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Development

Small-Scale Irrigation Management Project (SSIMP)

FINAL REPORT
AWO IRRIGATION PROJECT
ENVIRONMENTAL ASSESSMENT

VOLUME I

MAIN REPORT

January 1991

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January 1991

Prepared by

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CHAPTER I

INTRODUCTION

Background

This report has been prepared in conformance with the laws and regulations of the governments of the Republic of Indonesia and the United States of America, as administered by the appropriate agencies in terms of guidelines and decrees.

Indonesian Requirements

The basis for the Indonesian environmental assessment process is Government Regulation No. 29, 1986 (PP 29/1986), as implemented through a series of decrees by the Ministry of Population and Environment. These decrees establish the process whereby a new project is the subject of a Preliminary Environmental Information (PIL) Report (Ministerial Decree No. 49/MENKLH, 1987) and, should the PIL commission so decide, a complete Environmental Assessment (ANDAL) Report (Ministerial Decree No. 50/MENKLH, 1987). In addition to the ANDAL Report, Ministerial Decree No. 50/MENKLH establishes guidelines for the Environmental Management Plan (RKL) and the Environmental Monitoring Plan (RPL).

USAID Requirements

The US Government requirements on environmental planning were first set forth in the National Environmental Policy Act of 1969, extended to US-funded overseas projects by the Foreign Assistance Act Amendments of 1986. The details of the process are set forth in USAID Regulation No. 16. The USAID regulations establish a process similar to the Indonesian PIL process, whereby if a project has been determined to have a potential for significant environmental impact, an environmental assessment (EA) is required, or if it lacks such potential, a declaration of "no significant impact" is made and no further environmental study is required.

Combined Process

Environmental specialists from the Ministry of Population and Environment, Ministry of Public Works, USAID, and the engineering consultant firm, Harza Engineering Company, conferred in April 1988 to evaluate the need for an environmental study for each of the ten proposed surface water projects under the USAID-funded Small-Scale Irrigation Management Project (SSIMP). It was decided that most of the projects had potential for significant environmental impacts. It was further decided that a combined team of Indonesian and American consultants would prepare a single environmental report for each project, structured so as to satisfy each government's requirements and prepared in both Indonesian and English. It was agreed that, although the Indonesian ANDAL is best translated into English as "Environmental Impact Assessment," that the ANDAL is most similar in intent of meaning to what is known in the United States as an "Environmental Assessment".

This report for the Awo Project has been prepared by the SSIMP Technical Assistance Team and the Hasanuddin University Environmental Studies Center, with the support and assistance of SulSel Public Works' Water Resources Division.

Environmental Policy

The governments of Indonesia and the United States have similar policies regarding environmental management. Their attitudes are effectively stated in the preamble to Indonesia's Government Regulation No. 29, as requiring "... within the framework of implementing development with an environmental outlook therein as a deliberate and systematic effort to manage natural resources rationally for sustainable development aimed at enhancing the living standard. Any activity as a rule has its impact on the environment, which shall be predicted at the initial stage of planning, in order ... to cope with any negative impacts and to enhance any positive impact ..." (translation by the Canadian International Development Agency). The US National Environmental Policy Act (NEPA) contains similar language, mandating the inclusion of environmental planning in any action of the federal government that may exert significant environmental effects.

Objective of the Environmental Assessment

The major objective of this environmental assessment is to inquire whether there are any probable major negative impacts of this irrigation project on the environment. Conversely, this report also assesses possible negative impacts of the environment on the function and efficiency of the project. Once harmful effects are identified, a plan is provided to mitigate these impacts.

Scope of Report

As a result of an Environmental Scoping Session held in Ujung Pandang in April 1988, and of subsequent visits to the site by environmental experts, a list of priority issues was developed. This list has been reorganized into four basic categories to reflect the requirements of Indonesia's Government Regulation No. 29/1986. These are: water resources, land resources, biological resources, and socioeconomic and cultural resources.

2'

Information on climate and physiography is also presented, as required by that regulation (PP 29/1986). An account of the scoping session is found in Appendix D to this report.

Methodology

The methodology for each of the four main areas of assessment followed standard research procedures common to the respective disciplines. In brief, they were:

- Water Resources. Streamflow estimates were developed from simulation studies that relied on records of automatic water level recorder readings, discharge measurements and rainfall records. Water quality was based on standard laboratory analyses done at the Analytical Chemistry Laboratory of Hasanuddin University. Water use estimates were based on household interviews.

- Land Resources. Land use definition relied on visual assessment of the study area in conjunction with inspection of available maps and aerial photographs. Details on soils were obtained from soil maps available from the National Board of Land Titles (Pertanahan). The agriculture analysis was based on a series of interviews with farmers and government officials in provincial, district, subdistrict and village offices.

- Biological Resources. The primary methods of investigation of biological resources in the study area were to visually review local conditions, and to interview villagers and officials from relevant sectoral agencies (Departments of Agriculture, Livestock, Fisheries and Forestry). This was supplemented by appropriate published information for the area.

- Socioeconomic and Cultural Resources. This assessment relied on primary and secondary data that included quantitative and qualitative characteristics of the study area population. These data included results of the various "Rapid Rural Irrigation Appraisals" (RRIA's), the Household Survey (HHS), and a number of in-depth interviews with study area villagers and officials from relevant sectoral agencies including Departments of Village Development, Health, Statistics, Public Works, the Regional Development Planning Board, and both the District and Subdistrict administrative offices.

Sponsoring Agencies

This project is jointly sponsored by the Ministry of Public Works of the Government of Indonesia and the Agency for International Development of the Government of the United States.

CHAPTER III

ALTERNATIVES TO THE PROPOSED PROJECT

No-Action Alternative

In the event that the project is not implemented, some advances in cropping intensity might be expected through irrigation schemes at the local level, either by weirs on tributary streams or by privately-owned or village-owned pumps. These improvements probably could not keep up with natural population growth, however, so the younger farmers, unable to obtain sufficient irrigated paddy fields locally, would seek land elsewhere or leave the agricultural sector. Unless some major development were to occur nearby to create markets, it is likely that the Awo area would remain one of subsistence farmers, more or less locked in a low-medium living standard.

The possibility also exists that, with or without the project, colonists will degrade the upper catchment area of the Awo to the extent that flood peaks are steepened and low flows diminished in the main stream. With the project, action might be taken to protect the upper catchment area.

Alternative Irrigation Technologies

Groundwater Utilization

Groundwater depths and quantity have been examined in the Awo service area. It has been evident that cost and reliability of ground water use are not as favorable as using the abundant river water for irrigation.

Improved Water Management

Water conservation and improved on-farm management are parts of the extension package for the Awo project, but good management cannot provide rain water when the natural supply is unreliable.

Siting Alternatives

Structures

Diversion Weir. The selected weir site has resulted from exploration of several alternatives on the basis of geotechnical considerations, areas flooded, and canal costs. Until late in 1988, the weir was to be placed at a site near the hamlet of Dake, just downstream of an island that divides the river into

5

two channels. The present site, 1.7 km downstream of that point, has the advantage of shortening the supply canal and providing an adequate foundation for the weir. It also has a lesser impact on flooding at Dake. Another site, 1.4 km downstream of the selected site, was also studied, but found to require a lateral dike to prevent flooding several hectares of paddy fields on the right bank. Even with the dike, the weir pool would inundate about five hectares of paddy fields on the left bank. Exploratory drilling downstream indicates that the increasing depth of river alluvium would cause problems if the site were moved farther.

Canals. A single right bank canal to transport all of the irrigation water to the upstream end of the service area, where the left bank would be supplied by bridging the river with a flume is proposed. The cost of such a bridge is relatively high, due to the depth of the river bed gravel and cobble, but the crossing becomes more attractive if combined with a road bridge for access to the left bank. The road crossing is required for effective operation of the system. A separate left bank offtake from the weir is not attractive because of the topography.

Other canal routing alternatives have been evaluated on the basis of economics, reliability, and ability to serve an effective command area. The dimensions of the service area, long and narrow, are dictated by topography and soils.

Auxiliary Structures. The existing access road to the site, which runs through the right bank service area from the Sengkang-Siwa-Palopo road, has been selected as most appropriate and other, new routes would be excessively expensive to construct. A bridge across the Awo for access to the lower part of the left bank is required; otherwise access to the left bank service area will be cut off during rainy season flooding of the Awo River.

Selection of the sites for the construction area and the weir workers' camp will not be final until well into the design of the project. There appears to be an excellent site on high ground on the left bank. Several irrigation system construction camps will be scattered throughout the area. They will be located at sites selected by the contractors.

Service Area. The selection of area to be served by the project has been based on existing land use, topography, and soils.

Scheduling Alternatives

There is basically only one schedule worth considering for a small-scale irrigation project: to bring the entire system on line as soon as possible. The Awo area was selected for priority development among the five South Sulawesi projects because the need for irrigation, hence the reliability of economic return, is the easiest to establish.

The weir and the conveyance system will be constructed simultaneously. Simultaneous construction is preferred as long as the local labor supply is adequate, since project benefits begin to accrue sooner.

CHAPTER II

DESCRIPTION OF THE PROPOSED PROJECT

Type of Project

The Awo Project is a surface water irrigation project with a net command area of about 2,500 hectares.

Location of Project

The project area is located near the east coast of the province of South Sulawesi, Indonesia, about 50 km northeast of the district capital of Sengkang and approximately 260 km from the provincial capital of Ujung Pandang. The project location is shown on Figure II-1. The weir and canal headworks will be on the Awo River, approximately 20 km from its mouth.

Limits of the Study Area

The study area for this environmental assessment consists of the Awo river basin, extending from the headwaters above the weir site to the downstream service area, as well as the coastal area located below the service area. As this project is located within four villages in the subdistrict of Pitampanua, the study area includes the entire land area and population of these four villages. All borrow areas are located near the weir site or the irrigation service area; there are no areas located outside the river basin that are directly affected by the project except for the Eastern Extension Area which generally lies near the coast between the Awo and Keera catchments.

Project Life

The project economic evaluation is based on a fifty-year life span, but with effective maintenance and periodic replacement of mechanical equipment such as gates, an indefinite project lifetime is not unreasonable.

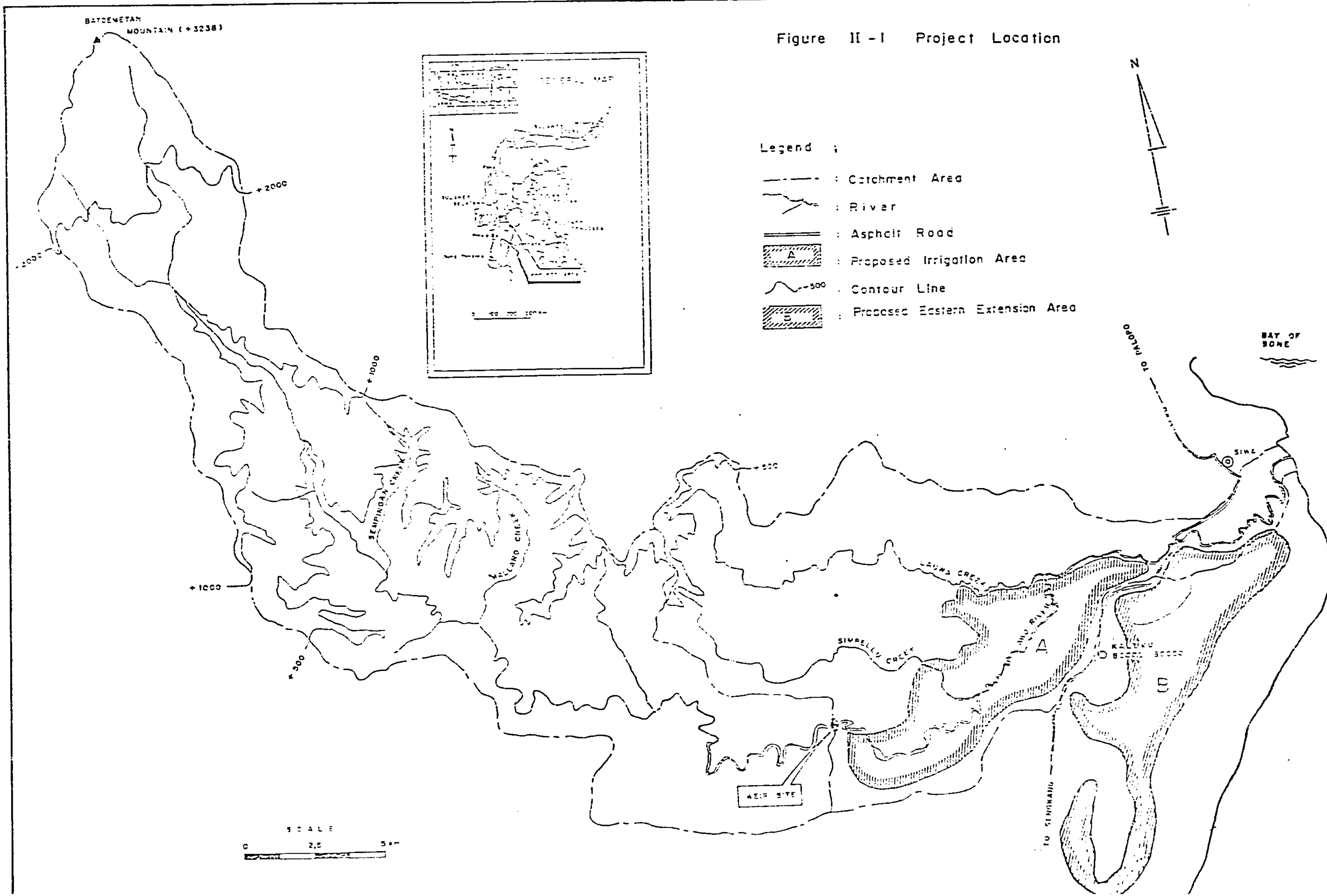

Figure II - I Project Location

Description of the Project

The Awo Irrigation Project is an agricultural enhancement project which will provide a reliable source of water to a 2,500 ha service area in the Awo basin west of the Sengkang/Siwa road. The project design includes provisions for extension to a further 2,200 ha area which lies between the Sengkang/Siwa Road and the coast (the Eastern Extension Area).

Pre-Construction Period

The Awo Irrigation Project was investigated in 1982 when engineers from PU identified potential irrigation areas for locally-funded simple irrigation development schemes. They found that approximately 500 ha of land along the right bank of the Awo River was adequate for that purpose. In fiscal year (FY) 1982-1983, Provincial PU contracted PT GeoACE to design the scheme. The design report, however, revealed another 1200 ha of potential irrigation area that lay along the left bank of the river. Based on that report, in FY 1983-1984, PT GeoACE was again contracted to design a 1,700 ha irrigation area on both sides of the Awo River. PT GeoACE then revised the previously designed gabion diversion weir to a more rigid and permanent masonry weir.

In 1984, an appraisal group from USAID identified potential areas for irrigation development projects in South Sulawesi. The group reviewed the Awo scheme and confirmed that irrigaion development in this area be included as a potential SSIMP site. The USAID Project Paper was completed and the Awo Project was approved for development under the SSIMP loan agreement. In 1988 PT GeoACE was once again contracted to review its previous design with the assistance of the TA Team. PT GeoACE was asked to produce a complete preliminary design of the irrigation system as well as land evaluation and geotechnical investigation. Under this contract, PT GeoACE revealed another possible extension irrigation area of 800 ha on the right bank of the Awo River, so that the total irrigable area was estimated as 2,500 ha.

In May, 1989, Provincial PU contracted for the engineering services of PT Dacrea for a detailed design of the Awo Project for the total 2,500 ha irrigation area. During the course of this work a further 2,200 ha were identified as potentially irrigable. Provincial PU agreed by January 1990 that this "Eastern Extension Area", as it is now called, would merit future investigation, but that construction would not be undertaken using SSIMP funding. In December 1990, PU and USAID agreed to allocate some SSIMP funds to further investigation of the Eastern Extension Area.

Since 1984, there have been a number of economic, social, and environmental investigations of the Awo area. In 1984, a joint USAID and P3SA study group reviewed economic and social issues in addition to technical ones, in the process of selecting the site for inclusion in SSIMP. In 1986-87, P3SA developed a

Site Profile for Awo, based on a "Rapid Rural Irrigation Appraisal" they conducted jointly with USAID. In November-December 1987, USAID and P3SA conducted a Household Survey (HHS). Several subsequent site investigations have been conducted by the Technical Assistance Team's environmental scientists, economist, social scientists and engineers, accompanied by P3SA survey teams. During the same period (1988-90), a great deal of secondary data and information was also compiled.

Construction Period: Project Components

Irrigation Structures: Water Diversion. Water will be diverted from a pool formed by a weir on the Awo River, between the hamlets of Dake and Jonga-Jonga (see Figure II-2). It will be about 6 m high and 62 m long, with a crest elevation of 24 m above sea level. The weir will be constructed of stone masonry consisting of river cobbles in a matrix of mortar. A headworks structure at the south end of the weir will pass water to a sedimentation basin and then to the primary canal. The sedimentation basin will be periodically flushed back to the river via a canal which also functions as an overflow relief bypass. A sluice adjacent to the canal intake will allow for the removal of relatively coarse sediment that settles in the weir pool near the canal intake.

The pool formed by the weir will fluctuate in size according to flow. At the normal surface elevation of 24 m, the pool will extend about 2 km upstream and cover an area of approximately 31 ha. During the five-year flood[1], with about 2.7 m of water depth over the spillway, the pool will extend 2.5 km upstream and cover 66 ha.

Conveyance System. All primary and secondary canals will be lined to reduce seepage, minimize the width of land taken up by the canal, and control canal erosion. The canals will cross the tributary streams on embankments with culverts or on concrete flumes. A single primary canal will carry irrigation flow along the right bank of the river (looking downstream) to a division structure about 10 km from the intake. This canal has a conveyance capacity varying from 7.5 m^3/s at the headworks to 4.6 m^3/s at its last division structure. The average width at the water surface is 9 m and the approximate water depth is 2 m. From the primary canal one secondary canal will carry flow across the Awo River on an 80-m-long aqueduct to irrigate lands on the left bank. This secondary canal system is approximately 10.5 km long with a maximum conveyence capacity of 2.1 m^3/s and a maximum width of 5 m. It provides water to a net irrigated area of approximately 1,300 ha. The left bank canal will follow the north and northwest edge of the existing cultivated area, i.e., the edge of the alluvial lands.

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1. The flood flow that has a probability of one in five of being equaled or exceeded in any year.

