The livestock grazed in the study area are cattle, water buffaloes, horses, goats, sheep, chickens, and ducks. Average heads per farm household in the study area are summarized as follows.

Raising Head of Livestock per Farm Household

Livestock	Head per Farm Household
Cattle/cows	0.75
Water Buffaloes	0.67
Horses	0.25
Goats/Sheep	0.14
Chickens	9.11

Source: Household Survey, JICA Study Team, 1994
Agricultural Census 1993, Statistical Office, Kab. Wajo

Livestock raising in the study area is not an important of agricultural activity, and most livestock are grazed on a small scale in and around the farm land and home yard, except for one private company. Annual income derived from livestock raising is of little significance to the farm economy. As far as livestock raising in the area is concerned, however, it plays an important role not only in farm operation but also in protein food supplies for local people. The cattle and water buffaloes are usually utilized as power in land preparation, and live goats, sheep, chicken, and eggs are sold in the local markets or used for home consumption. In addition, horses are raised by both farmers and non-farmers, and utilized as an important transportation measure for farm products.

3.5.6 Fishery

Fish culture in brackish water ponds are the most important fishery sub-sectors in the 3 Kecamatans related to the study area, and account for about 81% of the total production value of the fishery sector. In terms of per capita production value, brackish water ponds account for Rp. 0.98 million followed by marine fishery (Rp. 0.16 million) in the 3 Kecamatan.

Brackish water ponds extend along the coast of Bone bay, and the total area is about 4,385 ha in Kec. Sajoanging which is the only Kecamatan with a coast related to the study area. Production from brackish water ponds is about 4,750 tons with 1.08 tons/ha of unit yield in 1992. This amount of production accounts for 43% of the total production in Kab. Wajo and 4.6% in South Sulawesi Province. During the 1988-1992 period, the annual increase of area, production, and unit yield was calculated at 6.3%, 12.4%, and 0.9%, respectively. The number of brackish water pond establishments (or fish farms) in 1992 was about 580 with a small annual increase of 2.7% during the 1988-1992 period. On an average in 1992, production value per establishment was estimated at Rp. 22.6 million in the brackish water pond sub-sector.

According to information from the fishery services of Kab. Wajo, major species cultivated in brackish water pond are milk fish and shrimp (black tiger). Mixed cropping of these two species is common under extensive farming. Double cropping is also common; the first season is from April to September, and the second season is from October to March. Damage is sometimes done to the fish culture in the brackish water ponds due mainly to high temperature of water and high density of sea water. According to the information from fish farmers, no production is performed in two out of five crop seasons on an average. Fresh water from rivers is essential for the shrimp farming, but not so important for milk fish farming.

3.5.7 Marketing and Processing

(1) Marketing of agricultural products

The institutional framework for implementing intervention in the marketing of food crops with the objectives of fostering production and expanding farm incomes are comprised of BULOG (National Logistics Agency) at a national level and DOLOG (Regional Logistics Deport) at a provincial level. Under DOLOG, a Sub-DOLOG at the Kabupaten level is supposed to purchase selected food crops including paddy/rice, soybeans, and maize in the producing areas and provide storage facilities for collection. Under the marketing system of DOLOG, KUDs play an important role as village collection centers.

There are three channels in paddy/rice marketing from farmers to consumers. The surplus from farmers is sold to KUDs and/or middle men through brokers. The paddy collected by KUDs is sold to Sub-DOLOG usually after milling, while the paddy collected by middle men is generally transported outside of the Kabupaten, mainly to Ujung Pandang and Pare Pare. Most of surplus is marketed through these two channels. A small amount of surplus is sold at local markets in and around the study area by small brokers and/or directly by farmers. According to data from Sub-DOLOG in Kab. Wajo, collection made by KUDs-DOLOG line Kab. Wajo is about 15,500 tons (in terms of rice) or about 11% of the Kabupaten's surplus.

In addition to the marketing activities, DOLOG is responsible for price stabilization of rice and principal palawija in the market. DOLOG generally purchases these crops when the market price falls below the floor price, and when the price is over the ceiling price, DOLOG sells its stock. At present, DOLOG in Kabupaten Wajo only controls the rice price.

(2) Distribution of farm inputs

In corresponding to the strengthening of intensification programs, the use of farm inputs such as fertilizers and agro-chemical have increased and the supply system of farm inputs has been established in the province. In the system, supply of fertilizer is the responsibility of PT. PUSRI in the province. PT. PERTANI also handles the supply of farm inputs including seeds, fertilizers, and agro-chemicals. Distribution of farm inputs to farm level is done through a KUD Kiosk or by local distributors. The Food Crop Agricultural Service Office also takes responsibility for the seed supply, and all seeds handled by this agency are marketed through the present extension system. In South Sulawesi Province, there is a seed center located at Maros, and this center is responsible for seed production.

Presently, there are no serious constraints to farm input supply in the province as well as in Kab. Wajo. Input supply usually depends on self-financing of farmers. Input supply under the credit of an intensification program is not common in Kab. Wajo.