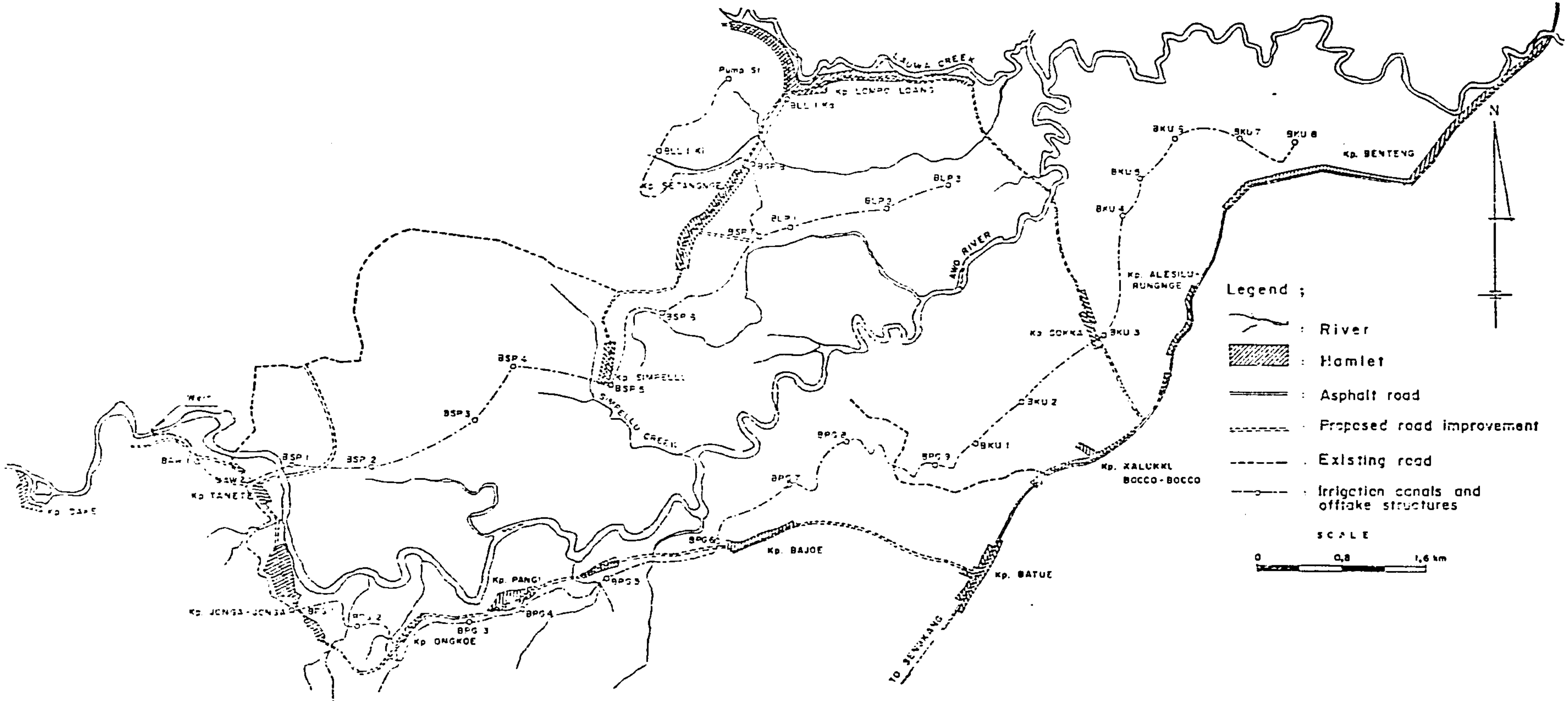

Figure II - 2

PROJECT DETAILS

At the end of the primary canal a division structure will supply irrigation water to a secondary canal which continues eastwards for another 6 km to irrigate the eastern 700 ha of the service area. This canal has a maximum capacity of 1.1 m^3/s and a maximum surface width of 3.5 m.

The remaining 3.5 m^3/s of design capacity in the primary canal is to be used in the future to irrigate the Eastern Extension Area. The 500 ha of service area lying along the primary canal route will be served by tertiary canals fed directly from the primary canal.

Delivery System. The service area is divided into approximately 60 tertiary blocks, each of less than 50 ha. Each of these blocks is supplied by a tertiary canal fed either from the primary or secondary canal system. To provide maximum operating flexibility, the design capacity of each tertiary canal will be sufficient to irrigate each tertiary block as a single golongan. Thus the project golongan system can operate between individual tertiary blocks or within the tertiary blocks. The tertiary canals will be approximately 1 m wide. These canals will generally be unlined.

Quaternary canals will distribute the irrigation water from the tertiary canals to the paddy fields. Those canals will be approximately 0.6 m wide and will be unlined.

Drainage System. The primary drainage system for the proposed scheme will be the existing drainage network consisting of the Awo River and its tributary streams. Some of these streams have had dikes erected by the local farmers to provide supplemental irrigation at present, but this has led to drainage problems. It is proposed to re-open these channels and in some instances to re-route them. About 25 km of new primary drains will also be provided.

Support Facilities: Roads. About 22 km of existing village roads in the project area will be upgraded to all-weather gravel roads, with short new spurs to the river, workers' camps, and borrow areas. These roads will provide access for the construction contractors and will provide permanently improved access to the project area in support of increased agricultural production.

Several new bridges will be included in the road upgrade. One crossing of the Awo River will be constructed as an integral part of the aqueduct for the left bank secondary canal. A second major river crossing will be built on the road between the hamlets of Kaluku, Bocco-Bocco and Setangange. A number of short-span bridges will be built across tributaries of the Awo River.

Buildings. Project offices and housing for the project operating staff will be built in the area.

Construction Period Conditions

Construction of the Awo Project will be accomplished by five separate contractors, under the general supervision of PU. The work will be divided approximately as follows:

Contract No.	Type of Contractor	Work Included
1	Local	Local Roads
2	"	Permanent PU Buildings and Awo Bridge
3	International	Weir and Awo River Aqueduct/Bridge
4	International	Left Bank Irrigation System
5	International	Right Bank Irrigation System

The work is expected to be completed over a period of about two years. The local contracts will be tendered prior to the other contracts so that roads and buildings are available for use by PU and the other contractors as early as possible during the irrigation system construction.

Equipment Use. All equipment used in the construction of the project, from shovels to bulldozers, will be provided by the construction contractors and retained by them on completion of the construction.

Mechanical items, such as gates and hoists, will be purchased from suppliers within Indonesia. Some of these items are manufactured in Ujung Pandang and some may have to be obtained in Java.

Resource Use: Materials. The materials required by this project are relatively simple: cement, stone, sand, earth, and some lumber and plywood for forms and miscellaneous construction.

The estimated volume of each of the main construction materials needed for the project is as follows:

Material	Volume
Cement	320,000 bags
Sand	130,000 m^3
Gravel	2,400 m^3
Stone for Masonry	100,000 m^3
Excavation	400,000 m^3
Fill	190,000 m^3

Excavation and fill materials will be obtained from, and used in, localized areas along the canal alignments. Sand, gravel, and stone will be obtained mostly from borrow areas in and along the Awo River, primarily within the weir pool area.

Cement will be purchased by contractors on the open market at the nearest possible source (probably Pangkajene, where there is a large plant), depending on the economics of price and transportation.

Construction lumber and plywood are available in Palopo and Sengkang, approximately 90 km and 75 km by road from the project area, respectively. Steel reinforcing bars will be brought in from Java, or imported.

Alternatively, construction materials can be obtained through Siwa port, thus reducing the road transportation requirements.

Energy. Energy required will be both electrical, provided by generators on site during construction, and petroleum-based, as diesel fuel for powering vehicles and heavy equipment.

Transportation and Storage. Small stockpiles of materials will be maintained near the weir and other major structure sites, in quantities sufficient for meeting the construction schedule. Materials excavated from the canal will be stockpiled nearby for subsequent use on dikes and roads or where fill is needed.

Waste Disposal. All waste generated by the construction process will be removed from the site, except human waste. Sanitary facilities at the workers' camp will consist of pit latrines. These will be moved periodically and the abandoned pits filled in. Solid waste from the camp will be buried in the vicinity.

Work Force: Characteristics. The work force for the overall project is expected to comprise about 1,000 persons at its peak. About 600 will be laborers; 300 will be drivers, masons, carpenters, and other semi-skilled workers; and the rest skilled workers (such as mechanics, equipment operators, and ironworkers), foremen, and management.

Each contractor will hire his own crews. Due to the dispersed work areas, crews will probably be working concurrently on different structures and different sections of canal or road.

The work force probably will include male and female members. Many laborers on construction projects in South Sulawesi are women, and they can be expected to play a part in hand excavation work and in carrying materials used for masonry canal lining and structures. Most of the skilled and semi-skilled workers are expected to be men.

Source. Laborers and many of the semi-skilled workers are expected to be drawn from the immediate local area. Additional semi-skilled labor, skilled labor, and management personnel will probably move to the area from other areas in South Sulawesi and from construction company offices elsewhere in Indonesia.

Worker Accommodations and Facilities. It is usual in Indonesia for work crews to live at home if recruited locally or to live in temporary shelters adjacent to the work area if they come from a significant distance. There is sufficient land for camps, already cleared and not too steeply sloping, owned by the government or private landholders, and within walking distance of the major structure sites. Several camps are likely to be established by the various contractors because of the dispersed locations of construction areas.

The contractors will either provide rice and fish to the workers as part of their pay or make arrangements with local entrepreneurs to bring those and other commodities to the camps for sale to the workers. Fuel wood will either be provided by the contractor, or some local entrepreneur will sell fuel wood to the laborers. Wood will probably be obtained from colonists in the upper basin.

Some permanent buildings of brick, timber, and concrete will be constructed under the second contract. These will include offices, workshops, and residences for the PU management-level and permanent operating personnel.

Training Program. No training program is planned for the construction work force. The contractors are expected to have, on their staffs or among regular part-time employees, the required skilled and semi-skilled workers for their contracts.

Operation Period Conditions

Division of Responsibilities. Established GOI policy provides that PU assume responsibility for operation and maintenance of diversion facilities, primary and secondary canals, tertiary offtakes, and the first 50 m of each tertiary canal. Water users' associations (WUA's) and their members are responsible for operation and maintenance of tertiary canals, quaternary boxes, and quaternary canals.

PU responsibilities for system operation are at the Cabang Dinas office, which normally covers about 25,000 ha of technically irrigated lands in one or more districts; at the Ranting Dinas office, which normally covers one or more systems totalling about 7,500 ha; and at the Sub-Ranting office, covering about 1,500 ha forming all or part of a system. PU's contact at the WUA/farmer level is the gate keeper who covers several tertiary offtakes and passes information back and forth between farmers and the Sub-Ranting personnel.

The Cabang Dinas office for Awo will probably be in Sengkang or Soppeng, at least one-and-one-half hours drive from the project site. The Ranting Dinas will probably be located in Sengkang initially. Sub-Ranting offices will be at the project site.

Irrigation: Method of Operation. The project is designed to divert water from the Awo River, through the primary and secondary canals, to meet the crop water demands determined for each tertiary block. Water delivery at the tertiary offtakes is normally continuous over a period of time. To limit peak demands of the tertiary offtakes, delivery to blocks within each tertiary unit will probably be rotated on a schedule determined by the WUA. Diversions are typically adjusted every two weeks for projects in SulSel, but shorter time periods may be adopted for the Awo project to improve water use efficiency during drier months.

Diversion amounts and gate settings are typically determined at the Cabang Dinas level. Gate keepers report requests for water for each tertiary to the Sub-Ranting office, where they are consolidated and reported to the Ranting office. The Ranting consolidates Sub-Ranting requests, compares them with the estimated available streamflow, and recommends a diversion rate which is approved or adjusted by the Cabang Dinas. Gate settings for each structure are then determined and passed down to the gate keepers.

Equipment Use. Operating equipment for the system includes primarily the permanently installed, manually operated gates for control of flows. Gate keepers will use bicycles and Sub-Ranting personnel will use motorbikes to inspect the system and keep in touch with users and each other.

Hand tools for routine maintenance, clearing of brush, etc., will be provided to PU staff. Heavy maintenance, such as gate or masonry repairs, will probably be contracted out or performed by special staff of the Ranting or Cabang Dinas offices with access to a pickup truck, welder, hoist, etc. Periodic measurements of flows, water quality, etc., will be conducted by trained staff from the provincial or Cabang Dinas office using special instruments.

Resource Use. The main project impact on resources will be the redistribution of water in the area, which is the purpose of the project. There will be little energy used in operation of the manually controlled system. Some fuel will be needed for operation of project vehicles. Small quantities of sand, gravel, stone, cement, and other building materials will be used on a continuing basis for routine maintenance.

Chemical inputs will gradually increase with intensification of agriculture, but Indonesian farmers generally apply fertilizer at rather low rates, about 300 kg/ha. Pesticide use also tends to be at rates below those recommended by pest control specialists; presumably factors such as cost, labor input, and the inability to measure precisely the amount dispersed enter into the situation.

Labor Force. The basic operation and maintenance of the tertiary and quaternary systems will be performed by the WUA's and their members, with advice and some logistic support from PU and the Agriculture Department. Most area farmers have basic agricultural skills in rainfed paddy culture and palawija crops, but will require some training for effective intensification of cropping.

Operation and maintenance of the system will be performed by the PU staff described above. Initially, the staff is expected to include two Sub-Ranting heads, a dam tender, and about 15 gate keepers. Cleaning of the primary and secondary canals is the responsibility of PU, and will probably be contracted out. Cleaning of tertiary and quaternary canals will be done by the farmers using the system.

Training Programs: Operating Work Force. The PU will provide its local staff with orientation training for operation and maintenance of the system. This will also include training in the keeping of flow records. Training will be conducted during the final months of project construction and during the turnover period.

Farmers. Extension training will be provided to farmers who are not accustomed to irrigation systems. The training is expected to consist of evening lectures in the villages or hamlets, supplemented, with field advice by extension agents through the Contact Farmer system. PU will receive assistance in WUA organization and in on-farm water management from the Indonesian non-governmental organization, LP3ES (Lembaga Penelitian Pendidikan dan Penerangan Ekonomi dan Sosial).

Public Bathing and Livestock Watering: Method of Operation. Public bathing and laundry steps for the use of villagers living in the service area will be built by the project along secondary canals that go close to hamlets. Once built, there will be some monitoring of the structures to see that they remain in good condition.

The project will also construct livestock bathing and drinking sites to minimize damage to canal banks on secondary canals that go close to hamlets. These structures will be built in accordance with published PU specifications. PU will monitor the condition of these sites once the system is operating, to see that they remain in good condition.

In order to assist villagers in the Awo service area to manage their irrigation system, community education and eventually, community-led enforcement programs will be initiated through the joint efforts of Public Works, LP3ES, and the Departments of Agriculture and Livestock. This is necessary if the canals are to be effectively protected from violation of the no-livestock regulations. Maintenance of the livestock watering holes could be incorporated into an overall community livestock management program.

If begun before the system is installed, and continued vigorously, the education program could reduce the amount of plant matter and domestic trash thrown into canals and drains, illegal taps and other abuses of the system.

Waste Water Management. Waste water created by this project, consisting of irrigation return flows and rainfall runoff, will be returned to the nearest part of the river system through a system of surface drains.

Project Outputs. The project outputs will be a reliable supply of irrigation water, and sites along the canals for public bathing, laundry washing, and livestock watering.

CHAPTER IV

EXISTING ENVIRONMENTAL CONDITIONS

Methodology

The methodology employed in the study relies upon a checklist developed from the initial Scoping Meeting held in April 1988 in Ujung Pandang. Assessment of the boundaries of the total catchment area is based on maps developed from aerial photographs. The study area population is based on the administrative boundaries of villages located at least partially within the project service area.

Socioeconomic information, and some of the information presented on domestic water use, agriculture, forest use, wildlife, fishing, etc., were collected through field interviews and surveys of the local population. These interviews were conducted by Public Works' staff assigned to SSIMP, by USAID staff from Jakarta, and by the TA Team. Most of this information has already been made available in several reports, including results of a Household Survey (HHS), a "Rapid Rural Irrigation Appraisal" (RRIA), a "Site Profile", and a series of extended, internal memos.

Climate

Temperature

The temperature in the area is relatively even, with the highest monthly mean temperature, 28.5°C, in February, and the lowest monthly mean, 26.0°C in June (from the records of the P3SA climatological station at Sengkang, referred to hereafter as "P3SA, Sengkang").

Rainfall

The project is in the moist tropical climatic zone, with annual rainfall averaging just over 2,500 mm. Major rainfall events occur in every month of the year, but are most frequent during March-July (Table IV-1).

The timing and amount of rainfall in the project area are extremely variable, and records are limited. The rain gauge at Siwa provides 10 years of record near the coast, but records for the upper basin are non-existent.

Table IV-1

Average Monthly Rainfall In The Awo Project Area

Station	Elevation (m)	Year of Records (number)	Rainfall	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Keera	2	5	mm	79	82	92	273	532	343	392	272	207	135	45	128	2630
			days	5	5	5	12	16	11	13	10	6	5	7	6	101
Siwa	4	28	mm	119	126	177	277	459	346	279	211	162	146	141	111	2554
			days	9	9	13	15	18	15	13	10	8	8	8	8	134
Bajo	10	27	mm	177	205	277	299	241	214	1[illegible]2	125	98	118	158	180	2274
			days	10	11	15	16	14	11	11	7	5	7	9	10	126

Source : Rainfall records, Dinas Pertanian, Ujung Pandang; PU, PMA (Penyelidikan Masalah Air); and DHV Consulting Engineers, "100 years of Rainfall Recording in South Sulawesi, 1879-1980." March 1981.

Relative Humidity

The average annual relative humidity (RH) is 75 percent, with the maximum monthly average of 80 percent in June and the minimum monthly average of 71 percent in February and October (P3SA Sengkang).

Evaporation

Mean annual pan evaporation is 1,466 mm, reaching its maximum monthly average of 149 mm in October and its minimum, 99 mm, in June (P3SA Sengkang).

Topography and Geology

Topography

The upper catchment of the Awo River is characterized by steep, strongly dissected ridges reaching more than 3,200 m in elevation near the headwaters. In the service area the terrain is gently rolling to flat, with alluvial lands terraced for paddy fields. The service area varies from less than 8 m in elevation at its lower end to 24 m at the upper end.

Geology

The geology of the Awo area is described on the regional geological map issued by the GOI Directorate of Mines in its Geological Survey of Indonesia (1974). These maps indicate that:

- The flat land comprises sedimentary material, including alluvium and coastal deposit groups which consist of clay, silt, sand, and gravel, derived from tuffite, fine-grained tephra, sandstone, and mudstone.

- The mountainous area consists largely of irregular mountain ridges on basaltic volcanics. Rock types include a variety of sedimentary, igneous, and metamor phic types including quartzite, sandstone, shale, andesite, and basalt. There is a small area of karstic hills over marble and limestone, just north of the river in the middle of the catchment, with a rolling plain on marl and limestone to the south of this.

Water Resources

Major Surface Water Bodies

The Awo River is the only significant body of fresh water in the project area. It drains a basin with a total area of approximately 400 km^2, about 60 percent of which lies upstream of the

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project weir site. The upper basin is strongly dendritic, with many small streams flowing into the Awo.

Streamflow

The Awo is a perennial river, with the annual discharge ranging from 350 to more than 600 million cubic meters (MCM) at the weir site. Streamflows near the site have been measured since 1986 at an automatic water level recorder station installed under SSIMP. Flows for additional years have been calculated using a correlation with records for the Siwa River. The Siwa lies just north of the Awo, the basin has characteristics similar to those of the Awo basin, and records date from 1978. These flows are presented in Table IV-2.

The mean half-monthly discharge of the Awo rarely falls below 3.5 m^3/s and can exceed 50 m^3/s in wet years. The erratic rainfall pattern of the upper basin is reflected in the flow characteristics, with the peak month for the year falling anywhere from March to July. Half-monthly average flows below 5 m^3/s occur occasionally in September to February, and are most frequent during October and November.