(3) Processing and Storage Facilities

The processing and storage facilities for paddy/rice are fairly well arranged in Kab. Wajo as well as in the study area. The number of rice mills in Kab. Wajo is 350 of which 88 are located in the study area . About 95% of mills are private both in Kab. Wajo and the study area, and KUDs operate only the remaining 5%. The total milling capacity is estimated at about 357,700 tons/year in Kab. Wajo and about 78,000 tons/year in the study area as shown below:

Rice Milling Capacity in the Study Area and Kab. Wajo (1992)

	Study Area			Kab. Wajo		
	(No.)	(ton/day)	(ton/Yr)	(No.)	(ton/day)	(ton/Yr)
KUD	4	25	7,300	18	63	18,396
Private	84	242	70,664	332	1,162	339,304
Total	88	267	77,964	350	1,225	357,700

Note: 292 days of annual operation days are assumed for the estimate of annual milling capacity.

Since annual paddy production is 45,400 tons in the study area and 355,000 tons in Kab. Wajo (average of recent five years), the above estimated milling capacities are assessed to be sufficient and possible to mill all the paddy produced in the study area and in Kab. Wajo respectively.

Storage capacity of the existing warehouses is 35,000 tons (with 93 facilities) in the study area and 130,500 tons (with 376 facilities) in Kab. Wajo. These available capacities are assessed by comparing against the required storage capacities for wet season paddy production, for which maximum storage capacity is considered to be required.

Present Storage Capacity Compared with Required Storage Capacity

		Study Area	Kab. Wajo
1. Existing Storage Capacity	(ton)	35,000	130,500
2. Marketable Surplus			
a. Wet season production	(ton)	42,800	305,300
b. Farm population	(prn)	33,000	269,500
c. Per capita consumption *1	(kg)	242	242
d. Total consumption	(ton)	8,000	65,200
e. Marketable surplus	(ton)	34,800	240,100
3. Required Storage Capacity			
a. Marketable surplus	(ton)	34,800	240,100
b. Period for collection	(day)	45	60
c. Period for shipping	(day)	120	120
d. Required capacity *2	(ton)	21,800	120,000
4. Balance (1 - 3.d)	(ton)	13,200	10,500
(1 / 3.d x 100)	(%)	160.6	108.8

*1: Assumed that farmers keep their paddy for their annual home consumption including use for seeds and losses.
*2: (3.a / 3.b) - (3.a / 3.c) x 3.b

As seen in the table above, the existing storage capacity in the study area is assessed to be sufficient to store all the marketing surplus and is about 1.6 times larger than the required capacity. In Kab. Wajo, the existing capacity is slightly larger than the required capacity.

3.5.8 Land Tenure and Land Holding

From the result of the household survey, the average land holding size in the study area is estimated at 2.95 ha, out of which paddy field accounts for 2.34 ha. This average size of land holding is larger than that of Kab. Wajo (2.33 ha) and the whole province (1.34 ha). The land holding size and tenurial condition of the typical farmer are summarized as follows.

Land Holding Size and Tenurial Condition of Typical Farmer

		Own (ha) (1)	Rented-In (ha) (2)	Rented-Out (ha) (3)	Net Holding (ha) (1)+(2)-(3)
1)	Irrigated sawah	-	-	-	-
2)	Rainfed Sawah	1.27	1.27	0.20	2.34
3)	Upland	0.04	-	-	0.04
4)	Tree crops land	0.38	0.01	-	0.38
5)	Grass land	0.07	-	-	0.07
6)	Others	0.14	0.01	0.04	0.11
	Total	1.90	1.29	0.24	2.95

*1 Average annual income of households in the whole samples.
*2 Average figure of land rent per ha.

3.5.9 Farm Budget

The farm budgets of typical farmers in the study area are analyzed based on the results of the household survey. The land holding size of a typical farmer is set at 2.34 ha of paddy field and 0.42 ha of upland and orchard. The result of the analysis is shown in Table 3.5.2 and summarized as follows:

Farm Budgets of Typical Farmers in the Study Area

(Unit: Rp. 1,000)

Item	Rainfed Area	Pump Irrigation Area
1) Gross Income	3,028	5,818
- Farm Income	2,237	5,405
Paddy	2,237	5,219
Palawija	192	-
Perennial crops	186	186
- Off-farm Income	237	237
- Others	176	176
2) Gross Outgoing	2,800	4,299
- Production Cost	1,560	3,059
- Living Expenses	1,237	1,237
Food	718	718
Other than food	519	519
- Loan Repayment	3	3
3) Net Reserve	228	1,519

*1 Crop budget used in the analysis is shown in Table 3.5.3.

By reading the tables of farm budgets, characteristics of the farmers' economy in the study area are summarized as follows:

1) More than 70% of the gross income is derived from paddy production, and the share of income from upland and perennial crops in the gross income is comparatively small.

2) About 4 to 8 % of the gross income is derived from off-farm income consisting of wages earned from non-farm activities, working in urban areas, or in other rural areas, etc.

3) The food expenses amount to 58% of total living expenses.

4) The net reserve of the rainfed farmer is negligible, while farmers using a pump irrigation system have a good balance of over Rp. 1.5 million per annum.

It can be concluded that the rainfed farmers who are the majority in the study area (more than 95% of total farmers) have no or a little re-investment funds for improving of their farming activities.