Table IV-2

Half-Monthly Mean Discharge At Weir Site, 1978-1987

Period	Mean Discharge (m^3/s)[a/]										
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1:5 Year Low Flow
Jan 1	9.20	20.67	23.92	10.19	14.05	9.94	9.16	14.96	17.98	5.45	9.20
Jan 2	9.19	16.87	15.67	4.95	9.25	14.11	14.37	18.48	11.59	5.44	9.19
Feb 1	6.94	29.59	13.25	5.95	11.56	17.43	20.66	22.99	26.72	3.73	6.94
Feb 2	5.60	31.28	13.46	8.98	14.62	15.20	17.39	18.12	18.01	2.70	8.98
Mar 1	15.99	19.73	21.61	12.68	42.68	18.92	16.30	22.45	23.88	10.63	15.99
Mar 2	14.67	24.07	14.25	18.34	31.00	12.02	23.98	22.43	29.75	9.63	14.25
Apr 1	42.80	36.69	31.79	28.99	31.60	18.81	24.61	26.33	34.18	31.09	26.33
Apr 2	36.16	25.38	26.15	28.74	35.80	14.17	22.80	19.30	32.21	26.03	22.80
May 1	51.21	30.38	32.77	38.73	35.15	38.69	48.92	28.49	40.46	37.51	32.77
May 2	62.20	22.74	33.02	38.76	26.54	37.68	38.41	43.24	26.87	45.90	26.87
Jun 1	47.55	27.12	32.69	16.75	35.62	40.94	58.05	47.40	42.73	34.72	32.69
Jun 2	34.19	50.60	45.81	25.96	20.09	57.52	32.44	31.81	26.92	24.52	25.96
Jul 1	18.15	34.41	20.72	33.09	11.58	47.14	31.39	42.70	27.39	12.28	18.19
Jul 2	11.50	10.76	11.96	49.13	7.22	57.12	44.95	27.86	25.01	7.21	10.76
Aug 1	16.75	17.85	18.94	20.43	8.73	25.23	41.79	30.57	15.33	11.21	15.33
Aug 2	18.16	23.69	16.36	14.31	5.20	22.28	24.84	40.14	13.09	12.29	13.09
Sep 1	10.41	28.48	9.54	23.69	4.67	17.12	35.27	21.26	16.30	6.37	9.54
Sep 2	22.33	18.96	6.37	20.52	4.54	12.17	24.76	14.79	10.38	15.47	10.38
Oct 1	12.55	14.61	8.03	29.06	4.88	11.49	17.25	12.79	11.70	4.42	8.03
Oct 2	10.61	15.18	7.96	14.27	3.39	10.91	14.09	10.67	11.83	4.18	7.96
Nov 1	16.99	19.57	4.80	14.58	3.32	13.56	13.31	13.74	18.16	11.39	11.39
Nov 2	21.32	15.32	5.43	12.42	3.49	10.20	14.26	18.59	16.29	14.70	10.20
Dec 1	12.06	15.84	9.55	12.66	3.85	10.03	13.81	15.26	12.56	7.63	9.77
Dec 2	12.46	23.99	6.21	7.56	5.12	9.52	16.53	13.90	10.15	7.93	7.56

a/Figures for 1987 are actual. Figures for 1978 to 1986 are based on correlation with the Siwa River.

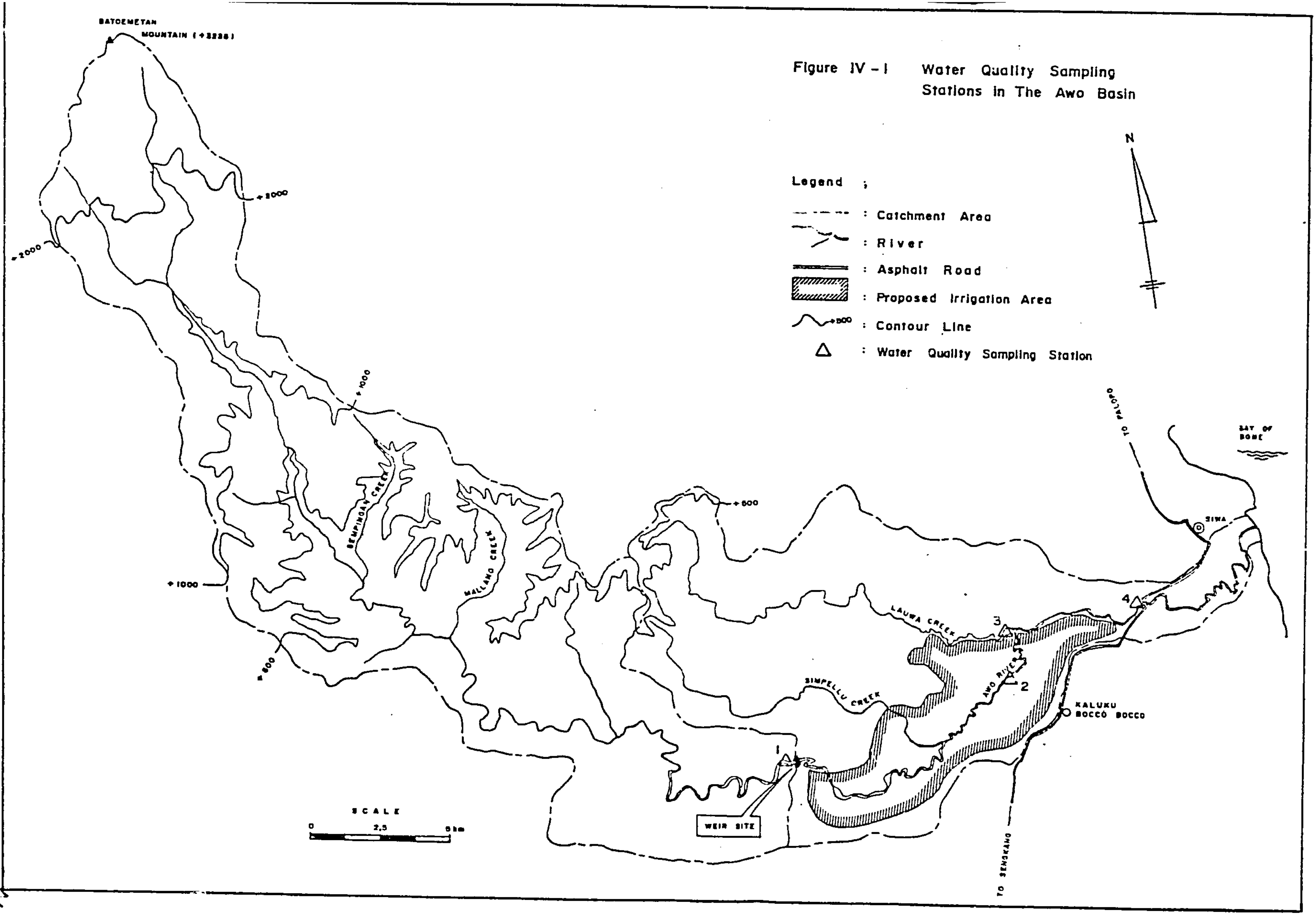

Figure IV - 1 Water Quality Sampling Stations in The Awo Basin

Water Quality

Water samples were collected in December 1989 at four locations in the project area (Figure IV-1) for analysis by the Analytical Chemistry Laboratory of Hasanuddin University. The sample sites were as follows:

Station 1: Awo River at weir site

Station 2: Awo River, northwest of Kampung Kaluku Bocco-Bocco

Station 3: Lauwa River, near junction with Awo River

Station 4: Awo (at this point known as the Bulete) River upstream of main highway bridge in Bulete

The samples were analyzed for a broad range of parameters to permit characterization of standard physical and chemical properties, including major ion composition, nutrients and dissolved and suspended matter. The resulting data are presented in Table IV-3.

The Awo River can be characterized as a standard calcium bicarbonate water, since the ionic composition is dominated by these two ions. Both magnesium and chloride are present in proportions somewhat higher than would be expected given the normal range of Indonesia surface waters, reflecting local watershed characteristics. Concentrations of all of the major ions are generally lower than found in other South Sulawesi surface waters.

Both the Awo River and its smaller tributary, the Lauwa, are slightly acidic, having pH values ranging from 6.3 to 7.0. Conductivity at all stations was fairly low, indicating that these waters have relatively low levels of dissolved substances. Turbidity levels were moderate, comparable to other surface waters in South Sulawesi, but color was relatively high, ranging up to 115 units at the downstream Awo station.

In contrast to the Awo, the waters of the Lauwa River were markedly enriched in sodium, and again this is probably due to local variation in surficial geology in this sub-watershed.

Nutrient levels (N and P) in these waters are lower than is commonly found in more-developed watersheds. Both phosphate and nitrate are present at concentrations which may be limiting to algal growth, thus resulting in low levels of primary production as mentioned above. All of the stations, and particularly the Lauwa, showed high coliform counts, probably reflecting the widespread use of most surface waters for sanitary purposes.

Table IV-3
Water Quality in the Awo Project Area

St.No./ Description	Sample No.	pH	D.O. (mg/l)	Cond (umhos /cm)	Temp. (C)	Color Pt-Co Scale	Turb (NTU)	Alkalinity (mg $CaCO_3$ /l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	SO_4 (mg/l)	Cl (mg/l)	PO_4-P (µg/l)	NO_3-N (mg/l)	TKN (mg/l)	TP (µg/l)	TS (mg/l)	TDS (mg/l)	TVS (mg/l)	VDS (mg/l)	TC (cells/ (100 ml)	FC (cells/ (100 ml)
1. Weir Site	1	6.85	4.3	160	29.0	20	6.0	74	7.5	2.80	11.0	6.7	5.62	11.5	13	0.11	5.30	220	133	100	59	51	4300	1000
	2	6.80	3.8	150	29.0	25	5.0	74	6.4	3.50	11.3	4.9	5.07	11.0	20	0.09	6.94	120	52	46	42	39	7500	1000
	3	6.85	3.8	140	29.0	25	5.0	74	7.8	2.80	11.2	5.5	5.25	15.8	13	0.05	1.57	90	126	96	61	48	4300	1000
	Mean	6.83	4.0	150	29.0	23	5.3	74	7.2	3.03	11.2	5.7	5.31	12.8	15	0.09	4.60	143	104	81	57	46	5367	1000
2. Awo River, middle station	1	6.80	4.6	150	29.5	70	8.0	92	8.7	4.90	11.5	5.9	6.00	14.6	25	0.05	2.02	100	157	126	63	44	2300	1000
	2	6.80	4.5	150	28.5	90	5.0	95	10.3	5.60	11.3	6.1	5.44	13.7	3	0.05	3.25	100	221	197	113	67	2300	1000
	3	6.85	4.4	150	28.7	80	10.0	95	13.3	3.50	11.2	6.0	5.24	15.6	3	0.08	1.45	60	183	137	70	46	2300	1000
	Mean	6.82	4.5	150	28.6	83	7.7	94	10.8	4.67	11.3	6.0	5.56	14.6	12	0.06	2.24	87	187	153	82	52	2300	1000
3. Lauwa River	1	6.85	3.5	155	29.5	30	6.0	85	15.2	3.90	10.6	4.6	5.80	13.7	26	0.08	2.15	120	177	121	64	46	46000	10000
	2	6.90	3.4	153	29.5	25	6.0	86	12.0	4.20	10.2	4.5	5.72	15.6	13	0.05	3.51	30	179	128	69	43	11000	10000
	3	7.00	3.6	150	29.3	25	5.0	86	15.0	4.20	10.2	5.0	5.26	11.9	13	0.05	2.16	80	185	167	104	77	>24000	10000
	Mean	6.92	3.5	153	29.4	27	5.7	86	14.1	4.10	10.3	4.7	5.59	13.7	17	0.06	2.73	93	180	139	79	55	19000	10000
4. Awo River just above main highway bridge	1	6.30	4.4	160	28.5	98	17.0	85	8.7	4.00	11.4	5.9	6.79	12.8	29	0.09	2.52	60	170	125	80	52	3900	1000
	2	6.35	4.2	165	28.5	100	12.0	84	8.3	3.70	11.2	6.0	6.37	13.5	3	0.11	1.22	80	245	224	129	85	4300	1000
	3	6.30	4.8	168	28.0	115	11.0	85	9.2	3.30	10.7	5.6	5.26	16.5	36	0.16	1.57	60	193	183	72	47	7500	1000
	Mean	6.32	4.4	164	28.3	104	13.3	85	8.7	3.67	11.1	5.8	6.14	14.9	23	0.12	1.77	67	204	177	93	63	5233	1000

Legend:

D.O.	= Dissolved Oxygen	Ca	= Calcium	TS	= Total Solids
Cond.	= Conductivity	Mg	= Magnesium	TKN	= Total Kjehldahl Nitrogen
Temp.	= Temperature	SO_4	= Sulphate	TDS	= Total Dissolved Solids
Turb.	= Turbidity	Cl	= Chloride	TVS	= Total Volatile Solids
$CaCO_3$	= Calcium Carbonate	PO_4	= Ortho-Phosphate	VDS	= Volatile Dissolved Solids
Na	= Sodium	TP	= Total Phosphorous	TS	= Total Coliforms
K	= Potassium	NO_3	= Nitrate	FC	= Fecal Coliforms

Note: Samples taken on 15-12-89.
Source: Analytical Chemistry Laboratory, Hasanuddin University.

In the Awo, the amounts of both organic and inorganic dissolved constituents increased in the downstream direction, probably reflecting increased human use of the water as well as the effects of local agricultural practices. Particulate inorganic matter appeared to decrease with distance downstream, possibly due to the settling of suspended particles in these slower flowing reaches.

Most parameters tested fall well within the recommended water quality limits as specified by the Indonesian government for a variety of uses (MENKLH, 1988); the exception is the high coliform values which make these waters unacceptable for use as drinking water. The Lauwa River samples, with their very high values of both total and fecal coliforms, also exceed the limits set for raw or domestic water supply. Considerable sanitary wastes enter this stream from the hamlets located along its length.

Ground Water

There is a general lack of quantitative knowledge of ground water availability across the alluvial plain in which the service area is located. Within this plain, rainfall is the ultimate source of water which sustains the underlying water-bearing formations. Other sources of replenishment are infiltration from the river or seepage from pumped water used for irrigation. Of these sources of recharge, direct infiltration of rainfall is probably the most important. The rate and amount of infiltration generally depend on several variables, among which rainfall and the permeability of the soil are the most important.

To evaluate the ground water potential of the area, an order-of-magnitude estimate is useful. If it is assumed that 10 percent of the annual precipitation within this plain infiltrates into the water table, and the average annual precipitation on the plain is 2,500 mm, then the annual ground water recharge would be 250,000 m^3/year per square kilometer (or 7.9 $l/s/km^2$).

If the ground water is to be used, abstraction should not exceed this estimated recharge. In the project area the four villages cover an area of 224 km^2, of which at least 50 percent is on the plain. This should provide at least 885 l/s of ground water. This quantity of ground water would be suitable for domestic supply, but would not be sufficient to irrigate very much land. However, given the amount of surface water available, there is little or no need to seriously consider resorting to ground water for irrigation.

Domestic Water Use

About 59 percent of the households in the project area rely on shallow wells, and the other 41 percent rely on river and stream water for domestic water. Drinking water is generally boiled before use. There appears to be no major problem during the drier months in water availability, except for some households living in the coastal estuary, who must travel farther upriver for fresh water since shallow wells in the estuary area become saline. Most water collected is of fair quality, having been filtered, to some extent, through the alluvial sand.

The UNHAS Environmental Study Center water survey team made enquiries of households regarding the amount of water used (both well water and river water). Converting their figures to a per capita basis (assuming an average of 5 persons per household), then per capita use is approximately 112 liters per day (l/cap/d). The UNHAS team estimated a drinking and cooking water demand of 12 l/cap/d. Other uses (bathing, laundry, and sanitation) require approximately 100 l/cap/d. Some of these activities take place in the river, so water is not consumed.

These figures indicate that the total domestic water demand of the four project villages, with a population of about 22,000 people, is roughly 2,500,000 l/d, or 29 l/s. If the area has at least 885 l/s of ground water available, then the entire population (except for those living in the coastal estuary during the dry season) should have no difficulty in meeting their domestic requirements through shallow wells.

Land Resources

Land Use

The population of the Awo catchment is largely concentrated on the flat lands of the coastal plain, although in recent years there has been significant movement of people into the coastal hills and up the Awo valley into the upper watershed. This has resulted in large areas of the catchment being converted from the original forest to various types of agricultural ecosystems. The basin can be conveniently divided into the upper catchment (upstream of the weir site), and the lower catchment area. Approximate areas for various land use categories are summarized in Table IV-4, from Figure IV-2. Figure IV-2 was prepared on the basis of a land use map by UNHAS based on 1978 aerial photos, and updated using 1982 aerial photos and field reconnaissance and checking in 1989.

The upper catchment, totaling approximately 23,470 ha, is largely covered with dense tropical deciduous forest. This is largely primary forest, especially in the upper reaches; access for logging is limited by the difficult terrain. An area of approximately 2,470 ha in the middle reaches of the upper watershed, along Sempingan Creek, and along the southern border of the catchment has been largely cleared, and is now covered with a mixture of grassland and scrub forest. Access to these areas is apparently from the Siwa catchment to the north, and from the Bila catchment to the southwest, with a road entering from the latter watershed. Access to much of the upper catchment is along rudimentary tracks which are not suitable for 4-wheeled vehicles,

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but many colonists use motorcycles and horses to get to their illegal homesteads.

It is doubtful that the condition of the existing roads between the coast road and the upstream limit of the service area inhibits clearing of the hilly parts of the basin to a significant extent, since the potential colonist must traverse some tens of kilometers of hill roads, which become progressively worse as one goes farther up into the basin, in order to find new forest available for clearing. Many colonists enter the upper basin through Districts SidRap and Luwu, but those roads also are of marginal quality. The hill farmer seeking forested land available (albeit illegally) for clearing and planting must be resigned to a laborious trip over difficult roads in order to visit market centers along the coast road. Upgrading the short stretch of already good road within the project area will not change the situation much.

Many of the colonists in the upper basin use motorcycles for access to "civilization," allowing them to reach their clearings when these are well beyond the limits of the road.

The job of the Forestry Department in preventing clearing and cultivation in the Protection Forest of the Awo basin is made more difficult by the district government's policy of improving the roads to encourage colonization, which it considers desirable.

A band of dense forest extends southward across the Awo to the southern boundary of the watershed. This forest is under pressure from both east and west and will likely be completely converted to grassland and mixed dryland agriculture in the near future.

Immediately to the west of the weir site, both north and south of the river, is an area of what is termed mixed dryland agriculture. This is also found further to the west along the Awo River, and is a complex patchwork of dry fields (ladang) used for annual crops such as pepper, pasture (some of which is alang-alang grassland), and plantation or perennial tree crops (kebun), the most important of which is cloves. Small areas of scrub are also found, particularly in valleys along temporary or permanent streams. This land use type also occupies most of the western portion of the lower catchment, particularly the rolling upland areas.

The flattest areas are all converted to rainfed paddy fields, which occupy 6,090 ha or 37 percent of the lower catchment. Near the mouth of the river, there are small areas of fish ponds (tambak) (170 ha) and mangrove vegetation (160 ha) which amount to only 2 percent of the area of the lower catchment. More extensive areas of fish ponds are located to the north and south, outside of the Awo catchment.

Table IV-4

Estimated Land Use in the Awo Catchment

Land Use Category	Upper Watershed ha	Upper Watershed %	Lower Watershed ha	Lower Watershed %	Total ha	Total %
Paddy Field (Sawah)*	-	-	6,090	37	6,090	15
Mixed Dryland Agriculture (Pasture/Ladang/ Kebun)	2,830	12	7,130	43	9,960	25
Scrub Forest/ Grassland	2,470	11	-	-	2,470	6
Forest	18,170	77	2,860	18	21,030	53
Mangrove	-	-	160	1	160	<1
Fish Ponds	-	-	170	1	170	<1
Total	23,470	100	16,410	100	39,880	100

* Note: Paddy field is gross area and includes substantial riverine and hamlet areas. Net paddy field area is approximately 4500 ha.

For the 40,000 ha watershed as a whole, forest occupies approximately 53 percent, mixed dryland agriculture 25 percent, rainfed paddy fields 15 percent and scrub forest/grassland 6 percent, with minor amounts of coastal fish ponds and mangrove.

The proposed service area of 2,500 ha is made up of practically all lowland rainfed paddy fields, with small areas for the hamlets and associated home gardens. In an average year, 90 percent of the proposed service area is cultivated in the wet season, about 49 percent is cultivated in the early dry season, and about 22 percent is planted in a third crop in the late dry season.

All provincial lands have been classified by the Ministry of Forestry. Figure IV-3 shows the current forest classification for the project area. "Protection Forest" (Hutan Lindung) is intended for watershed protection, and logging is not permitted. In "Limited Production Forest" (Hutan Produksi Terbatas), only selective cutting should be practiced.

By comparison with current land use (Figure IV-2) it can be seen that this classification does not conform well with actual conditions. A significant percentage of the area classified as "Protection Forest" in the central portion of the catchment has already been converted to garden/grassland/tree crops, while the area of "Limited Production Forest" in the upper basin appears to be almost completely deforested according to 1982 aerial photos. In practice, there is a lack of administrative mechanisms to enforce these forest use zones. RePPProT (1988) has recommended changes in the forest classification for this and other areas of the province to bring it more into line with existing conditions.

Soils

Most of the flat service area is composed of dark grey alluvium, with the main material consisting of clay deposits. Some of the coastal area consists of alluvial hydromorphic soils, originating from marine clay deposits. There are all classified as slightly to fully weathered acid soils with low base saturation. Soils in the mountainous area are podzols and regosols, which originate from sandstone and tuff. These soils are also generally slightly to fully weathered with low base saturation and pH values of 4.5 to 5.5. They are usually highly erodable.

Erosion and Landslides

Erosion is not a serious problem in the far upper catchment area, largely because the vegetative cover is still quite dense in most places. However, moderate to heavy erosion is found on the lower slopes. Here, the forest has been clear cut for shifting cultivation (mostly maize and upland paddy) and for tree crops (cloves, cacao, and candlenut), and the grass cover is repeatedly burned to provide young grass for cattle forage. Within the service area, erosion is limited, since the area is so flat.

Agriculture

Cropping Patterns. Paddy is the most extensively cultivated crop in the project area, being planted in the wet season with the onset of rains. This planting period can vary considerably but normally occurs from April to May; harvest follows in August to September. In an average wet season, 1,900 ha of paddy are planted with an additional 480 ha of upland area planted to mixed crops including mungbean, soybean, and maize.

Following the wet season, pump-irrigated paddy is attempted over approximately 550 ha, and secondary crops are planted over 750 ha. The main secondary crop planted is mungbean, with additional amounts of soybean and maize. A second dry season crop is usually attempted covering the period of January to March with all of the area relying only on rain. Again, mungbean is the predominant crop, with some maize found.

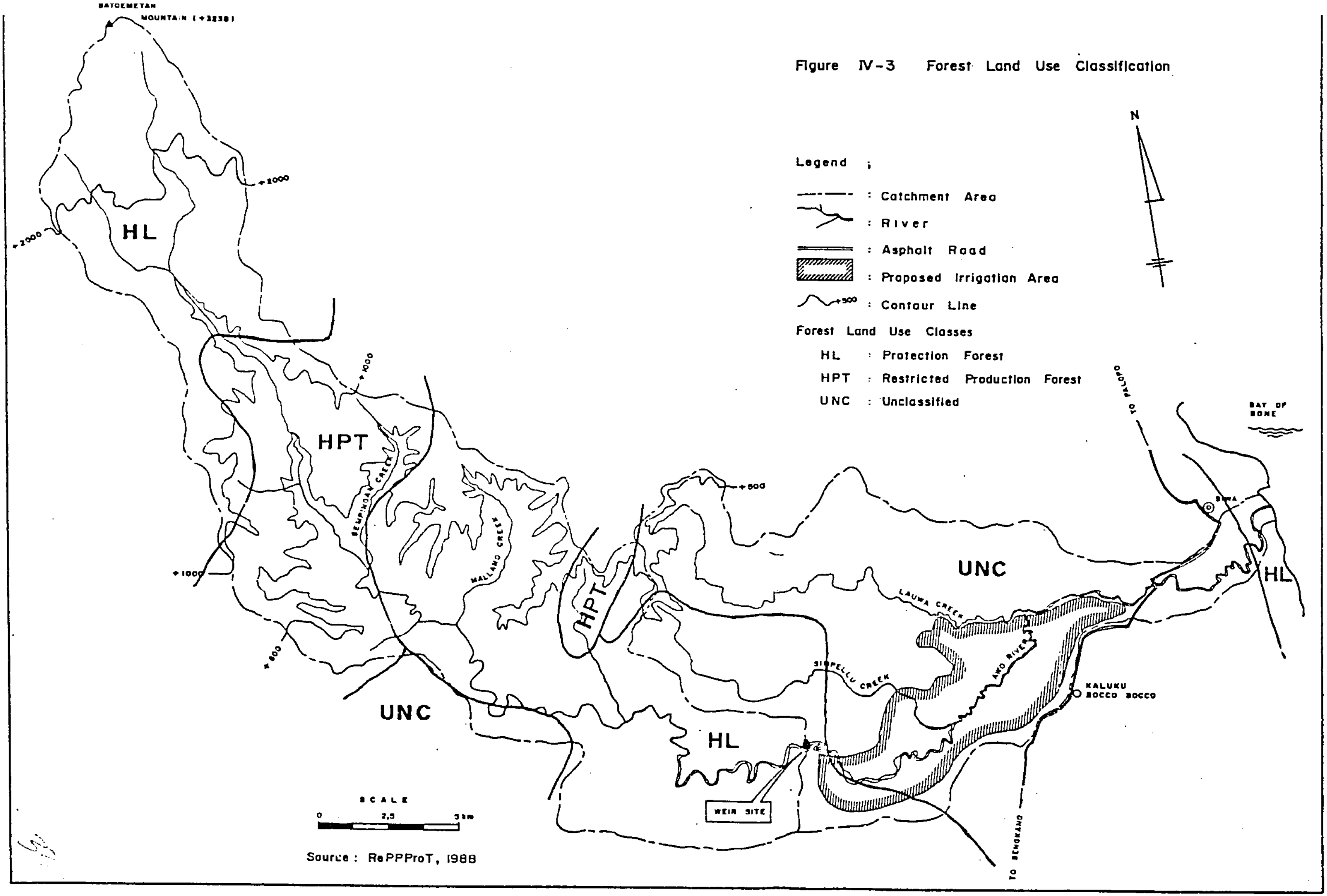

Figure IV-3 Forest Land Use Classification

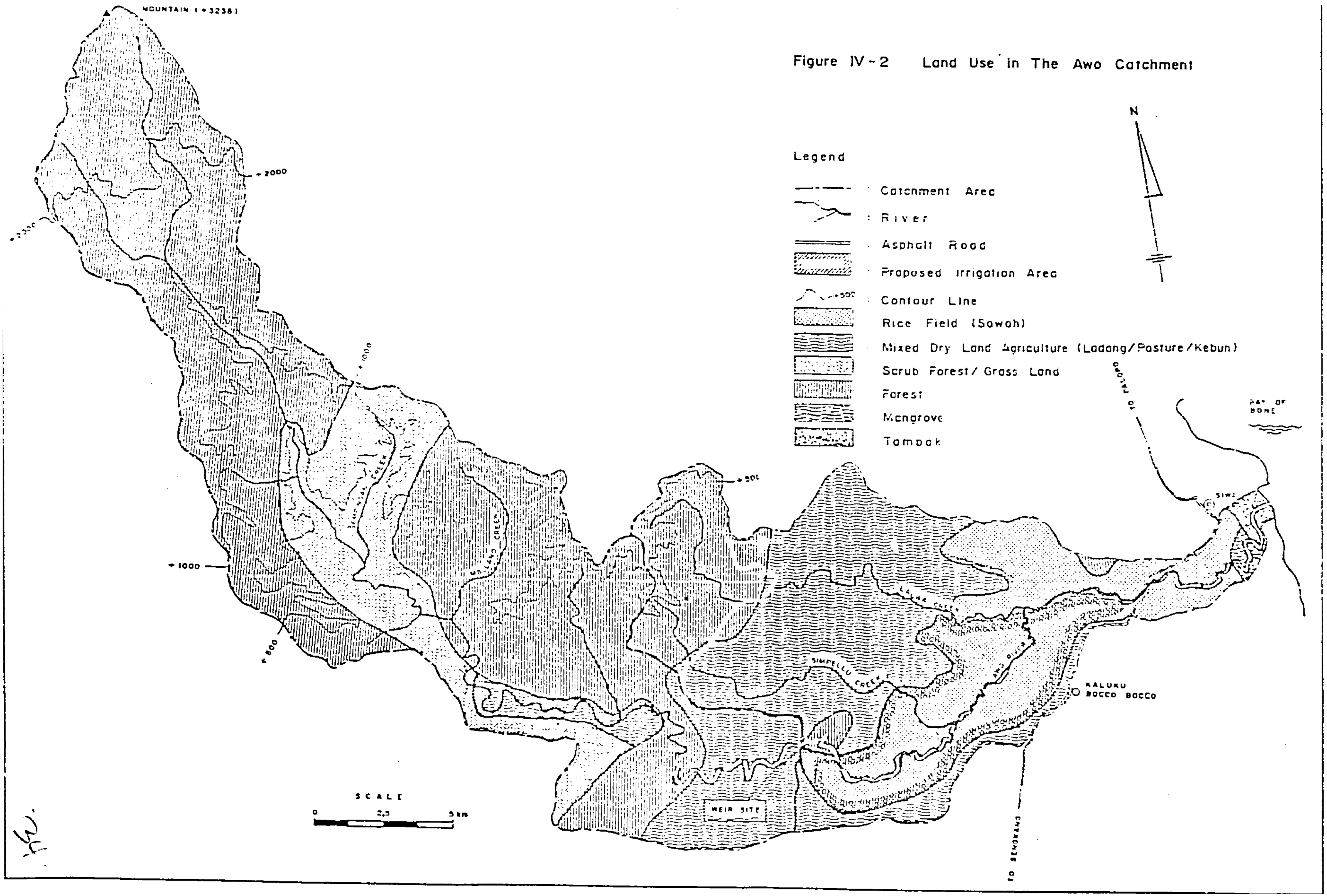

Figure IV - 2 Land Use in The Awo Catchment

Cropping intensity under the present regime is estimated at 160 percent.

Farm Practices. Current farming in the project area can be described as relatively low-input and risk-minimizing. Without secure water supplies, farmers are understandably reluctant to make full expenditure for the water-complementary inputs recommended in the rice intensification packages.

Paddy. Paddy is grown under both rainfed and pump-irrigated conditions. Paddy is started in seedbeds of roughly 4 to 5 percent of the area to be planted at rates of 50 to 60 kg/ha. The most prevalent seed variety is IR 42. Farmers often use seed of the same stock source for many seasons before acquiring new seed. Fertilizer and pesticide applications to the seedbed are not common. After approximately 30 days, the seedlings are transplanted. Family, exchange, and hired labor are all used in transplanting.

Land preparation precedes transplanting and involves plowing, harrowing and puddling. Draft animals include water buffalo and cattle. Use of two-wheel tractors in land preparation is already common. There are at least 80 hand tractors owned by farmers in these four villages and more are seasonally brought in and rented.

Fertilizers and pesticides, while used, are applied at rates lower than that recommended by the Department of Agriculture. The types of fertilizer used include urea, ammonium sulphate (ZA), triple-super-phosphate (TSP), and limited amounts of potassium chloride (KCl). When used, TSP is normally incorporated into the soil at land preparation or soon after transplanting, and the other fertilizers are mixed and applied 2 to 3 times (usually broadcast by hand) during plant development. Pesticide (insecticide and herbicide) application is generally made from knapsack sprayers, but application rates are lower than recommended rates. Additional weeding during the plant growth stages is done by hand.

Harvest and post-harvest activities are carried out by hand, employing family, exchange and hired labor. The paddy is cut with a sickle, and the grain is separated from the stalk by beating it against a rack or barrel. The grain is winnowed and sun dried before bagging for sale or storage. Rice straw is commonly burned in the fields.

Table IV-5 presents typical seed, fertilizer, pesticide and labor inputs per hectare for paddy production and other crops in the project area.

Table IV-5

Typical Farm Input Use Under Without-Project Conditions

Farm Input	Unit	Paddy	Mungbean	Soybean
Seed	kg/ha	55	25	50
Fertilizer				
Urea,ZA	kg/ha	135	-	-
TSP	kg/ha	70	-	-
KCl	kg/ha	16	-	-
Pesticide	l/ha	1	2	1
Labor	work days/ha	80	47	51
Draft	team days/ha	12	2	4

Source: HHS Farm Survey and interviews with local agricultural officials.

Secondary Food Crops (Palawija). Secondary food crops, including mungbean, soybean and maize, are planted under rainfed conditions almost throughout the year. During the wet season, with the lowlands planted to paddy, secondary crops are found in upland areas, which are drier, with unbunded fields. Secondary crops continue to be cultivated during the dry and then the transitional seasons, ranging from October to March. During these periods, the crops are found in the lowland areas, which at this time have insufficient water supplies to support paddy.

Mungbean is the dominant secondary food crop currently grown in the project area, with lesser amounts of soybean and maize planted. Cultivation practices are primitive. In the case of mungbean, seeding (by both dibbling and broadcasting) occurs at a rate of about 25 kg/ha, with little or no land preparation preceding the activity. Some minimal plowing (harrowing) may follow to turn the seeds into the soil. Alternatively, paddy straw may be scattered over the broadcast seed. Fertilization of the crop is not practiced. Weeding and crop maintenance activities are very limited, but due to plant susceptibility to insects, pesticide is commonly applied at rates of up to 2 l/ha.

The crop is harvested by plucking the maturing pods. The seed is beaten or trampled out of the pods, and then separated, cleaned and dried. While mungbean production is relatively less labor intensive than paddy cultivation, producers still employ hired labor.

Table IV-5 above presents typical input use per hectare for mungbean production in the project area.

Crop Yields and Production Levels

Crop yields and production levels for the project area under present conditions are derived from results of the project farm survey, data provided by the subdistrict Pitampanua Agricultural Office, and discussions held with government officials and non-government specialists. The project Household Survey indicated annual yields from as low as 2.1 t/ha in rainfed areas, up to 3.2 t/ha attainable in pump-irrigated areas. The annual rainfed paddy yield averaged 2.6 t/ha, while the pump-irrigated areas averaged 2.9 t/ha in the wet season and 2.7 t/ha in the subsequent dry season. Yields for lowland mungbean production averaged 400 kg/ha according to the survey.

Average annual crop production and area under existing conditions are shown in Table IV-6. Annual average production for the project area is approximately 6,300 tons of dried paddy, about 300 tons of mungbean, and about 250 tons of mixed crop production (mungbean, soybean, maize, etc.) per annum.

Table IV-6

Average Crop Area and Production in Project Service Area (Without Project)

Season and Crop	Planted Area (ha)	Harvested Area (ha)	Harvested Quantity (tons)	Yield (tons/ha)
I. Wet Season				
Lowland				
sppl. pumpfed paddy	550	550	1,595	2.9
rainfed paddy	1,346	1,279	3,325	2.6
Upland				
mixed cropping	484	412	124	0.3
II. Dry Season 1				
Lowland				
pumpfed paddy	550	523	1,412	2.7
rainfed soybean	91	82	41	0.5
rainfed mungbean	478	430	172	0.4
Upland				
mixed cropping	179	135	41	0.3
III. Dry Season 2				
Lowland				
rainfed soybean	43	39	20	0.5
rainfed mungbean	365	329	132	0.4
Upland				
mixed cropping	179	135	41	0.3

Source: Subdistrict Pitampanua Agriculture Office, '88. Field surveys '87-88.

Livestock

The larger livestock of the Awo catchment area are almost all located in or near the settled areas, and virtually none are in the upper catchment. Cattle (sapi Bali) and water buffalo serve as the main draft power for plowing. Horses are used for local transport, but are rarely used to draw carts or to plow. There are relatively few goats and pigs (these are kept by Torajanese Christians), and they are mostly used for domestic consumption and local feasts. Table IV-7 shows the estimated livestock population of each of the four project area villages.

Livestock are used for draft power, investment, and consumption purposes. Cattle are the most numerous, and provide the main source of draft power in the study area. There are relatively fewer cattle and water buffalo in the downstream villages of Lauwa and Bulete, since many farmers have converted to using 2-wheel hand tractors. Overall, there are more than 80 tractors owned by local farmers, and many more are seasonably brought in by truck and rented for land preparation.

Table IV-7

Large Livestock in Project Area, 1986

Village	Livestock				
	Cattle	Water Buffalo	Horses	Goats	Pigs
Awota	819	426	19	31	-
Lompo Loang	1,021	615	17	42	176
Lauwa	643	415	15	37	-
Bulete	260	460	9	62	-
Total	2,743	1,916	60	172	176

Notes:
1. Figures given are rough estimates as totals differ by more than 50 percent, according to source.
2. Approximately 20 percent of Awota Village is owned by PT Bina Mulia Ternak, a large livestock ranch along the southern hills of the villages reported to control 10,000 ha extending westward into District SidRap. The number of cattle in this fenced off area of Awota is unknown.

Source: Dept. of Livestock and the District Wajo Statistics Office, 1986-87.

The Household Survey showed an average of 3.4 draft livestock owned per sample household, but that as many as 46 percent of the households owned none. The percentage of households owning large livestock and numbers of animals owned were higher in the upper portions of the service area.

Probably due to the numbers of tractors used in the area, there were no reports of shortfalls in draft animal availability at the stage of farmland preparation. Contracting out the task of land preparation is common in the area, using livestock or tractors at roughly equivalent rates of Rp 50-60,000 per hectare. Land preparation by tractor can be accomplished in 2-3 d/ha, while the same task accomplished by livestock takes 12-15 days. Payment is said to be flexible with partial payment at the time of the service and the remainder paid at harvest.

Biological Resources

Terrestrial Vegetation

The Awo catchment area encompasses an area of approximately 400 km^2, most of which is in the Latimojong Mountains, the highest chain of mountains in South Sulawesi. Batumetan Mountain, at 3,238 m, is the highest peak, and forms the northern border of the upper Awo catchment area, located in adjacent District SidRap.