3.6 Agricultural Support Services

3.6.1 General

Agriculture development has long been the priority government policy in Indonesia and a number of government and non-government institutions have been organized to support the development at various administrative levels.

The key agencies for agricultural development in the province are Provincial and Kabupaten Food Crop Agricultural Service Offices (DINAS). The Provincial Office comprises of an administration section and seven subdivisions (Sub-DINAS) for planning, food crop production, horticulture crop production, farm management, plant protection, extension, and aerial development.

3.6.2 Mass Guidance Agricultural Intensification Program (BIMAS Program)

BIMAS Program is one of the strongest administrative supporting services for agricultural development in Indonesia. The objectives of the program are to accelerate agricultural development through the establishment of a group guidance program. Since the first trial was implemented, the program has steadily developed in the whole country and has been modified and improved year by year. The latest program is the super group guidance intensification program called SUPRA INSUS Program implemented in the selected provinces since 1987. The introduction of the SUPRA INSUS Program to the South Sulawesi commenced in 1987.

The BIMAS Program presently implemented in South Sulawesi is SUPRA INSUS, INSUS, and INMUM. The objective crops of the program include paddy, palawija crops, and vegetables, however, the priority crops at present are paddy, maize, and soybeans. SUPRA INSUS is applied for a unit of a number of farmer groups in the same irrigation system with areas of 15,000 to 35,000 ha. INSUS is a program for farmer groups and INMUM is for individual farmers.

For successful implementation of the BIMAS Program, a BIMAS Committee chaired by the Governor and a BIMAS Daily Executive Committee chaired by the chief of the regional agricultural office are organized at a provincial level. At Kabupaten, Kecamatan and village level, BIMAS coordination committees chaired by the head of a respective administration unit is also organized to strongly support implementation of the BIMAS Program.

3.6.3 Agricultural Research

Agricultural research in South Sulawesi Province is covered by the Maros Research Institute located about 40 km north from Ujung Pandang. The main activities are to execute experimental work under the instruction and supervision of CRIFC, and to collect information from extension services on the technical problems associated with the farming practices of local farmers.

The technology development by the research institute is formulated into "packages" of improved technology and envisaged to be transferred to extension services through the Food Crop Agricultural Service Offices and the Estate Crop Service Office at different levels. The extension services then transfer the package technology to the farmer levels by offering

guidance to key farmers. However, in the present technical research and development system, all the results obtained through research activities in the province are firstly reported to the central institute and considerable time is required for the findings to reach extension service levels.

3.6.4 Extension Services

One of the strongest supporting arms for the implementation of the BIMAS Program is the agricultural extension service. At the Kabupaten level, the Kabupaten BIMAS Office under the direct control of the Provincial Secretariat of the BIMAS Committee is in charge of budget arrangement and personnel management of the extension service including the Rural Extension Center (BPP). Technical recommendation and guidance are prepared by service offices of Kabupaten under the technical guidance of the service office of the province. In general, the chief of the Kabupaten Food Crop Agriculture Service Office is appointed as the chairman of BIMAS Daily Execution Coordination Committee and the chairman of the Forum on Agricultural Extension Coordination of the Kabupaten simultaneously.

Agricultural extension staff consist of two kinds, Subject-matter Specialist (PPS) and Field Extension Worker (PPL). PPS is working at the provincial level office or stationed in the Kabupaten. PPL is stationed at the Kabupaten BIMAS office, BPP and, service area of PPL (WKPP).

Extension services to the farmer level are carried out by extension staff in BPP. There are 130 BPPs established in South Sulawesi. The extension service area covered by each BPP differs, but about 10,200 ha or 7,600 farm households per BPP is average. The number of BPPs in Kab. Wajo is five of which three are located in the related three Kecamatan, Sakkoli, Doping, and Anabanua. The service area per BPP in Kab. Wajo is larger than the provincial average; about 15,700 ha or 11,100 farm households per BPP in average.

The number of PPLs in the province totals about 1,800, 73 %, for food crops and 16 % for estate crops. Extension activities employed in the province include PPL daily activities, training course for the chief of farmer groups, demonstration of plot operation, field visits, radio broadcasting, cultivation trials, publications, etc. Among these, the first three are the major activities.

The daily activities of extension workers are carried out under the training and visit (TV) system. WKPP of each PPL is divided into 16 farmer group areas with one key farmer as a leader. Each PPL has to visit every key farmer group twice a month, two groups a day, and WKPP four days a week. In addition, PPL is requested to attend BIMAS Daily Execution Coordination Committee (POSKO) at the farmer group level, held once every two weeks, as technical adviser.

Training courses for the chief of farmer groups are held at the provincial level and at Kabupaten levels. The provincial government training course is held three or four times a year in general and participants to the course are selected chives of farmer groups . The number of training courses held in Kabupatens differ depending on the districts, however the course is held at least once a year.

Status of Extension Service in Related Kecamatan and in Kab. Wajo

	BPP (Person)	PPS (Person)	PPL (Person)	No. of Kontak Tani (No.)	No. of Demo Farm (No.)
1) Three Kecamatan Related to the Study Area	3	-	24	287	-
2) Kabupaten Wajo	5	3	82	864	-

Source: Agricultural Service Office, Kabupaten Wajo.