Ranging from sea level to the peak of Batumetan, the forest of the Awo catchment area can be differentiated according to altitude, temperature. and cloud level, into four major zones. Whitten, et al. (1987) suggest the following classification:

lowland and hill forest	0 - 1500 m
lower montane forest	1500 - 2400 m
upper montane forest	2400 - 3000 m
subalpine forest	3000 + m

The natural climax vegetative formation of most of the Awo catchment area is tropical, seasonal, evergreen forest, which centuries ago probably extended almost to the coast. For at least a century, but particularly since 1976, progressive clearing has removed much of the original forest from the coastal plain. This cleared band extends inland about ten kilometers and on into the foothills of the Latimojong Mountains, to an altitude of approximately 350 m (lowland and hillforest, according to the typology above).

The natural forest, which dominates the upper part of the catchment, is a true rain forest with three canopy layers, or strata. The upper, or "A" stratum consists of mature trees 25 to 35 m high, with emergent giants reaching over 40 m. The second, or "B", stratum, contains shade-adapted species whose canopies reach 15 to 20 m, and the third layer, the "C" stratum, consists of smaller species of 5 to 10 m in height. There is a weak shrub layer and ground cover is sparse, but climbers and epiphytes are abundant. The size and diversity of trees in this forest are shown in Table IV-8.

It has been proposed that the Latimojong Mountains be classified as a Nature Reserve (Whitten, et al., 1987), but no final decision has been made, and it is unclear how many hectares might eventually be included in such a scheme, or where the boundaries might be drawn. At this time the Latimojong Mountains have a "conservation value" of only 245, on a scale where the highest score in Sulawesi is 1,954 for the Dumoga Bone National Park, located in North Sulawesi. This index of conservation value is a score calculated from six factors: species richness, habitat area, rarity, rate of loss, degree of protection and degree of distinctiveness, such that the higher the score the greater the conservation value. One reason the conservation value score is so low for the Latimojong Mountains is that little is known about the area and few people have scientifically explored it. Thus, while the preservation of the forest in the Latimojong Mountains is of considerable interest to the Awo Irrigation Project, overall it is not counted among the most valuable areas to be preserved in Sulawesi at this time.

The forest contains many trees of commercial timber value (see trees noted with "(C)" in Table IV-8). However, many areas are difficult to log economically, given the steep slopes of the mountainside, and limited roads in the far upper catchment area where the most valuable trees are located. Also, a large part of the upper catchment area is classified as protection forest, where logging is officially banned, based on a Management of Forest Use Agreement of 1982 (see Figure IV-4).

Some of the "climbers" in this forest are of commercial value. There is a great deal of rattan that is being taken out at this time. Virtually all of this rattan is being taken out by floating it down the river to a transfer point on the lower portion of the river, just below the proposed weir site. The rattan is cut, sorted, and dipped (to kill insects) in Paojepe Village, and then moved out by truck.

Officially, there is no longer any shifting cultivation occurring in the catchment. In reality, it is widespread in the lower hills, to a height of 350 to 450 m, where maize and upland paddy (padi gogo rancah) is planted. The hills are stripped, burnt, and planted in crops. Usually the hillsides are abandoned after 2 to 3 years, and the land then converts to alang-alang grass.

A number of people from District SidRap, other parts of District Wajo, and elsewhere, engage in upstream shifting cultivation. Hasanuddin University estimates there are at least 180 farmers with more than 7,600 ha used for agricultural production within the conservation forest area, in the Siwa Forestry District (1987/88).

In addition to shifting cultivation, this land within the conservation forest is used for plantation, and a small part is used for cattle production. Plantation tree crops include cacao, clove, coffee, candlenut, and cashew. The oldest trees are about 12 years old, probably with an average age of about 5 years. These trees have been planted with the support of the Department of Perennial Crops (Perkebunan), and with the consent and support of other government agencies and outside investors.

Table IV-8

Density of Tree Species in the Upper Awo Catchment Area

Species	Number of Trees per Hectare According to Height						
	10-15	15-20	20-25	25-30 (meters)	30-35	35-40	>40
Albizzia procera (C)	1	15	4	2	1	-	-
Aleuritus moluccana	-	3	2	-	-	-	-
Alstonia scolaris	5	25	23	5	3	1	-
Anthocephalus cadamba	-	5	4	2	2	5	1
Artocarpus altilis	-	-	1	-	-	-	-
Artocarpus dasyphyllus	-	8	8	1	0	-	1
Artocarpus integra	-	1	-	-	-	-	-
Artocarpus teysmanii	-	11	5	4	1	-	-
Bischiffia javanica	-	-	-	3	-	-	-
Broussonetia papyfera	-	-	1	-	-	-	-
Canangium odorata	-	4	4	4	2	2	4
Cordia subcordata	-	-	1	-	-	-	-
Derris microphylla	-	1	3	1	-	-	-
Dracontomelon mangiferum (C)	3	20	18	13	7	6	3
Durio zibethinus	-	-	-	-	-	1	-
Eugenia sp. (C)	-	1	3	1	-	-	-
Ficus spp.	2	13	5	1	3	-	-
Ficus ampelas	-	-	1	-	-	-	-
Ficus benyamina	-	-	-	1	4	-	6
Gluta renghas	-	2	1	-	-	1	-
Gossampinus malabarica	-	3	3	1	-	-	-
Horsfieldia globularis	1	2	2	-	-	-	-
Lagerstroemia speciosa	-	3	-	-	-	-	-
Laplaca sp.	-	3	-	-	-	-	-
Mangifera sp.	-	1	-	-	-	-	-
Mangifera indica	-	4	1	-	-	-	-
Myristica sp. (C)	-	-	-	1	-	-	-
Neonauclea sp. (C)	-	11	3	1	-	-	-
Palaquium obtusifolium (C)	-	1	-	-	-	-	-
Pangium edule	-	1	1	-	-	1	-
Parinari corymbosa	-	-	-	-	-	-	2
Phoebe opaca (C)	-	6	1	1	-	-	-
Phyllanthus emblica	8	4	2	1	-	-	-
Pongamia pinnata	-	1	-	-	-	-	-
Pterocarpus indica	-	21	27	14	45	5	9
Pterocymbium tenctorium	-	2	6	7	2	1	1
Pterospermum sp. (C)	3	26	8	6	3	2	-
Pterospermum celebicum (C)	-	11	8	2	1	1	-
Querqus celebica (C)	-	11	16	13	4	1	6
Spondis pinnata (C)	-	2	4	2	1	-	-
Sondaricum koetjape	-	4	2	2	2	-	-
Sterculia foetida	1	2	1	-	-	-	-
Vitex cofassus (C)	-	8	4	-	-	-	-

Table IV-8 (continued):

Vitex pubescens	3	9	1	1	-	1	-
Vitex quinata	3	5	1	1	-	-	1
Wormea ochreata	3	5	2	-	-	-	-
Becceng-becceng*							
Peahu *	-	1	1	1	1	-	-
Bulung *	-	1	2	-	-	-	-
Lai-laiya *	-	-	-	1	1	-	-
Alariseng *	-	-	-	-	-	1	-
Cenda *	-	-	-	-	-	1	-
Bitouto *	-	-	1	-	-	-	-
Tumea *	-	5	1	-	-	-	-
Total	37	263	185	99	43	30	34

Trees in ten observation plots, each 50 x 40 m, were counted, at altitudes of 250 m to 1,090 m. Five plots were in Natural Forest, three plots in Secondary Forest, and two plots in Farm land.

Note: (*) = local name; Latin name unknown.
'(C)' = trees with commercial value.

Source: UNHAS Field Study, 1988.

There continues to be economic pressure to convert protection forest to tree crops. By 1985/86, there were at least 360,000 clove trees planted in the four project villages, of which most were located in the hills of the Awo catchment area. Once these trees are mature (in about 10 years), they yield an average of 10 kilos of dried cloves per year. Assuming the price of Rp 5,000 per dried kilo, then the gross income would be an estimated $ 10 million dollars per year. Presumably under free market conditions, prices will eventually plummet and there will be little incentive to continue planting clove trees, but by that time all of the original forest on the lower slopes will have been destroyed.

Second-growth forest in the lower valleys that still have trees is dominated by Artocarpus teysmanii, Pongania pinnata, Ficus benjamina, Zizyphus inermis, and a dozen other large trees with some 30 species of subdominants.

In the second-growth forest on the fringes of the service area the habitat is greatly altered by cutting for construction materials and fuelwood, and by planting and escapes of cacao, coffee, coconut, mango, banana, other fruit trees and sago palm. This area provides many of the necessities of the rural population, but is a poor wildlife habitat.

A thick grassland of "alang-alang" (Imperata cylindrica) dominates steep slopes and other areas of thin soils and low soil fertility. Although this land can be considered as 'fallow', once alang-alang grass forms it takes a long time for the next succession phase to become established. This aggressive grass can form dense stands more than two meters high, which allow few other species to grow and which provide poor habitat for wildlife.

The people responsible for clearing the forest from these hills include local residents, seasonal workers who live elsewhere, and some public servants, military personnel and businessmen who are making long-term investments in clove production. Officially, no more land is to be converted to clove production, and the emphasis has now turned to planting candlenut (kemiri) and cashew (jambu mente) trees.

Wildlife

There has been no detailed, site-specific study of the terrestrial wildlife fauna of the Awo catchment area, but the situation may be inferred, on the basis of published studies of animals in neighboring regions of Sulawesi, and from interviews with local residents. Bats and rodents are the most diverse and abundant groups, while the larger hoofed mammals are scarce. Monitor lizards and python are not uncommon.

The birds of the region are too diverse to be listed on the basis of casual observation, but fieldwork by the Project Environmental Scientist indicated a considerable variety and abundance of species throughout the area. These included several species of birds of prey, fruit-eaters, numerous insectivores, and seed-eaters. Such diversity is indicative of a healthy ecosystem.

Field observations by the environmental team and inquiries of farmers indicate that deer (Cervus timorensis), wild pig (Sus celebensis), and monkeys (Macaca maura) are present.

Endangered Species. Given the lack of specific details on terrestrial fauna of the Awo catchment area, it is difficult to say whether any of Sulawesi's endangered species are likely to be surviving in the area. It is possible to draw up a rough listing of those species that may be found. Whitten, et al. (1987: 48-52), report that the IUCN Red Data Books list 16 species considered to be at risk of extinction on Sulawesi. Some of these species can be eliminated from a listing for Awo, since they have never been sighted along the east coast of South Sulawesi (Whitten, 1987, UNDP/FAO, 1982). Thus, there are perhaps 9 species--5 mammal, 2 bird, and 2 reptile--that may be found in the Awo area. The species and their risk status are shown in Table IV-9.

Table IV-9

Species at Risk, Possibly Found in the Awo Catchment

English Name	Latin Name	Status*
Sulawesi tarsier	Tarsius spectrum	I
Sulawesi civet	Macrogalidia musschenbroeckii	R
Babirusa	Babyrousa babirussa	V
Lowland anoa	Bubalus depressicornis	E
Mountain anoa	B. quarlesi	E
Chinese egret	Egretta eulophotes	V
Milky stork	Ibis cinereus	V
Estuarine crocodile	Crocodylus porosus	E
Forsten's tortoise	Indotestudo forsteni	R

*Note: I = insufficiently known; V = vulnerable; R = rare; E = endangered.
Source: Whitten, et al., 1987: 48-52.

Whitten notes that it is widely recognized there are still species on Sulawesi that have never been properly identified, much less their risk of extinction examined. Thus, it is possible that there are species in the Awo catchment area at risk of extinction, that go unknown.

Of the species that have been identified as at risk, the two bird and the reptile species might be found in the lowland or coastal/estuary area. However, given the already rather complete conversion of the area to agricultural and fish pond development, and the fact there is a relatively large number of settlements in the area, it is unlikely such species would be found in this habitat.

Of the five mammal species at risk, two (the tarsier and the civet) are rather small and might easily pass unnoticed, surviving quite well in the middle and upper catchment areas. In the case of the three large mammals, there may be sufficient existing, relatively undisturbed habitat for them to survive in the relatively inacessible mountainous part of the upper catchment area. Since there are many shifting cultivators, collectors of rattan, loggers, and sport hunters passing through much of the middle catchment area, it would seem unlikely that such vulnerable or endangered species would have a good chance of survival there.

Sport Hunting. The hill area of the middle Awo catchment is part of a large sport hunting area. Visitors from as far away as Jakarta are reported to come to this area, principally to shoot deer. The preferred method is to use rifles while riding on the back of a truck at night, using bright lights mounted on the cab of the truck to attract and stun animals, which prevents their running away. Since roads are poor to non-existent in the truly steep areas of the catchment, presumably this high ground is relatively safe from hunters with rifles on trucks, as a natural habitat.

Freshwater Biology

There has been no site-specific study of the aquatic biology of the Awo River, as is true of the majority of South Sulawesi's rivers, which remain virtually unknown (Whitten, et al., 1987). The available hydrological data indicate that the Awo River exhibits large seasonal fluctuations in discharge with mean half-monthly flows, ranging from a low of 3 to more than 60 m^3/s. This great variation in flow over the course of the year places significant stress on aquatic organisms, and thereby reduces the diversity of plant and animal communities.

Benthic Fauna. The Awo River is presumably host to a variety of micro and macrobenthic organisms, such as amphipods, small molluscs and various aquatic insects (stoneflies, caddisflies, dragonflies, midges, etc.). Attached algae of various species are also likely to be present.

Fish Populations

While Sulawesi is known to have a number of indigenous species, all of the fishes which are commonly harvested for food are either introduced or widely distributed throughout the region. Table IV-10 lists the most important of these. Most of the endemic fish are lake dwellers (Whitten, et al., 1987), with only a few (apparently all halfbeaks, Dermogenys spp.) being confined to rivers. The indigenous fish fauna is very poorly known, with almost no information available on distribution.

Wb

Table IV-10

Common Sulawesi Fish Species

Scientific Name	Common Name English	Common Name Indonesian
Puntius goniotus (javanicus)	Javanese carp	tawes
Cyprinius carpio	common carp	ikan mas
Tilapia (Oreochromis) mossambica	tilapia	mujair
Tilapia nilotica	Nile tilapia	nila
Clarias batrachus	catfish	lele
Ophiocephalus (Channa) striatus	snakehead	gabus
Trichogaster pectoralis	-	sepat siam
Osteocheilus hasselti	-	nilem
Osphronemus goramy	gouramy	guramy
Anabas testudineus	climbing perch	betok
Monopterus albus	swamp eel	belut
Anguilla sp.	eel	sidat
Helostana temminekii	-	-
Mugil cephalus	mullet	-

In general, in tropical rivers experiencing distinct wet and dry seasons, there is a common pattern of movement of adult fish upstream at the beginning of the wet season, as the waters rise. As flooding occurs, the fish move out onto the flood plain and reproduce. Over the course of the dry season, as water levels fall, the fish move back into the river and downstream. By the end of the dry season, the fish are concentrated in lower reaches of the river or in permanent pools, where they are often subject to intensive predation. Such a pattern is probably common in the Awo River and in other Sulawesi rivers and streams.

Many, if not most, of the species listed in Table IV-10 are likely to be present in the Awo River, but none in sufficient numbers to support a commercial fishery of any kind. In informal conversation with senior fisheries specialists in the Livestock Faculty of Hasanuddin University, familiar with the rivers flowing through District Wajo, state there is no commercial potential on any of these rivers. Similarly, they state that the primary focus on fisheries for home consumption and commerce continues to be marine fishing and coastal fish pond (tambak) development.

In the lower reaches of the river (the coastal estuary), there is likely to be some casual harvesting of fish by children or artisanal fishermen, using cast nets or basic traps. This provides a supplement to the supply of animal protein in the diet of the families involved, but overall, remains a rather unimportant food source to the area. The close proximity of the sea allows the population easy access to marine fish. These fish are sold by travelling petty traders who carry fresh fish up to more remote hamlets by motorcycle or they are sold in regular markets.

Within the immediate area, there are estimated to be hundreds of families living along the coast or along the estuary who make their living by combining coastal fish pond cultivation with reef fishing and, to a limited extent, with harvesting fish from traps set in the river. Such fish traps in the river remain rather unimportant, partly because the estuary is part of a local port and is subject to rather heavy boat traffic.

The Bugis population maintain a strong cultural preference for consuming marine fish, and secondarily, the fish raised in brackish water fish ponds. Many Bugis distrust the quality of river fish, citing that they are unclean, subject to contamination, and taste "muddy." Thus, in the populous middle reaches of the river (through the service area), there is very little fishing, except to catch a few small fish for the occasional meal.

Both mullet (Mugil cephalus) and freshwater prawns (Macrobrachium sp.) are known to be common in rivers in this general area, and are quite likely to be found in the Awo River. Both of these species could be classified as being anadromous in that they move seasonally in the river. Macrobrachium requires brackish water for successful reproduction, with the young then moving upstream to feed and grow. Mullet are primarily an estuarine or nearshore species, but they are known to move up into freshwater systems for feeding, and are present in Lake Tempe and the upper Walanae River. Neither species exhibits any major spawning run on the river. While probably present in the river, they have no commercial potential, and as a local food source, are unimportant.

The eels, Monopterus albus and Anguilla sp., are also likely residents of the Awo River. They move out to the marine environment to reproduce. Although eels are known to be a popular food source in parts of North Sulawesi and elsewhere, within the project area, for cultural reasons, eels are not a popular food among most local residents, and are sometimes referred to as a "Chinese" food.

Other marine brackish water species may be present in the lower reaches of the river on an occasional basis. These include sea perch (Lates calcarifer) and milkfish (Chanos chanos), among others.

Other Aquatic Fauna. Various lizards, including the monitor lizard, are found along the banks or in the Awo River. Estuarine crocodiles (Crocodylus porosus) may once have been common, but are no longer found in the river. Sulawesi has four species of brownish-grey freshwater snakes, and it is possible that one or more of these species are present in the watershed.

Estuaries and Coastal Mangrove

The combined estuary of the Awo-Bulete River and the nearby Siwa River extends approximately five kilometers inland from the joint mouth of the rivers. Coastal mangroves border the estuary to the north and south. In the absence of human activities, the estuary would be fringed by dense mangrove, but since the area is settled (the main settlements for Subdistrict Pitumpanua are here), most of the mangrove areas have already been converted to fish ponds. Thus there is only a narrow fringe of mangrove remaining along the coast.

In informal conversation with South Sulawesi fishery experts, the SSIMP study team inquired about the effect of damaging the coastal estuary and mangrove areas which may serve as a breeding ground for some marine fish. There has been some acknowledgement that such damage may hurt the breeding grounds for marine fish. According to these experts, there have been no studies of such effects in the general area. Current fisheries development in the area has focused on brackish fish pond development, that, in itself, destroys mangrove.

The downstream river channel itself is heavily used by motorized boats that travel 3 to 5 river kilometers inland. Both river channels serve as transit routes for raw products going out (i.e. cloves and cacao, etc.) and trade goods coming into the subdistrict. However, in this respect, the Awo-Bulete River remains of secondary importance relative to the Siwa River.

The distance inland where transition between fresh water and brackish water occurs varies by season. During the rainy season, fresh water occurs to the mouth of the river. During the dry season, brackish water is reported to move as far as 5 river kilometers inland. Both the Siwa and the Awo-Bulete Rivers are the major source of fresh water for domestic consumption during the dry season (August to December) for an estimated 480 fishing and fish pond cultivation families living in the fish pond/mangrove area of Bulete Village.

Fish Ponds. Brackish water aquaculture, known as tambak farming, is practiced all along the coast to the north and south of the Awo-Bulete River. In Bulete Village, much of the land that is suitable for fish ponds has already been converted in the past five years, as is true along much of the South Sulawesi coast. The Department of Fisheries estimates there are between 1,065 and 1,490 ha of brackish water fish ponds in Bulete Village, between the narrow fringe of coastal mangrove along the coast and the inland, rainfed paddy fields.

Two species, milkfish (bandeng or <u>Chanos chanos</u>) and tiger shrimp (udang windu or <u>Penaeus monodon</u>), are raised. The majority of fish pond farmers use simple technology where tidal patterns are manipulated by floodgates. Control over salinity is very limited and most fish pond farmers rely on rainfall rather than fresh river water to reduce salinity. As milkfish are able to tolerate a wide range of salinities better than shrimp, milkfish are raised where there is little or no control over salinity and shrimp are raised when there is more rainfall.

Virtually none of the fish pond farmers pump any water from either the Awo-Bulete or Siwa Rivers into their fish ponds, since the water from the rivers is already saline in the estuary.

Most fish pond farmers are small-scale, and have a low level of technology, so they are able to raise only two crops of fish per year. Few fish are raised in the driest part of the year, particularly in October and November.

There are currently no plans to extend the Awo Irrigation Project to provide freshwater to the fish pond area.

There are two ice manufacturing plants in Siwa, so that pond-raised fish and shrimp can be packed and shipped. There are no refrigerated trucks in the area. However, most fish and shrimp are sold locally and little is sent by truck or bus to Ujung Pandang.

Socioeconomic Resources

Population Profile

Project Beneficiaries. The initial 2,500 ha to be developed, of the potential 4,700 ha project service area comprises parts of four villages (Awota, Lompo Loang, Lauwa, and Bulete), with a total 1987-88 population of 21,474 (Table IV-11). Irrigation improvements will principally benefit the owner-cultivator and sharecropper households who cultivate land in the service area. The average area of cultivated paddy fields per household is 1.45 ha. Assuming each household had the average amount of land, then about 1725 households, or about 40 percent of the households living in the four villages will directly benefit from the 2500 ha project. Median farm size is smaller, at 1.1 ha. If all farmers had farms of this size, then 2272 households, or about 53 percent of the four villages' population would benefit.

Population Growth. The four project villages have experienced considerable immigration in the last few years, with the districts of Soppeng, Bone, SidRap, and Enrekang contributing immigrants. Officially, during the period 1980 to 1988, the population grew at an annual rate of 1.8 percent (during this same period, South Sulawesi's total population grew at an annual rate of 1.7 percent). However, there are many seasonal migrants in the area, who are not counted as contributing to the growth rate even though they are frequently in the area; if they were counted, then the growth rate would probably be closer to 2.0 percent.

Many new arrivals establish fields in the part of the Awo watershed upstream of the weir site or at the fringes of the service area. Since these lands are unsuitable for paddy fields, farmers plant tree crops, such as cloves, cacao, and bananas, and row crops such as maize. Some who plant here visit only seasonally and continue to maintain residences outside the project area. These farmers increasingly use barbed wire fences to mark their claims in the foothills, and to control cattle movements.

Table IV-11

Population of Project Villages
According to Place of Residence

Village (Desa)	Village Sub-Area (Dusun)	Population	Total Households per Village
Awota	-	(3,770)	520
	Jonga-Jonga*	1,486	
	Ongkoe*	1,353	
	Dake	931	
Lompo Loang	-	(4,199)	663
	Setangnge*	846	
	Sempelu*	1,037	
	Lompo Loang*	1,200	
	Masara	695	
	Batang Pare	421	
Lauwa	-	(3,479)	789
	Bocco-Bocco*	2,072	
	Alesilurunge*	745	
	Lamonnyi*	662	
Bulete	-	(10,026)	2,199
	Tobarakka*	1,927	
	Benteng*	1,860	
	Cappapadang	2,657	
	Leworeng	1,677	
	Ading	984	
	Buluawo	921	
Total Population/Households:		21,474	4,171
Population/Households Living in Village Sub-Areas Receiving Irrigation:		13,188	2,562

* These village sub-areas (dusun) will receive irrigation in the 2500 ha service area.

Source : Village interviews. Data for Bulete is taken from 1988; the others are 1987 figures.

Density. With an overall density for the four villages of 92 persons/km^2 (Table IV-12), this area is slightly less densely populated than the average for all of South Sulawesi (106).

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Population densities are now 168 persons/km^2 in Bulete, 105 in Lauwa, 64 in Lompo Loang and 46 in Awota. Thus the most densely settled villages are located on the flat land directly along the main highway while the less densely settled areas are in the hillier inland areas. Of course, densities are also affected by the aerial size of the village. Awota Village has a large, unpopulated area, but it can still be considered "less densely settled" even in the area that is populated, compared to down-stream villages, given the smaller size of hamlets and its distinctly "rural" and more isolated nature.

Table IV-12

Population Densities According to Land Use Characteristics

Village	Total Pop.	Total Area ha	Total Area Pop. Density	Paddy Field ha	Paddy Field Pop. Density	All Agric. Land ha	All Agric. Land Pop. Density
Awota	3,506	7,550	46	604	580	2,567	137
Lompo Loang	3,260	5,120	64	1,382	236	3,327	98
Lauwa	3,699	3,533	105	1,237	299	2,615	141
Bulete	10,026	5,985	168	1,966	510	5,207	193
Totals:	20,491	22,379	92	5,189	395	13,716	149

Note: Population figures differ slightly from those in previous table since the year and source differ.

Source : Village statistics, BANGDES data, and data from Dept. of Statistics, District Wajo, for 1987-88.

Population densities vary according to land use. Together, these four villages support a population of 149 persons/km^2 of agricultural land, and a population of 395 persons/km^2 of rainfed (and some pump-irrigated) paddy fields (Table IV-12).

Age Distribution. The population of the area is principally of working age, with 63 percent between the ages of 15 and 54 years, while only 30 percent are less than 15 years, and 7 percent are aged 55 years and older (Table IV-13).

Sex Ratios. The overall sex ratio for the four villages is 92 (males to females x 100). This is virtually the same as the average for all of South Sulawesi (93). The relatively lower sex ratios (Table IV-13) for Awota (86) and Lompo Loang (88) are similar to the overall sex ratio for Kabupaten Wajo (87). Lauwa and Bulete both have sex ratios of 94. Thus the two more remote villages have more of a "surplus of females" or conversely, a "deficit of males" than in the two villages located along the highway. Since virtually all of the low sex ratios (85 or less) occur among the population aged 45 years and older, it is probably at least partially due to the greater longevity of women and polygamy among the older population, rather than solely due to male out-migration.

Table IV-13

Population by Age Group and Sex, and Sex Ratios, for the Four Villages, 1986

Age Group	Awota M	Awota F	Awota Sex Ratio	Lompo Loang M	Lompo Loang F	Lompo Loang Sex Ratio	Lauwa M	Lauwa F	Lauwa Sex Ratio	Bulete M	Bulete F	Bulete Sex Ratio
0 - 4	186	204	91	173	202	86	195	200	98	482	513	94
5 - 9	188	211	89	165	185	89	186	181	103	472	502	94
10 - 14	177	187	95	159	173	92	172	179	96	459	486	94
15 - 19	173	191	91	150	154	97	161	171	94	487	520	94
20 - 24	172	189	91	135	150	90	155	162	96	486	493	99
25 - 29	170	182	93	131	146	90	163	175	93	439	466	94
30 - 34	154	178	87	137	144	95	157	164	96	412	430	96
35 - 39	135	164	82	126	137	92	143	154	93	407	460	88
40 - 44	129	146	88	92	102	90	103	115	90	301	331	91
45 - 49	119	150	79	83	98	85	83	98	85	258	302	85
50 - 54	82	113	73	44	66	67	74	93	80	257	288	89
55 - 59	46	72	64	29	42	69	47	51	92	146	168	87
60+	31	58	53	33	58	57	76	78	97	252	215	116
Totals:	1762	2045	86	1457	1657	88	1715	1821	94	4858	5174	94

Source : Statistics office, District Wajo. Statistik Potensi Pembangunan Propinsi Sulawesi Selatan, Tahun 1986, Kabupaten Wajo, Kecamatan Pitumpanua.

Household Size. Households in the project villages principally consist of nuclear families, as is true throughout most of Indonesia. Household size averages between 4.9 to 5.1 persons. In general, households in the town of Bulete tend to be smaller than households in the rural hamlets of Awota.

Ethnicity and Religion. The majority of the population in the four project villages are ethnic Bugis, who are Muslim. In 1986, there were six religious schools (Ibtidayah) in Bulete Village and one in Lauwa Village, with 542 children attending. A few of the local citizens have acquired sufficient wealth to have made the pilgrimage to Mecca.

Lompo Loang Village has a hamlet of ethnic Torajanese, who settled here in 1969, with an estimated total of 70 households. About 60 of these people are Catholic and 330 people are Protestant. Each Christian group has its own church and religious education in Lompo Loang Village.

Archeology. The project area has been inhabited for centuries, but there are no known prehistoric, or historic sites of archeological interest in the service area, or the weir/weir pool area.

The four project villages have a number of small graveyards scattered through the project area. Most of them are for the predominantly Muslim population and a few are for the burial of Christians. In virtually all cases, these gravesites are located on higher ground that will not be inundated by irrigation. There are no known graveyards located along the route of the main or secondary canals.

Kinship and Marriage. Bilateral extended family ties are strong in the Awo area, with family members providing reciprocal labor and economic assistance to each other in time of need and for ceremonial occasions such as weddings and funerals. Marriage partners are generally sought within the area and from within the same religious-ethnic group.

In the past, this area was ruled by Bugis political, social, and economic elites of royal descent. Many of these same leading families continue in positions of civil and religious authority. The ties of kinship and marital alliances continue to be important, and young entrepreneurs moving into the area have sometimes married into influential families.

Education and Literacy

In the past, many children either never attended school or dropped out before completing primary school. This is not a problem today. Of the 3,793 primary school age children (7 to 12 years old), 94 percent were attending the 18 primary schools and 3 kindergarten in the four villages (in 1986, most recent data available) (Tables IV-14, and IV-15). Attendance rates are highest in Bulete and lowest in Awota. In three villages (Awota, Lompo Loang, and Lauwa), attendance rates are slightly higher for girls than boys, but overall, their rates are the same.

After primary school, attendance rapidly drops off, particularly in Awota and Lompo Loang, the two villages located farthest from the intermediate and senior high schools located in Bulete/Siwa. Actual attendance rates in higher levels of schools are difficult to assess, however, since some families send their older children to live with relatives or as boarding students in the district capital of Sengkang, and to Ujung Pandang. These students are not included in local statistics.

Table IV-14

Primary School Age Children Attending School, 1986

Village	Population Aged 7 to 12 years			
	Males		Females	
	No.	% Currently Attending School	No.	% Currently Attending School
Awota	315	85	290	87
Lompo Loang	381	91	354	92
Lauwa	344	94	308	96
Bulete	929	97	872	97
Totals	1,969	94	1,824	94

Source : Dept. of Statistics, District Wajo.

Thus the majority of the population aged 7 to 35 years can be considered literate, while literacy rates rapidly decrease among the older population since many never had the opportunity to attend school as children. Some adults have participated in government sponsored adult literacy programs (Paket 'A'), and are now literate. Overall, the literacy rate for the four villages is probably about 60 percent.

Table IV-15

Educational Facilities and Numbers of Classes, According to Level of School, 1986

Village	No. of Schools				No. of Classes			
	TK	SD	SMP	SMA	TK	SD	SMP	SMA
Awota	0	3	0	0	0	20	0	0
Lompo Loang	0	3	0	0	0	20	0	0
Lauwa	1	2	0	0	3	20	0	0
Bulete	2	10	2	1*	6	89	18	2
Totals	3	18	2	1	9	149	18	2

* By 1989 there were two SMA's in Bulete.

TK = Kindergarten; SD = Primary School; SMP = Intermediate Secondary; SMA = Secondary

Public Health

Incidence of Diseases. Data taken from the main health clinic (PUSKESMAS) in Bulete Village and supported by informal interviews with village leaders, indicate that malaria and dengue fever are not seen as major problems in the four project villages. Local health officials report that the area had a limited insecticide spraying program to control mosquitoes in the past few years. However, this program was terminated as malaria is not a serious problem. This viewpoint is supported by a recent World Bank-funded review (Kesavalu, 1989) of Sulawesi's malaria control program. This report concluded that as is true of some other parts of South Sulawesi, the incidence of malaria and dengue fever is not a serious problem in District Wajo.

The reported number of gastric and intestinal diseases, such as gastritis, diarrhea and even, probably, cholera, continues to be a problem (Table IV-16). The incidence of these diseases tends to rise during the dry season when the quality of domestic water decreases. Medical personnel report this is particularly true in the more heavily settled areas of Bulete Village where the water table is only 2 - 3 meters deep, and easily polluted by inadequate toilet and bathing facilities that have usually been built too close to wells. The problem of intestinal diseases is also a major problem among the coastal hamlets of Bulete which have no fresh water during the dry season (usually August through December). Coastal inhabitants must purchase water from boats that transport water collected from the Awo-Bulete and Siwa Rivers, or from wells located near the rivers.

In the villages farther upstream, the incidence of diarrhea, cholera and gastritis is also higher during the dry season, again due to consumption of polluted water that has been inadequately boiled.

No evidence of the transfer of schistosomiasis into the area has ever been reported, nor is there evidence that it has been tranferred to other areas away from Lake Lindu, in Central Sulawesi.

Table IV-16

Gastro-intestinal Disease Incidence, Bulete

Year/Quarter	Diarrhea/Cholera	Gastritis
1984:		
1	76	1
2	54	5
3	25	2
4	150	1
1985:		
1	117	15
2	69	59
3	45	48
4	90	55
1986:		
1	75	68
2	56	69
3	46	100
4	123	114
1987:		
1	51	92
2	52	99
3	117	92
4	80	64
1988:		
1	135	108
2	98	50
3	144	83
4	166	66

Source: Data from the main health clinic (PUSKESMAS), Bulete Village.

Drinking Water Supply. A majority of the population obtains drinking water from wells, but significant numbers still must obtain their water from streams and rivers (Table IV-17). As mentioned previously, wells are often located close to sanitary facilities and become contaminated. River waters are widely used for sanitary purposes, resulting in a lack of water that would meet drinking water standards. All water should be boiled before consumption, but this requires the expenditure of fuelwood resources.

Table IV-17

Primary Sources of Drinking Water

Village	Total Households		Source of Drinking Water			
			Well		River	
	No.	%	No.	%	No.	%
Awota	502	100	392	78	110	22
Lompo Loang	646	100	357	55	289	45
Lauwa	769	100	514	67	255	33
Bulete	2199	100	1152	52	1047	47

Source : Dept. of Statistics, District Wajo, Sengkang.

Housing and Sanitation. Housing styles conform to Bugis and Torajanese housing standards, where people live in clean, airy wooden houses built about two meters up, on wooden supports, in an architectural style known as panggung. The area beneath the house is often less sanitary, being used as work and storage space and sometimes for tethering livestock. Frequently there are polluted pools of water and waste materials, caused by livestock and from food and water being dropped through floors from kitchens.

Among the population there are wide differences in the size and quality of housing construction, ranging from two-room dwellings to large houses with four or five bedrooms. Minimum standard houses consist of thatched roofs and woven bamboo walls. The better houses have metal sheeting roofs, louvered glass windows, and the outside wooden walls are painted or covered with siding.

Basic sanitation facilities--toilets, or a combination well, bathhouse and toilet--are not uniformly valued, even when a family can afford to build them. More progressive households have built toilet and bathhouses near wells (unfortunately, often the source of polluted water), but these things are not yet the general rule and minimum effort goes into maintaining them. In Bulete, the most progressive village, about 65 percent of the households have toilets (only two percent have septic tanks), while in the other three villages, only 22 to 28 percent have toilets. Again, in Bulete, about 50 percent of households have some sort of bathhouse, while in the other 3 villages between 19 to 27 percent of households have bathhouses.

Overall, the majority of the population is adequately, if not comfortably housed. A small proportion of the population could be described as having sub-standard housing. Some sub-standard housing exists because families have recently moved from somewhere else in the project villages and have yet to build a better house, so that they are essentially living in poor quality quarters at the building site of their new house. Other houses are of poor quality where the family has lived there for some time (e.g., some areas of Awota).

Nutrition. No data is available on the nutritional status of the population. There is no visual evidence of any particular malnutrition in the area. This would only be expected to be a problem in drought years with widespread crop failure. Being close to the sea, there is probably adequate availability of fresh and dried fish to provide sufficient animal protein in the diet.

Health Services. Each village has at least one resident health care worker, as well as several midwives. The main health clinic is located in Bulete Village, where there is a resident medical doctor, a dentist, several nurses, and attendant health care workers. The nearest hospitals are in Sengkang, about 1.5 hours away, and in Palopo, about 1.0 hour away.

Economics and Labor Force

Occupations. The reported labor force in these four villages is predominantly engaged in agricultural production (76 percent) although only 53 percent of the labor force is principally engaged in paddy production. Another 7.5 percent are fish pond farmers or fishermen, 3.3 percent are engaged in small industry, handicrafts or skilled trades, 2.6 are principally traders (many more do this as a secondary occupation), 2.6 are public service employees, and the remaining 8 percent are scattered among a wide variety of occupations.

Annual Income. Net per capita income on project area farms is low, as would be expected in traditional rural areas, averaging Rp 140,000. An average farm of 1.8 hectares in the project area consists of about 1.45 ha of paddy field, 0.15 ha of dry field, and 0.2 ha of orchard or home garden. Gross annual income for the farm family (average family size of five) is estimated at just under Rp 1,340,000. Farm and related production expenses total approximately Rp 660,000, living a net income of about Rp 660,000, which for an average farm family would just cover living expenses (fuel, clothing, medical needs, off-farm food purchases, household inprovements, etc.). Under such circumstances, the annual net family savings or reserve for the average farm would be minimal, if any.

When looking at median (most common farm size) and small farms, the income situation is worse. The median farm in the project area is 1.1 ha and the small farm is 0.75 ha. To maintain basic family expenditures of Rp 660,000 per year (Rp 11,000 per person per month), the median farm would have to generate additional income from outside sources of Rp 320,000 and the small farm would have to generate Rp 340,000. Other income sources include such activities as other-farm wage labor, trading, transport, carpentry, wood gathering, livestock management, and home industry/handicrafts -- but it should be noted that the extent and availability of these other employment opportunities in the project area are limited.

Bank and Credit Facilities. The nearest branch of Bank Rakyat Indonesia (BRI) is located in Siwa. The major sources of agricultural credit to farmers in recent years have been four: BIMAS, KUT, KUPEDES and private, non-institutional sources.

The BIMAS program provided credit for purchase of a standard set of farm inputs according to government guidelines, plus provision of a living allowance. The last operational year of this program in the study area was 1983. Areas covered in the project villages over the last three years of this credit program averaged about 400 hectares at rates of Rp 45,000 per hectare served. Recovery rates over the same period for the project villages averaged 54 percent.

KUT (Kredit Usaha Tani) is designed so that farmers obtain credit in the form of inputs rather than cash, and on an individual basis rather than according to pre-determined levels as was the case under the earlier BIMAS program. The KUT credit is only available through cooperatives (KUDs) which have been approved as reliable by BRI. Interest payments on loans are one percent per month for members and 1.5 percent for non-members. The Lauwa KUD reported KUT input loans valued at Rp 20,698,500 for 1977. Fertilizer was by far the largest distributed input, but seed and agrochemicals were also distributed.