In addition to the above activities, the Government is now carrying out extensions by the use of mass media such as radio and television broadcasting. This is an ideal system. The farmers can easily receive the latest and various information through these radio and television broadcasts. The number of televisions owned at present is low but is generally increasing. After completion of the project, a lot of farmers will have television along with other improvements in their living standard. In this case, they will have more detailed visual information.

As indicated above, the extension system in the province is considered to be fairly well established. However, the technical background of extension staff and extension materials are limited particularly for palawija and vegetable crops and accordingly extension activities for these crops are weak in general. For PPLs, chances to brush up their technology are considered to be limited at present, although some training courses are held.

3.6.5 Agricultural Credit

The Indonesian People's Bank (Bank Rakyat Indonesia; BRI) is the state bank specializing in agricultural credit covering the whole country, and authorized to finance the credit of crop intensification programs for qualified individual farmers. In order to provide an efficient loan service, BRI has established a broad network consisting of regional offices, branch offices, and sub-branch offices (BRI Unit Desa or Village Unit BRI).

At present, there are 3 kinds of credits, i.e. i) Keredit Usaha Tani (KUT), ii) KUPEDES, and iii) KPP.

In the Kecamatans related to the study area, BRI operates three Village Unit Branch Offices located at Jalang, Attapange, and Anabanua, respectively. A total of seven KUDs is also organized in the study area. However, credit programs are inactively operated in the study area, and credit has not been disbursed to the farmers and KUDs in Kab. Wajo, since the 1991/92 season. The Provincial Agriculture Services Office, South Sulawesi and PT. Pusuri, Sengkang reported this is only for Kab. Wajo, and farmers and KUDs in other Kabupaten still receive agricultural credit services from BRI. Major reasons for this inactive credit are attributable to the poor repayment capabilities of farmers and their attitude to loan repayments.

At present, BRI has a plan to start agricultural credits to KUDs in Kab. Wajo from 1994/95 crop season.

3.6.6 Agricultural Cooperative

According to the Law on basic regulations for cooperatives enacted in 1967, the Government has been promoting the establishment of a multipurpose primary agricultural cooperative "Koperasi Unit Desa (KUD) at the village level to support agricultural development. A village-level development unit of about 600 ha to 1,000 ha of lowland rice field may be represented by a KUD. In South Sulawesi, 496 KUDs have already been established, of which 28 KUDs are located in Kab. Wajo and 7 KUDs are available in the study area. The status of KUDs in Kabupaten Wajo and three the Kecamatans related to the study area is presented in Table 3.6.1. The total number of KUD members is 4,622 or about 50% of the total farm households in the study area.

Figure 3.6.1 shows the typical organizations of KUDs in the study area. A KUD comprises a congress, board, adviser, audit, and executing body headed by a manager. These are summarized as follows.

1) Congress (General Meeting): The congress is held basically once per year, and all of

the activities, accounts, and its auditing reset are reported to the members.

2) KUD Board: The board comprises five (5) members, i.e. chairman, vice chairman, secretary, vice secretary, and treasurer. The board is responsible for the appointment of a manager, supervision of the executing body, preparation of basic management and operation plans, and arrangement of congress.

3) Executing Body: The executing body consists of several business units/sections which tend to differ in KUDs depending on their management policies. The basic units which commonly exist in all KUDs are three (3) units, i.e. KUT, marketing of paddy, and collecting of electric charges. The KUT unit also sells farm inputs such as fertilizers and agro-chemicals. In most cases, KUDs are a collecting agency of PLN and a selling agency of PT. Pusuri. Apart from these basic units, some KUDs have several business units such as rice milling, handling of cloves, and a rental service for irrigation pumps.

KUD has four financial sources; i) handling charge of paddy from DOLOG, ii) handling margin of farm inputs from PT. Pusuri, iii) collecting margin of electric charge from PLN, and iv) KUT margin from BRI. In addition are profits from other business mentioned above. In general, KUD activities have performed well in regard to these financial sources. KUDs in the study area, however, have financial problems because their specific backgrounds stagnate agricultural production. Even though cooperatives are well established institutionally, they can't be expected to achieve progress without development of their economic background.

KUD activity is on a nation-wide scale, and a federation has been established by each administrative level. The Cooperative Office (Kantor Departemen Koperasi dan PPK) provides various support to the KUD, such as training leaders, financial support, and legal services.

3.6.7 Cooperatives and Associations related to the Project

The agricultural development activities in the rural area are closely connected with the social and cooperative activities from other fields including, the Village Community Resilience Board (Lembaga Ketahanan Masyarakat Desa, LKMD) and the Household Skills Education (Pendidikan Kesejahteraan Keluarga, PKK).

LKMD is established only at the Desa level, and its chairman is the Kepala Desa (village chief). The objectives of LKMD are to activate and strengthen the village community and to improve social life and welfare. Under three leaders (a chairman and two vice chairmen), LKMD's various activities cover, education, environment, economic and cooperative development, health and family planning, sports, and social welfare. LKMD also supports the activities of cooperatives and associations such as KUDs and water user's associations (P3A).