KUPEDES (Kredit Umum Pedesaan, general rural credit program) is a cash credit program administered by BRI. It can be utilized by farmers if a reliable KUD (and KUT credit) is not available. Money has been loaned in each of the project villages by the BRI Unit Desa located in Siwa, but in general, this credit is loaned to the trade sector foremost, with a residual flowing towards agriculture (about 15 percent of loans are classified as agricultural). The difficulty cited in loaning to the agricultural sector is the poor payback performance which is due in part to uncertain harvests, exposure to previous credit programs which were lax in collection, and the farmer perceptions and attitudes towards repayment of credit.

Private Credit: with the limited success and amount of institutional credit available to the agricultural sector, the most prevalent credit arrangements are amongst farmers themselves, or less frequently, with middlemen. Loans are made in the form of inputs (seed or fertilizer) with repayment to be made from the crop harvest, usually in-kind. The rates on these small loans are estimated to be 25 to 50 percent over a season. A typical loan would be in the input form of fertilizer to be paid back at harvest in an equal weight of paddy.

Settlements and Administrative System

Settlements. The settlement pattern and administrative system are interlinked. Within the village (desa) are several geographic sub-areas (dusun). Awota and Lauwa Villages each have three dusun, Lompo Loang Village has five dusun, and Bulete has six. Each dusun has between 400 to 2,500 people living in a number of hamlets, each hamlet having one or more administrative units (rukun tetangga, referred to as "RT"), of 25 to 50 households. These "RT" constitute the core work units for "voluntary" public works projects in the residential areas, and for road improvements, but have no particular relationship to communal work activities directly related to agricultural production.

Virtually the entire population is now settled in consolidated hamlets, even if they still engage in shifting cultivation. The majority of the population resides alongside the main north-south highway, while others live alongside village roads. This enables the government to provide better services, particularly schools, health care centers, and roads.

There are still a few hamlets with relatively poor access and where four-wheel drive vehicles can enter only in the dry season, such as the upstream hamlet of Dake, in Awota Village, and much of Lompo Loang Village. There are also some hamlets in Bulete Village, located in the fish pond and coastal area, that can only be reached by foot or by shallow-bottomed boat.

Administration. Village heads (kepala desa) are appointed by the subdistrict government, with the consent of village residents. Village administrative officers (pamong desa), including secretary and office staff, are responsible for handling administration, development, welfare, finances, and miscellaneous administrative and record-keeping duties. The village head is advised by the LKMD (Lembaga Ketahanan Masyarakat Desa), a kind of planning council at village level. Members of this council are local key persons and representatives of semi-governmental organizations like the rural women's group (Program Kesejahteraan Keluarga, or "PKK"), farmer groups (kelompok tani), water users' associations (Perkumpulan Petani Pemakai Air, or "P3A"), and the village advisory body (Lembaga Masyarakat Desa, or "LMD"), who finally make recommendations to the village head. In practice, the quality of the village administration strongly depends on the capabilities of the village leaders.

Land Ownership and Taxation

Land Ownership. There is now no open, or unclaimed land in the service area suitable for cultivation. The cultivated land is privately owned. There are four main ways to acquire land: inheritance, sharecropping (including various renting and leasing arrangements), pawning, and by purchase. The most common method of acquiring land is through inheritance. Virtually all farmers in Awota Village are owner-operators, while 87 percent are owner-operators in Lompo Loang, 66 percent are owner-operators in Bulete, and only 28 percent are owner-operators in Lauwa (Table IV-18). According to results of the Household Survey, about 40 percent of respondents indicated they acquired some land through sharecropping arrangements and about 33 percent acquired land by purchase (particularly in Lauwa Village).

Land inheritance follows Islamic custom where sons receive two parts and daughters receive one part. Land is 'registered' in the name of the person who receives it, so that men and women bring their own land into marriage. Generally, newlywed couples live with the wife's parents until they build their own house. Newlywed men may work their wive's parents' land if they have not yet inherited land. Houses are often inherited by the youngest child, as this person tends to remain living in the parental house after older siblings have married and moved out.

Some absentee owners sharecrop out their land and have moved to the district capital town of Sengkang or elsewhere (including, reportedly, Ujung Pandang, other parts of Sulawesi, as well as Java, Sumatra, etc.), and have become public servants or traders.[1] Some are still living nearby. Since 1986, Lompo Loang became an independent village, but was formerly part of Lauwa. Many residents of Lauwa continue to own land in Lompo Loang, and vice versa. A large portion of the land in Lompo Loang immediately north of Awota, is actually owned by the residents of Awota, living in the administrative sub-area of Jonga-Jonga.

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[1]There are two types of absentee owner-patrons. The first are former residents who fled during the Islamic rebellion in the 1960s. During the period 1955 to 1970, hardly any of the existing bunded lowland was cultivated and there were mass movements of households to more secure areas. Roads became almost non-existent and impassable. One result of this regional turbulence was that many craftsmen and small businessmen left and have never moved back to the area as they have become successfully established elsewhere. Some still own land in the area and sharecrop it out.

The second type of absentee owner-patrons are those persons who invested in developing "empty" land after 1970--particularly on the higher ground and surrounding hills. Often these are South Sulawesi businessmen who have never lived in the project area.

Table IV-18

Land Tenure Status in the Study Area

Village	Status per Village: Owner Operators and Owner Operators + Sharecrop	Sharecrop or Rent Only	Total Farmers
Number of Farmers:			
Awota	673	0*	673
Lompo Loang	821	121	942
Lauwa	300	784	1084
Bulete	988	499	1487
Totals:	2782	1404	4186
Percent Distribution:			
Awota	100	0	100
Lompo Loang	87	13	100
Lauwa	28	72	100
Bulete	66	34	100
Overall Percent Distribution:	66	34	100

* It is probable that there are at least a few households in this category living here that go uncounted.
Source: Village statistics.

Land Registration. Ideally, each village maintains its own records on land ownership, with copies of the records kept in the district capital of Sengkang. Most farmers in the Awo service area lay legal claim to their cultivated land through three systems of land registration.

However, very little of the agricultural land in the study area has ever been surveyed or transferred from government land (tanah negara) to the modern form of private land ownership that gives certificated title to owners. There are also very few extant records of land title using a system established by the Dutch, known as "buku rinci". With this system, books are kept on details of ownership within field complexes (lompo). These complexes were/are roughly measured and drawn on graph paper, accompanied by a numbered list of plot (persil) owners that match to the numbers found on the map. there are also simple lists of owners (peraturan pemerintah, or "P^2"), but no maps. Most land is owned, based on traditional claims (adat), where farmers "own" the land they use (hak pakai).

Following the 1960s, when there had been 15 years of wide-spread flight from the area due to religious-political unrest (Darul Islam), people returned and reopened the land for agricultural production. They also participated in government-sponsored clearing of forested hills to plant clove trees (mostly after

1976). During the 1970s the government consolidated settlements but did not consolidate landholdings or conduct any aerial mapping or a cadastral survey. Farmers usually own several types of land in scattered complexes.

With all this change, the old land ownership records were mostly lost or destroyed. Most have not been replaced. No copies of most of these books exist. In Bulete Village, for instance, only one of the six administrative sub-areas (dusun) still has its original land ownership records intact. Nonetheless, farmers and village leaders indicate there are no major problems or challenges to land "tenure" in the service area.

Land Classification and Taxes. Land is still classified according to old systems established by the Dutch, with some more recent refinements. As the land has never had a complete cadastral survey based on aerial photos, tax assessments are estimated, based on the amount of land and its classification, as reported owned by a farmer.

Agricultural land is divided into a few categories according to its general productivity. These categories are basically: rainfed paddy (sawah tadah hujan); irrigated (pumped) paddy; and, dry/upland fields (tanah kering), which is either used for mixed gardens (ladang), tree crops (kebun), or cattle grazing (padang). Public pasture land is not taxable, but the other categories of land are, at least in theory, taxable. The value standards vary by province and even by district to reflect differences in productivity, although the general categories remain the same across the country.

Land taxes (formerly the IPEDA tax; now the PBB tax) are collected within each administrative sub-area of the villages. Comparison of the reported number of hectares of agricultural lands from village estimates, with the number of hectares estimated by the Taxation Department in Watampone, indicates the land is under-taxed across the Awo area. In this comparison, only 19 to 36 percent of the productive land is being taxed at any rate. Most of the untaxed land is in the hills, upon which thousands of clove trees have been planted. The bunded lowland areas, particularly the service area, the amount of land that is taxed correlates more closely to the reported number of hectares planted to paddy fields. An estimated 41 to 87 percent of the bunded lowland is currently being taxed.

Other forms of taxes include fees currently being collected for pump-fed irrigation. Existing local water users' associations also collect their own fees or receive in-kind goods to pay for the cost of pumping water into the fields, and to remunerate those who own and operate the pumps. The amounts paid are subject to negotiation each season, depending on yields, estimates of the amount of water used, whether any pump repairs were necessary, etc. However, levels are typically 15-25 percent of the yields, and are arrived at through discussion and consensus among water users and the pump owner.

Completion of technical irrigation will probably be accompanied by a drive to complete a cadastral survey of the service area and to upgrade land titles to the modern system. Tax rates and tax efforts should increase, as taxable capacity increases. Technical irrigation should raise income sufficiently to allow for future water users' fees to help pay for some of the necessary costs associated with operation and maintenance of the system.

Infrastructure

Roads and Bridges. The main north-south road is part of the Trans-Sulawesi Highway. It is kept in excellent condition in the project area. The government is steadily improving the substandard bridges on sections of the highway north and south of the project area.

Within the service area, the roads and bridges still need considerable improvement. The main road into Lompo Loang Village has been upgraded past the Awo River, but still lacks a permanent bridge across the river. Further in, the road rapidly becomes impassable during the rainy season since the surface is lower than the paddy fields. The main road into Awota Village is on higher ground than in Lompo Loang Village, so is somewhat better drained. However, it is still quite rough and probably impassable after heavy rains. This road is little more than a trail by the time it reaches the weir site and needs considerable improvement. The trail continues up to Dake, but is very rough.

Transport. The population living along the main highway have excellent public transport. Large buses going from Palopo to Ujung Pandang are available for long-distance trips, and minibuses and trucks provide local transport into Siwa, Sengkang, etc.

During the dry season, a few local trucks and small buses go into the interior hamlets of the service area. During the rainy season, much of the interior is cut off, except by horseback or on foot.

Markets. The main markets in the area are in the main subdistrict town of Siwa (formerly a part of Batu Village) and in Lauwa Village (also known as Kaluku Bocca-Bocca). There are very small local morning markets scattered through hamlets that allow for the purchase of locally produced vegetables, eggs, and chickens.

Other supporting agricultural infrastructure in the project area includes a number of rice mills (over 30), four warehouses and five kiosks selling agricultural inputs.

Electrical Power. A large proportion of the houses in Bulete have electricity from the PLN generator in Siwa. Electrical lines are slowly extending along the main highway, so that some houses in Lauwa also have electricity. Houses located off the main highway, however, generally remain without access to electricity, except where a few have purchased small generators.

Communications. There are short-wave radios in the subdistrict offices and in the military offices in Bulete/Siwa. There are no telephones in the area.

Other Local Facilities. Each village is provided with administrative office facilities and a facility for holding public meetings. Most hamlets also have recreational facilities in the form of a playing field.

Farm Support Organizations

In addition to the village and hamlet organizations, the farmer has an opportunity to receive support and assistance from three farm-oriented systems.

Existing Irrigation Organizations. There are more than 15 pumps in the three upstream villages[1], located along the banks of the Awo River, that elevate water to irrigate 750 ha of paddy fields in small field complexes (known as lompo), averaging 50 ha in size. These pump systems have been constructed during the last ten years and operate primarily during the transitional season to irrigate paddy. Paddy fields with access to pump irrigation are thus in the low-lying paddy complexes near the river.

Some pump-irrigated paddy complexes have leaders and formal organizations. The village-controlled system in Awota has a formal organizational structure, including two sub-units and a corps of officers. In contrast, most other commands have a simpler organization and are run by their owners and appointed water distributors (mandor). Water users, however, concur on the appointment of the mandor, actively participate in canal construction and maintenance, and water distribution, and help determine water user fees for the season. Fees are collected at harvest time.

Most of the farmers in the paddy complexes in rainfed areas are not formally organized. However, within paddy complexes, cultivators typically meet prior to the wet season to decide on the timing of cultivation, and crop varieties to be planted. Prior to the beginning of the paddy planting, traditional ceremonies (called mappanarang) are held which promote cooperation in agricultural work. Food is exchanged and the timing and the varieties of paddy to be planted during the wet season are discussed. Additional group ceremonies are held after transplanting and harvesting in some villages. These rituals help to legitimize and sanction partial group control over agricultural cultivation.

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[1]Data for Bulete Village is not available.

Many farmers also participate in loosely structured farmer groups (kelompok tani), whose leaders (kontak tani) maintain contact with local government-sponsored agricultural extension service field staff (Petugas Penyuluhan Lapangan, known as 'PPL'). Thus the local administrative environment, backed by custom, supports the current organization of agricultural practice and can be expected to support irrigation development activities.

Agricultural Extension. The agricultural extension service is charged with spreading new agricultural technology and information. To accomplish this, the extension agent undergoes periodic courses at Rural Extension Centers, establishes demonstration plots, trains "lead" farmers at the local level, and attempts to assist farmers in procurement of farm inputs.

In the project vicinity, there are working districts covering each of the village areas in the command, and with the districts, an equal number of extension agents (PPL). The agricultural extension center (BPP) for the subdistrict lies in Bulete, along the main road traversing Pitumpanua, immediately adjacent to the project service area. While the agricultural extension services are set up to have the maximum impact with limited resources, the personnel are constrained by a number of factors. In addition to discharging their duties to instruct farmers and partake in ongoing training, extension agents have administrative duties including supervising crop cuts in the field, record keeping and report writing. Their mobility is often limited.

Cooperatives. There is one Kooperasi Unit Desa, located in Lauwa. It is not particularly active.

Regional Development

Although the service area falls within one administrative district, the upper watershed is administratively split between two districts (Wajo and SidRap). In the interests of controlling further degradation of the upper watershed, greater coordination and joint control measures are required between these two districts.

There is a great potential for further development efforts in the project area. Basic infrastructure to the area is already in place or will be improved by the project. The area is served by a first-class highway and access to transport is excellent along this route. Completion of the irrigation project will improve the local economy and also result in the opening up of the more remote parts of the project area. Although there are a number of sectoral development plans relevant to the area, there are currently no well developed plans for any integrated approach to development of the Awo area.

Attitudes Towards the Project

The farmers of the area are historically, and currently, very industrious and enterprising. They strongly desire to obtain irrigation, realizing that it would allow them a major breakthrough in agricultural productivity.

CHAPTER V

POTENTIAL ENVIRONMENTAL IMPACTS

Methodology Used to Identify Project Effects

Identification of the potential impacts of a particular project usually are based on several information sources, any of which may prove appropriate or inappropriate upon close examination. These sources of information are:

1. The published literature on similar projects, worldwide;
2. Local knowledge of problems that have been experienced on similar projects;
3. Concerns expressed by local officials in reports or at formal meetings;
4. Extrapolation of baseline environmental conditions by analysis of the interaction of resources with the project.

All of these sources have been used to some extent to determine the likely environmental problems with the Awo project.[1]

Local knowledge and concerns were addressed through the "scoping" activities for the project environmental studies. On 14 April 1988, a meeting was held in Ujung Pandang, with 31 participants, representing a number of government agencies, USAID, and technical consultants. The objective of the meeting was to bring to light concerns over general and specific effects of both the Awo and Salomekko Projects. An account of the meeting is presented in Appendix C to this report.

Participants discussed both positive and negative interactions of the project with its environment. The same general areas of potential impact were used in the meeting as in this report: water, land, biological, and socioeconomic resources.

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[1]The theory and methodology currently available to analyse a complex series of interactions involving changing technology and human activities with the environment is incomplete and still evolving. Prediction of impacts in this context, with so many largely unquantifiable variables is an inexact science and does not, as yet, lend itself to very much analysis using numerical modeling.

The general areas of concern were largely those already identified by specialists at USAID and by the Technical Assistance Team. These may be summarized as follows:

- Availability of river water for downstream users.
- Interactions of the project with the clearing of the watershed: effects of clearing on the project and effects of the project on clearing.
- Possibility of adverse health effects among downstream water users.

Pre-Construction Phase

Work during the pre-construction phase such as site surveys, public meetings, and test bores have produced generally positive social impacts among the local population, and raised public interest in the likelihood of receiving irrigation.

The greatest negative impact during pre-construction will be acquisition of some agriculturally productive land to be used primarily for supply and drainage canals. Since the land area to be taken is small and the local population is enthusiastic about the project, the impact should be small. It is important, however, that negotiations for compensation to the villagers for their land be conducted in an expediant and fair manner. Otherwise significant delays in the project and ill will amongst the populace could be generated.

It should not be necessary to resettle anyone as a result of the project construction.

Construction Phase

Potential environmental impacts during the construction phase will be mostly temporary ones. The local population will benefit positively from increased employment opportunities and a greater demand for locally procured goods and services while construction crews build the system. Prior to construction of the weir and canals the roads into the project site will be upgraded with the resultant improvement in transportation services in the area.

While construction is underway, the local population will be inconvenienced somewhat by increased traffic, noise, and dust; and there will be disruption of agricultural production along some of the canal routes as they are built. The disruption caused by the contractor, however, should be kept to a minimum. Clearing in the weir pool and borrow areas should be limited to just those areas, with fences if necessary, and contractors should attempt to minimize disruption of the daily activities of villagers. Dust during the dry season can be controlled by watering roads, and should be a responsibility of the contractor. The labor and logistics camps will be placed where they will create minimum impact on the environment and villagers. Pit toilets will be provided and relocated occasionally. Trash will be burned and all hazardous materials such as used motor oil should be stored and later removed from the site. The contractor should be prepared to supply his laborors with housing, food, drinking water and firewood when these items are scarce locally; otherwise competition for resources with the indigenous population will result and create price inflation. It is especially important that the laborers not be allowed to take wood from the watershed area, except where clearance for construction is necessary, since this area must be preserved for soil and water conservation.

Post-Construction Phase: The Operation Period

Given that the SSIMP surface water projects are only small to medium-scale, and socially and environmentally non-controversial, the investigation of potential impacts has been relatively straightforward. Virtually all the potential environmental impacts that have been identified pertain to the post-construction phase, also known as the operation period. These potential impacts are presented here, following the same sequences as earlier chapters: water, land, biological, and socioeconomic resources. They are summarized in Table V-1, "Summary of Environmental Impacts," found at the end of this chapter.

Water Resources

Water Quantity

Streamflow and Water Distribution. The primary objective of the project is to divert water from the Awo River for irrigation during the dry season and the early part of the wet season.

Mean half-monthly flows in the river range from 10 to almost 40 m^3/s, as shwon in Figure V-1. They are thus substantially greater than the projected maximum irrigation requirement over the entire year. It is only in particularly dry years that river flow may be less than the projected irrigation requirement, for brief periods. In the simulated data set (Table IV-2 and Figure V-I), this occurred in only one year of the ten year record, in the month of November.