PKK is a nation-wide women's association. The main objective of PKK is to promote the participation of women in public affairs to improve their social position. As shown in Figure 3.6.2, the organizational structure of PKK is established at each administration level. PKK at Desa level is further classified into three levels, i.e. Dasa Wisma (a group of 10-20 households), Rukun Tetangga (RT including several Dasa Wisma), Rukun Warga (RW covering several RTs). In general, the wife of each administrative chief is appointed automatically as a chairman of PKK at each level. The Dharma Wanita which belongs to the Bangdes (Rural Development Office) of Kabupaten and Province supports PKKs in their activities. LKMD also provides assistance to PKK at the Desa level.

All women including unmarried are members of PKK with a few exceptions. PKK's various activities include cooking and sewing classes, promotion of cottage industries, and

campaigns for the enlightenment of women's health and sanitation. These funds are covered by the government agencies which are concerned with those activities, because PKK has no fixed financial source. For instance, DINAS Kesehatan (Provincial Public Health Office) provides some financial support for the PKK activities on women's health and sanitation.

3.7 Environment

3.7.1 General

(1) Zoning of the ecological boundary area

Apart from project boundary area, an ecological boundary area is set up covering the whole area of Gilirang catchment area (518 km^2). Major ecosystems included are upper stream primary forest, paddy fields and mangroves. The ecological boundary area is further divided into three (3) areas in order to evaluate positive and negative significant impacts on the living environment at each area as follows:

a) Upper stream rolling area (upper stream area from dam site); Land is hilly and rolling and covered with forest and grass. There are some submerged areas due to the creation of the reservoir.
b) Central plain area (middle stream area from the dam site to the pisciculture zone); Land is low and fairly flat, and has been mainly developed for rainfed paddy fields at present.
c) Downstream coastal area (coastal area along Bay of Bone); Land is developed for pisciculture and the sea coast is covered with mangrove forest.

(2) Wildlife reserves in South Sulawesi

Four (4) wildlife reserves are located in South Sulawesi; Lampuka Mampie Reserve and Latimojong Mts. Reserve in central, and Bantimurung Reserve and Mt. Lampobang Reserve in the south of South Sulawesi. Although Latimojong Mts. Reserve is located northeast of the project area, the area and the surroundings are not included in the Reserve.

(3) Natural vegetation type in Sulawesi

Natural vegetation is dependent on various factors such as climate, altitude, soil water, soil type, and distance from the sea shore. Sixteen (16) types of vegetation have been reported so far in Sulawesi. The forests in the upper stream rolling area are Lowland Monsoon Forest; the forests in the downstream coastal area are Mangrove Forest.

(4) Flora in the ecological boundary area

The vegetation structure of natural forests, riverine forests, production forests, bush areas, and mixed gardens in upper the stream rolling area and central plain area were studied during the field survey. As a result, there are sixty one (61) tree and grass species in the primary forest, secondary forest/bush, forest plantation (roboisari), people production forest, mixed garden, and grassland. Sixteen (16) commercial tree species are included in the 61 species observed.

(5) Forest classification in Sulawesi

Forest in Indonesia can be zoned into five (5) categories, i.e. protected forest, conservation forest, limited production forest, regular production forest, and conversion forest.

Forest in Sulawesi occupies about 53% of total land, consisting of 32% of protected forest, 3% of conservation forest, 11% of limited production forest, 3% of regular production forest, and 4 % of conversion forest. In Sulawesi, the protected forest is located mostly in

areas of 1,000 m or more in elevation.

3.7.2 Lowland Monsoon Forest in the Upper stream Rolling Area

According to the vegetation survey, forest/bush in the submerged area of 1,100 ha is mostly riverine forest of the main stream and tributaries of the Gilirang river, and occupies about 400 ha or 36% of the submerged area. Hills are used as grasslands for cattle grazing. The proportion of forest area increases more in the upper portion of the area. Primary forests around the submerged area are located at the north hill (Lange forest group), east hill (Dulung forest group), and west hill (Karakati Labusa forest area) of Desa Paselloreng. These forests are categorized as limited production forests. Tropical primary forest is very valuable from a viewpoint of bio-diversity and wildlife conservation. Because these primary forests are located at higher elevation than the expected high water level of Gilirang dam (EL. 53.8 m), these forest will not be influenced greatly by negative impacts of the dam construction.

According to the Forest Office in Wajo, reforestation of government forest land is carried on yearly in the northern most are of the Gilirang river. High quality tree species including Teak, Akasia, Albisia, Kemiri, Mahoni, and Johar are being planted for timber production and environmental conservation.

3.7.3 Mangrove Forest in the Downstream Coastal Area

South Sulawesi formerly had about 110,000 ha of mangrove, but 70 % has been converted to brackish water fishpond (tambak) and in 1991 only 34,000 ha remain. There is also a mangrove forest in the downstream coastal area facing the Bay of Bone. The vegetation structure of a mangrove forest is a complex ecosystem composed of more than thirty (30) species of trees and bushes. The forest is rich in wildlife, and important for protecting coastal erosion and river-bank erosion.

Mangroves are observed at the river bank of Gilirang river at Cappabalatue, Desa Akkajeng, Kec. Sojoanging, 7 km from the Bay of Bone. It shows intrusion of sea water. Water quality analysis from this point showed high salinity contents. Mangrove trees contribute to the protection from river bank erosion. Dominant species of mangrove forest complex are changed by the condition of flood (high, low), salinity (high, low), and subtracted (sand, clay, coral). Impact to the mangrove forest by the dam construction will occur externally disturbing the mangrove ecosystem through decrease of water, sedimentation, and mineral supply.

Presently, the Green Belt Plan is on going in South Sulawesi. The Plan aims to a develop 200 m width mangrove belt along sea coast and river bank for environmental conservation. The Forest Office in Wajo has replanted 370 ha of mangrove at nine locations from 1990 to 1994.

3.7.4 Fauna and Endangered Species in the Ecological Boundary Area

Fauna in Sulawesi is one of the most distinctive in Indonesia. Of 127 indigenous mammal species, 79 species or 62 % are endemic. Mammal fauna is characterized by its primitive characteristics. The Indonesian Government has registered 16 animal species in Sulawesi which have become endangered.

Seventy five (73) animal species were found in the ecological boundary area by the field survey and by interviewing villagers. There are seven (7) species of mammal, 32 of bird, 13 of reptile, 13 of fish, five (5) of crustacean, and (3) of mollusk. There are four (4) endangered and law protected species in the 73 animal species; Musang (civil cat), Kera

tonkeana (monkey), Enggang sulawesi (Sulawesi horn bill), and Enggang kecil (small horn bill). These endangered species of fauna will be protected by prohibiting hunting by local people. However, their habitats will not really be affected by dam activity because only a small part of the forest area will be influenced by the reservoir.

3.7.5 Ethnic Groups and Religion in the Project Area

Seven (7) major ethnic groups are recognized in Sulawesi. In Kabupaten Wajo, the Bugis ethnic group, which is of Malay heritage, is the largest; there are no ethnic minorities or nomads in and around the study area. All people in Kec. Majauleng and Sajoanging are Islam and 96 percent of population of Kec. Maniangpajo are Islam while the rest is Hindu.

3.7.6 Fishing Rights and Water Rights in Gilirang River

The Indonesian Water Right stated that the Government shall control water and land for the prosperity of all Indonesian people. There are no fishing rights in Gilirang river. Everyone can catch fish without payment. Also there is no clear water use right in Gilirang river. Every farmer traditionally can use surface water for their paddy fields. Likewise in the downstream, pisciculture fisherman can use water for their fish ponds. Therefore a minimum supply of surface water in the dry season is needed for their traditional water use.

3.7.7 Non-spontaneous Removal of Inhabitants from Reservoir

(1) Present condition in the submerged area

Desa Paselloreng in Kec. Maniangpajo is located in the expected submerged area of the proposed dam. The submerged area is estimated to be 11 km^2 or about 12% of the total area of Desa Paselloreng (88.1 km^2). The largest cluster in Desa Paselloreng is located in the submerged area, and accordingly, the houses to be submerged would be 220 with 995 persons or about 70% of total households (315 households with 1,424 persons) in Desa Paselloreng. Within the largest cluster, public facilities such as village offices, elementary and junior high schools, and mosques are located. Further there are farm lands composed of paddy fields, uplands, and orchards. The list of public facilities in Desa Paselloreng is shown in Table 3.7.1, and the present land use in the submerged area is illustrated in Figure 3.7.1.

(2) Intention of the inhabitants in Desa Paselloreng

Recognizing the necessity for resettlement of the inhabitants in Desa Paselloreng caused by the project implementation, Bupati (Head of Kabupaten) of Kab. Wajo arranged a meeting for discussion of this matter with the inhabitants of Desa Paselloreng on September 20, 1993, before commencement of this study. The discussion meeting was held between the Land Control Office, Kab. Wajo, and 58 representatives of Desa Paselloreng. In the discussion meeting, both parties confirmed that:

a) In principal, the inhabitants of Desa Paselloreng agree to be removed from the reservoir area and dam construction area to be implemented under the Gilirang Irrigation Project, and
b) Location of new land for the inhabitants and amount of compensation shall be arranged and decided by the Government.

In the course of the study, an interview with 25 persons of Desa Paselloreng was carried out on September 23 to 25, 1994, along with an economical survey. Most of inhabitants stated the need of feasible compensation and the wish to move together to one location. Inhabitants were willing to cooperate with the local authority to move to another area.

However, their willingness to move and resettle has to be compensated by the Project or Government. Their proposal consists of the following three items:

a) New resettlement should be located in Lakabatua which belongs to PT Bina Muria Ternak (State Livestock Range Company).
b) The amount of compensation and payment procedure have to be negotiated between inhabitants and the Government. Compensation should be directed to the inhabitants.
c) All graves should be resettled to a site that is easy to visit. Mosques, schools, health centers, and other public facilities should be rebuilt by the Project or Government on the new resettlement site.

(3) Resettlement program

According to the order of the Ministry of Public Works, preparation of a resettlement program is needed for projects which resettle more than 200 households (Menurut Peraturan Menteri PU No. 46/PRT/1990). Following this order, DGWRD requested DINAS PU Pengairan, South Sulawesi Province on September 14, 1994 to formulate a resettlement program for the Project. In practice, the preparation of the resettlement program was carried out by the working team organized in Bupati Office, Kab. Wajo. The JICA Study Team provided relevant data and information to the working team for the program preparation, and explained the outline of the Project in a meeting held among members of the working teams on November 19, 1994 in the Bupati Office.

In the draft of the resettlement program prepared by the working team on December 2, 1994, the resettlement of inhabitants in Desa Paselloreng is programmed to be carried out within the following three options:

a) New employment in private sector plantations planned to be developed in Kab. Wajo,
b) New development of state-owned land near the submerged areas, and
c) Resettlement under a local transmigration program.

In addition, the further steps to be taken by the working team and the Government mentioned in the draft of the resettlement program are as follows:

a) To conduct extension and explanation to the inhabitants in Desa Paselloreng on the planned irrigation project and the resettlement program.
b) To make a physical inventory of Paselloreng village, covering the area by land use categories, number of houses, and public facilities.
c) To determine a new resettlement site under a decree of Bupati of Wajo.
d) To conduct an arrangement with the Ministry of Agriculture, BPN, Ministry of Forestry, PT. Bina Mulia Ternak, and other related parties for the conversion of land status where the proposed site is to be located.
e) To set up a team of related agencies for the implementation of the planned resettlement.
f) To determine proper compensation to the concerned inhabitants.
g) To prepare a site plan for the proposed site so that it will function similarly with that of the former settlement.
h) To provide the necessary infrastructures and facilities such as roads, power lines, water supply, mosques, schools, health services, administration offices, and a village-based institution office.
i) To carry out the resettlement plan in stages.

CHAPTER 4 PROJECT FORMULATION

4.1 Framework of Basic Development Concepts

4.1.1 Constraints for Agricultural Development

The major constraints for agricultural development identified through the assessment on the present conditions in and around the study area are summarized as follows:

(1) Irrigation aspect

1) Wide range fluctuation of annual rainfall year by year,
2) Lack of irrigation water resources during the dry season,
3) Unstable cropping of the rainy season paddy,
4) No comprehensive irrigation system excepting small scaled pumping units,
5) Poor drainage and habitual inundation,
6) Lack of farm and rural road networks, and

(2) Agricultural aspect

1) Population outflow and lack of inheritor of farm household,
2) Difficulty of land preparation due to heavy textured soils,
3) Prevention of transportation of farm inputs and outputs due to poor road networks,
4) Insufficient agricultural supporting services.

4.1.2 Needs of Development

South Sulawesi Province is one of the large rice granaries in Indonesia and plays an important role in supplying rice to other rice deficit provinces mainly in the eastern regions. During Repelita VI and IV period (1994/95-2013/14), it is programmed to develop about 100,500 ha of new irrigated land in South Sulawesi Province to sustain the established self sufficiency of rice.

In the Gilirang Project area, however, paddy is cultivated mostly under rainfed conditions and its productivity is still low. Consequently, the income level and living standard of the inhabitants are low compared with those around the Project area. Around the Gilirang Project area, there is the Sadang Irrigation Project in which double cropping of paddy is widely practiced. In addition, Langkeme and Bila Irrigation Projects are at the construction stage at present for the development of new irrigation systems for about 16,800 ha in total. After the completion of these projects, a further gap in economy will occur between the Gilirang farmers and farmers around the Project area.

In the light of the above situation and the constraints for agricultural development, the Gilirang Irrigation Project is needed to aim at i) sustainment of the established rice self-sufficiency, ii) improvement of the backward regional economy, iii) rectification of income levels among the regions, iv) increase of job opportunity, and v) improvement of living standards.

4.1.3 Basic Concept for Development

The basic concept for development in the Gilirang Irrigation Project would be as follows:

1) Unit yield and production of the wet season paddy should be stabilized and improved through establishment of new irrigation systems and introduction of irrigation farming practices.

2) Planted area of the dry season crops should be increased with a year-round irrigation system.

3) Special attention should be paid to increase the irrigation area up to the potential maximum area in conformity with government policy for equalization, as well as for maximum total benefits.

4) Present drainage conditions should be improved to assure the healthy growth of paddy under irrigated conditions.

5) The present farm road network should be improved and the agricultural activities be increased.

6) Agricultural institutions, which support agricultural development should be strengthened, especially in the field of agricultural extension services.

7) Special attention should be paid to environmental preservation in the Gilirang river basin.

4.1.4 Environmental Consideration

In cooperation with the parties concerned with DGWRD, the initial environmental examination (IEE) was carried out on 47 social and natural environmental components (21 social and 26 natural components). As a result, eight (8) environmental components (4 social and 4 natural components) which will unquestionably suffer significant impact by the Project, and 10 components (6 social and 4 natural components) which are likely to suffer significant impact by the Project were identified. The result of IEE is as shown in Table 4.1.1. In the Project formulation, therefore, special attention should be paid to these environmental components identified in IEE so as to minimize the predicted adverse environmental impacts of the Project.

4.2 Selection of Optimum Project Scale

4.2.1 Assessment of Potential Water Resources

The Gilirang river is the only water source in the study area for irrigation development. The high water season usually starts in April and lasts for 5 months until August and is followed by the low water season from October through March. Annual inflow varies from 76 MCM to 425 MCM at the proposed dam site, an average of 201 MCM, based on the discharge data from 1979 through 1993. The distribution pattern of rainfall also varies year by year. Accordingly, it is indispensable to construct a dam for the effective use of the water resource for irrigation development in this area. Irrigation in the dry season is especially almost impossible in the project area without a storage dam.

4.2.2 Exploitable Water Resources by Dam Construction

For the effective use of water resources, a bigger reservoir is preferred to store extra water for the next dry season. However, the highest crest elevation and the highest water level of the dam is limited to EL. 56.5 m and EL. 50.5 m respectively in accordance with the results of the technical and economical study considering the topographic limitations, as described in Annex 3. The maximum storage capacity is estimated to be 132 MCM under this

condition. The dead storage capacity is estimated at 17 MCM from the sediment transport study. Therefore, the maximum effective storage capacity of the reservoir is 115 MCM.

In addition to the effective storage capacity of the reservoir, runoff from the residual area (61 km^2) between the dam site and the weir site is expected as an additional water resource for irrigation in case the intake weir is constructed downstream of the proposed dam site.

4.2.3 Alternative Cropping Patterns

In order to propose the most suitable cropping pattern for the Project, the following three alternatives are assessed both from technical and economic viewpoints (for details, refer to Annex 6):

a) Type A; Paddy - Paddy
b) Type B; Paddy-Palawija-Paddy
c) Type C; Paddy-Palawija-Palawija
(These cropping patterns are illustrated in Figure 4.2.1)

Through the assessment, Type B pattern is selected for the Project taking the following aspects into account:

1) National and regional agricultural development policy

The recent study made on supply and demand balance of paddy shows that the importance of rice surplus from South Sulawesi Province to other rice deficit regions will increase in the future due mainly to a population increase in these regions as well as in Indonesia as a whole. Moreover, in the regional agricultural development plan, Kab. Wajo where the Project is located is specified as a priority production zone of paddy. Accordingly, the first priority should be given to paddy crop in the proposed cropping pattern. On the other hand, crop diversification is one of the important agricultural policies. With this in view, priority would be given to Type B and Type C patterns in the selection of the proposed cropping pattern.

2) Farmers intention

The results of the household survey show that about 62% of farmers would like to select Type B and 36% would choose Type A. The number of farmers who intend to select other cropping patterns is negligible.

3) Economic and financial return to the Project

In terms of economic prices, the expected net return of paddy per hectare is about 2.6 times higher than that of common palawija. While in terms of financial prices, the expected net return of paddy per hectare is about 50% higher than that of common palawija. The result of this assessment concludes that paddy brings higher benefit than palawija both to national and farmers economy. From this point of view, the selection of Type B would be made.

4) Crop cultivation technology

Type A and Type B patterns are commonly practiced in other irrigation systems near the Project area, while Type C is limitedly practiced because of difficulties mainly in selection of crop seasons and crop growth retardation by double cropping of palawija.

4.2.4 Water Demand

Water demand in the project area is mainly divided into two (2) categories of diversion water requirement; one is for irrigation purposes and the other is for river maintenance flow in which water demand in the downstream reach of the Gilirang river is included.

(1) Diversion water requirement for irrigation purpose

The diversion water requirement for the irrigation purpose is calculated based on the result of the irrigation water requirement study. In case the irrigation water is diverted from the intake weir in the downstream reach of the dam, 10 % of intake loss is assumed for the calculation of diversion water requirement at the weir. This loss is considered as a part of the river maintenance flow.

(2) River maintenance flow

Seasonal and annual fluctuations of the discharge are considerably large in the Gilirang river. Therefore, regulated stable flow from the reservoir is expected to stabilize water use of the inhabitants in the downstream reaches especially in the dry season. The river maintenance flow in the downstream reaches is designed to be a minimum 0.89 m^3/sec, which was the average discharge in the driest half-month (the first half of December) from 1979 through 1993, to attain suitable river conditions for inhabitants after the dam construction.

4.2.5 Assessment of irrigable area

The assessment of irrigable area is made based on topographic and soil conditions and the possible intake system for the irrigation development. As a result, the following three (3) alternative development areas are delineated giving priority to the existing rainfed paddy fields whose soils are evaluated as class II and/or III for paddy and palawija in the soil classification (for details, refer to Annex 4 and Annex 5):

1) The whole potential area of 8,600 ha in net, irrigable by direct diversion from the reservoir and canalization by gravity.

2) The area of 5,880 ha in net, irrigable by construction of an intake weir downstream of dam and canalization by gravity.

3) In addition to 5,880 ha mentioned in 2), a total area of 1,120 ha in net, irrigable by the introduction of small scale pumps for scattered small areas in the elevated hilly land. The total area of 7,000 ha in net; 5,880 ha by gravity and 1,120 ha by pump.

The above assessed possible irrigable areas for the development are summarized as follows:

Intake System	Net Irrigable Area (ha)
a) Direct diversion from the reservoir	8,600
b) Intake from weir	5,880
c) Intake from weir and pump irrigation	7,000