As a result of the project, flows in the river downstream of the weir will be reduced by 30 to 40 percent in a transition dry season. There will therefore be less water in the river for downstream users, and this will have some effect on uses such as bathing, laundry, drinking water supply, and livestock watering to the extent that these are dependent on the river. The practical consequences of this change, however, are likely to be fairly limited. Surveys have shown an average per capita water requirement of 112 l/d, which would correspond to a flow of only

0.002 m^3/s for the population of approximately 1,500 persons in Jonga-Jonga, the hamlet just downstream of the weir. This is a minor fraction of the normal river flow, and so under most circumstances adequate water will remain in the river for these purposes. Under normal conditions, it is unlikely that the effects of project operation on downstream flow will be distinguishable from normal fluctuations in discharge.

In contrast, in very dry years the project may be required to divert the entire river flow to the irrigation system. Just below the weir, flow will cease and water will be confined to pools in the river. These pools will continue to provide a source of water for bathing, laundry and stock watering for those dependent on the river. There will probably be adequate water for these purposes for the brief period (up to one month) during which these conditions will occur. If the project irrigation scheme is is enlarged to 4,700 ha by inclusion of the Eastern Extension Area (2,200 ha) then the dry river period could be for as long as three months (Figure V-2). Many persons will turn to the use of wells, or will make use of water in the irrigation canals which will be easily accessible. With increasing distance downstream, input of irrigation return flows and tributary discharge will tend to increase the flow of the Awo River.

Families living a considerable distance from the Awo River and closer to the main or tertiary canals may be expected to use these water sources for laundry and bathing. These activities probably will not cause serious damage to the watercourses, since good access is provided in the project design. Livestock watering, particularly the immersion of buffalo, requires more water, and the river may not be as convenient as the main canals. There will be a strong temptation, especially for children, to take buffalo to the nearest major watercourse. Watering buffalo in canals is very damaging to the canal banks and must be discouraged through construction of washing stations and an education program (see Environmental Management Plan).

Thus the impact of low river flow on domestic water use is expected to be minimal, even if the project is expanded into the Eastern Extension Area. Overall, the water table is high (below the weir), and it is relatively easy to dig shallow wells of less than 4 m depth that are adequate for domestic use. Also, hamlets immediately below the weir, as well as elsewhere, will benefit from the presence of large canals passing relatively close by, where the quality of water will be no worse than that taken from the river. No mitigation measures are therefore necessary since the supply of domestic use water is expected to remain plentiful, just as it currently is.

The river is currently used to transport wood and rattan harvested from the upper watershed. The weir will stop all traffic from continuing farther down the river. Environmentally, watershed destruction is viewed as detrimental to the project (see Land Resources below) and therefore any effect which inhibits these practices is seen as beneficial.

Fig. V-1 : WATER AVAILABILITY AND IRRIGATION DEMAND

IN THE PROPOSED AWO IRRIGATION AREA (2,500 Ha)

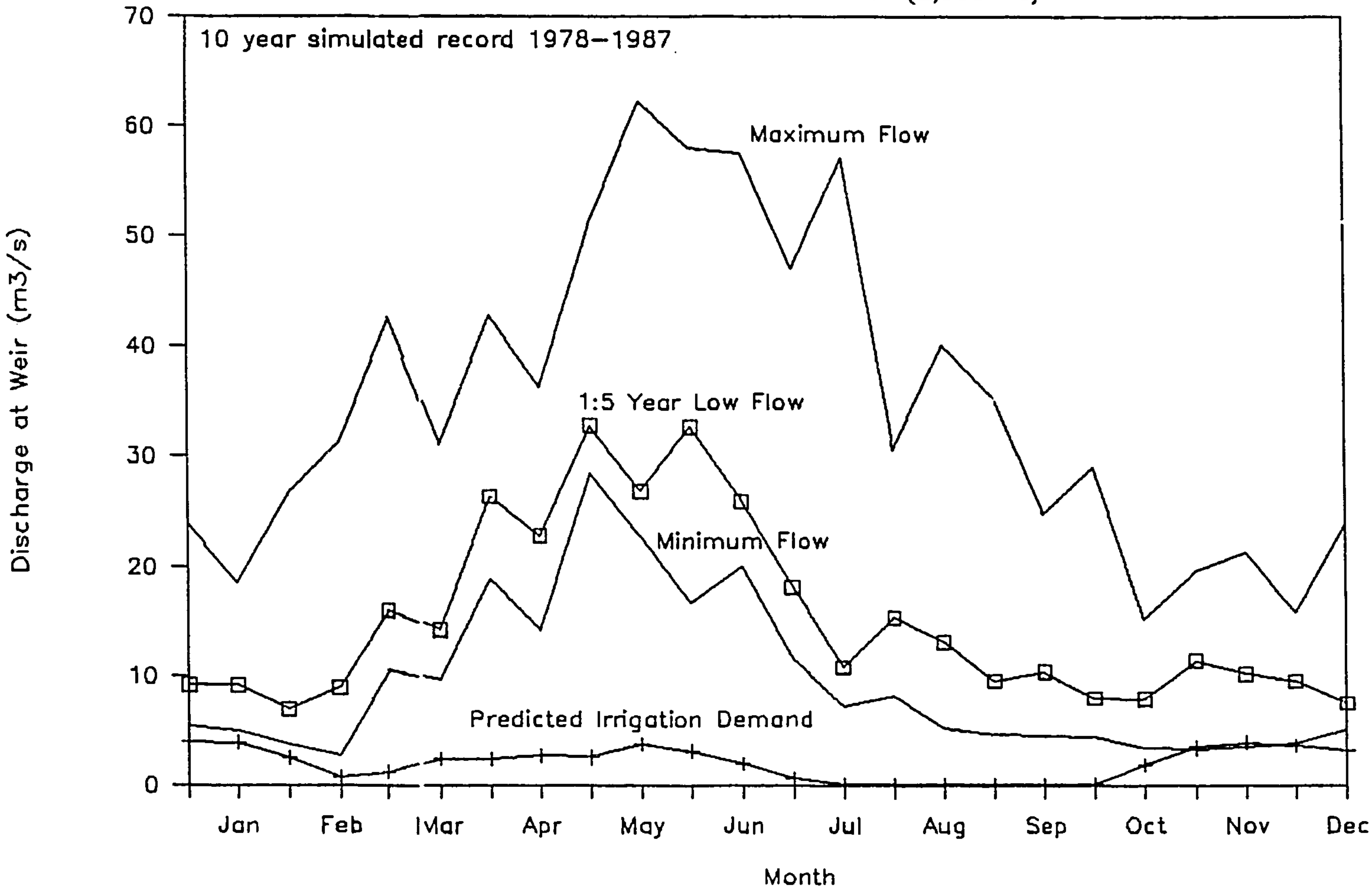
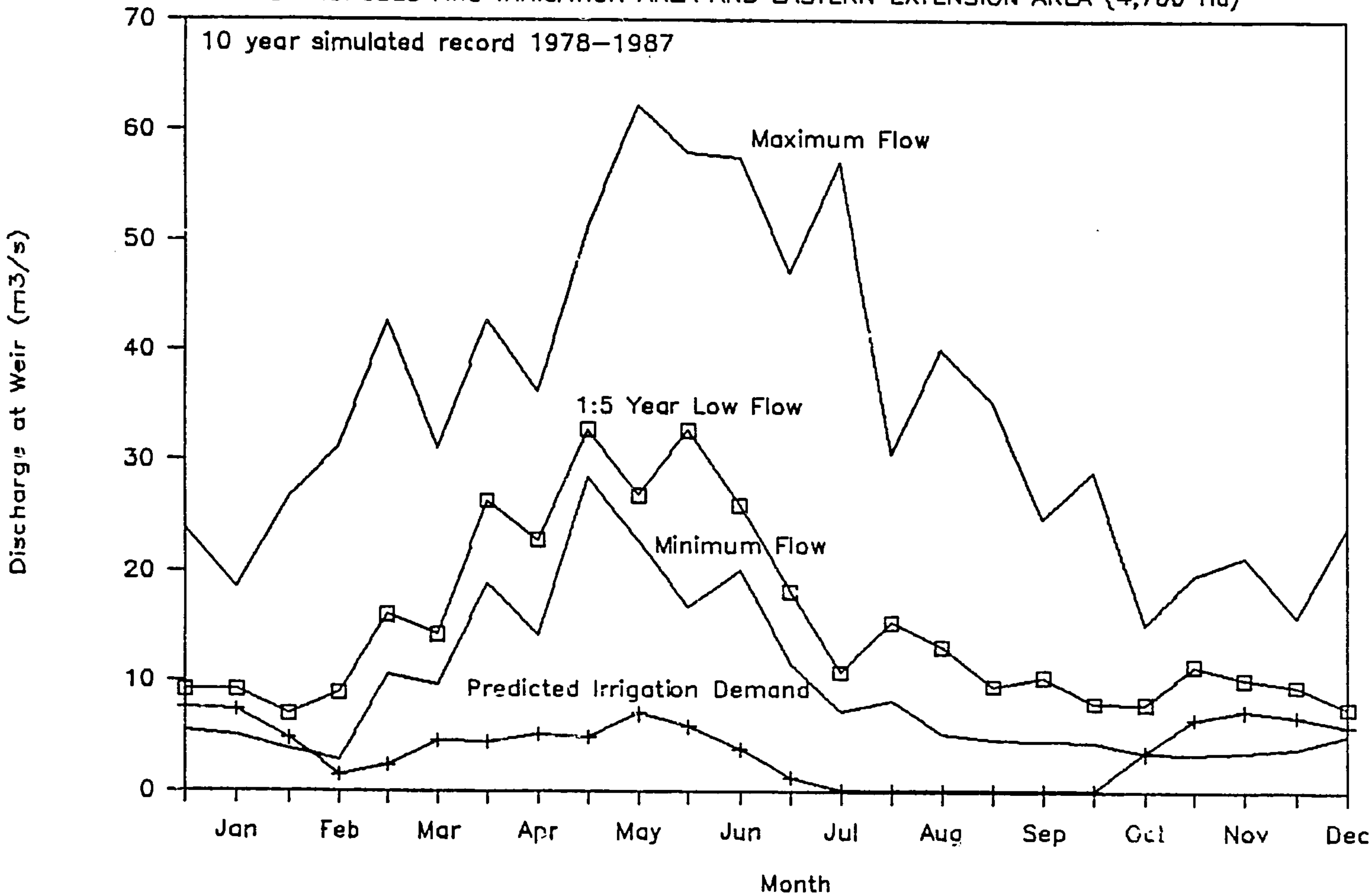


Fig. V-2 : WATER AVAILABILITY AND IRRIGATION DEMAND

IN THE PROPOSED AWO IRRIGATION AREA AND EASTERN EXTENSION AREA (4,700 Ha)



The amount of water available in the lower reaches of the river, downstream of the service area, will decrease through project operation, due largely to evaporation and evapotranspiration in croplands. During the dry season, when exposed surface water in palawija fields will be much lower than during the wetter months, the volume of evaporation will be lower, but irrigation runoff will also be less. Estimation of the discharge of the river downstream of the service area, compared with discharge at the weir, is complex, depending on many uncertain variables, but flow will be lower than under pre-project conditions. This should not affect fish pond operators in the estuary, who currently do not pump from the Awo river into their ponds. They rely instead, primarily on rainwater. River flow in the dry season is so low that salt water intrudes several kilometers up the river; the option of using fresh river water to control fish pond salinity is therefore not available to them. This situation will not be changed by the project. It is possible that salt water will intrude somewhat farther up the river during the dry season than is currently the case. This will depend upon the actual pattern of discharge in any particular year. Informants in the hamlet of Bulete, just upstream of the main highway, report that the river at that point can be saline in the dry season, although it was not when examined in December 1989 (see Table IV-3). At present some inhabitants of coastal hamlets travel up the Awo by boat to collect fresh water for drinking purposes. They may have to travel somewhat farther up the river for this purpose during very dry years.

Runoff and Drainage. The application of irrigation water, even under carefully controlled conditions, will result in increased flow in drains and then in the tributary streams into which they discharge. There also is likely to be a somewhat greater domestic waste-water flow into the same drains, due to wider distribution of water in the canal system.

Water Quality

Upstream. No water quality changes are expected to result upstream of the weir as a direct result of the project. Continued opening up of the forest, whether aided by the project or not, will indirectly increase the load of suspended solids. Clearing is also known to result in increases in dissolved ion content, since these are not as efficiently retained in the biotic structure. Use of the cleared area for pasture, with increased cattle populations, will lead to higher nutrient and coliform levels in the river as wastes are washed off the land.

Service Area. Wet season water quality downstream of the weir will not be significantly changed as a result of diversion at the weir or irrigation return flows, since the assimilative capacity of the river is high. During the dry season, the flow in the first three or four kilometers downstream of the weir will often be reduced by 20 to 80 percent (and sometimes cut off entirely). Waste water discharges from drains containing human and animal wastes may cause some contamination where dilution flows are absent. Irrigation return flows farther downstream, while containing some human wastes, will be of better quality than the flows from the more-upstream areas, where the better-quality irrigation return component is proportionately less. The extent of possible contamination cannot be estimated on the basis of available flow information, but its effect on the local population probably will not be serious if, as expected, people turn to wells and the local canal system for domestic water.

The two causes of water quality degradation under with-project conditions will be inputs of agricultural chemicals to the irrigation return flows and reduction in the assimilative capacity of the river due to reduced flows. Human and animal wastes will continue to flow into the smaller rivers and into the Awo, year-round, but only in the dry season is this likely to cause water quality to be measurably worse than at present.

The volume of agricultural chemicals in the runoff is not likely to be large enough to cause toxicity problems, since the majority of such input will be phosphate and nitrate nutrients. These may cause algal blooms where the river is sluggish.

Downstream Flow. Concern was expressed at the environmental scoping session that the irrigation return flows would degrade water quality in the lower reach of the river to the extent of making it unfit for human and animal use or for aquaculture. The two components of irrigation drainage that cause concern, fertilizers and pesticides, act differently. The first causes problems of excess nutrients and urea, the second problems of toxicity. The levels of fertilizer residues in return flows probably will not be high enough to cause problems when diluted by river flows, unless the farmers suddenly become excessive in their applications of fertilizers. Pesticide residues cause problems in two ways: direct toxicity and food chain effects. The first occurs with heavy discharges of chemicals, such as toxaphene or endrin, whose water solubility is great enough to permit the chemical to reach toxic levels in water. Such levels usually occur only after spills or careless discharges. The food chain effects are largely limited to chlorinated hydrocarbon insecticides (such as DDT, chlordane, and lindane) and a few rodenticides (such as 1080). None of these chemicals appears to be in use in Sulawesi, where the insecticides of choice are carbamates and organophosphates, which are rapidly degraded.

Ground Water

Quantity. The project may cause a slight increase in ground water recharge, due to percolation of irrigation water at the time of year when surface water is not now available. Households that do not dig wells at present may find the water table within reach.

The other side of this question, raising the water table to the surface, thus causing waterlogging and soil salinity problems, also is the subject of agency concern. The drainage system is designed to prevent waterlogging by removing excess surface water. Soil and water salinity is of course already high in the far downstream estuary area near the sea, but the project should have neither a negative nor a positive effect on this area.

Quality. Some contamination of ground water may occur in areas of exceptionally high fertilizer use, but the effect would be largely one of taste. It is unlikely that, even with maximum project development, this will be a problem.

Contamination by pesticides is a greater likelihood, not from normal crop applications but from careless storage or formulation, or accidental spills. Repeated mixing of pesticides at one spot often results in substantial soil contamination, especially when equipment is washed in the same area after use. This type of contamination is unlikely to be detected unless a sudden discharge of concentrated chemical results in enough contamination of ground water to cause illness or fatalities. Such incidents probably are not as infrequent as they appear to be from the lack of reported cases.

Land Resources

Land Use and Capability

Aproximately 65 ha of primarily agricultural land will be acquired for primary and secondary canals. A similar amount of land will be taken by tertiary, quaternary and drainage canals. Up to 31 ha (66 in extreme flood years) of brush-covered land will be inundated by the weir pool. An undetermined but small (less than 10 ha) amount of pasture and brush land will be taken for other things such as the weir intake structure, borrow areas, housing and offices. The approximately 5 percent of agricultural land lost to canals will be more than made up for by the increased production brought about by the irrigation scheme.

Within the service area little change in basic land use is expected; land now in agriculture will remain in agriculture and any hillier land will remain in pasture, brush, or tree crops. Some marginal land that is now considered too sloping for rainfed paddy fields may be leveled and terraced when irrigation becomes available. Some farmers at the fringes of the service area hope to do just that and take advantage of available irrigation. Others hope to use pumps and take water from canals to provide water to the higher ground, as they already do to a limited extent. The soils in most of those areas are relatively porous for paddy fields, however, and would require high water input for paddy production. Irrigation may be made available to the Eastern Extension Area (2,200 ha), in which case aquaculture in the area may benefit. Fish and shrimp ponds may receive freshwater indirectly from paddy drainage.

Land clearing in the basin upstream of the weir, already proceeding at a pace causing some alarm in the Forestry Department, may be accelerated by the project, due to improved access to markets and to sources of supply. A new settlement of loggers and a sawmill have begun operating during the last year next to the water level recording gage close to the road. Rattan is also unloaded from rafts at the same location for further transport down the road to the processing area in Paojepe.

Upgrading of the road system to the weir will improve access to the hamlet of Dake and will probably lead some entrepreneur to provide bus service. Farmers growing market crops on the slopes of the upper watershed will see this as providing better access to markets in Kaluku Bocca-Bocca, and Siwa. There are already a number of farmers who do not live in the area, who have permission to cut and burn large trees and to raise crops in the upstream area, using shifting cultivation techniques. Others regularly burn the grasslands to provide fresh-sprouted grass for their cattle. These farmers are likely to induce more relatives and friends to move in near them. There is no reason to believe that clearing in the watershed will be controlled in the near future, unless firm controls are implemented by local and regional government agencies. Access to parts of the upper basin already occurs from the districts of SidRap to the west and Luwu to the north. Movement into the basin from these directions will not be affected by this project.

Proper application of irrigation water in a system with effective drainage does not cause soil waterlogging, the fear of soil scientists who have observed salinization in areas where water tables have risen. Salinization is most likely to occur in areas of low relative humidity and hence high evaporation, when irrigation applications are excessive and drainage poor. These conditions are not expected to occur in the Awo service area.

Erosion and Soil Movement

Continued land clearing and hillside agriculture in the Awo basin is almost certain to produce a higher sediment load in the river, probably reaching carrying capacity at some times of year. This has been taken into account during design of the irrigation project, however. Sediments that settle in the weir pool will be sluiced out before entering the canals. During periods of high flow, much of the sediment deposited in the pool at lower flows will be resuspended and swept downstream. A section of the canal located just downstream from the intake will be built to serve as a trap for finer sediment that does not settle in the pool.

With or without the project, the expected increase in clearing in the upper basin will increase the silt load of the Awo and result in greater delta formation at the river's mouth. Tree crops (cloves and cacao) that are being heavily planted on the cleared upper slopes do not adequately prevent soil movement and may actually cause significant increases in erosion. This erosion may have a negative effect on shipping channels and on the biota in the coastal mangrove and off-shore reefs. Within the irrigation system, exceptionally high silt loads may clog canals, reduce project efficiency, and lead to higher maintenance costs.

At the present time, clearing and agricultural practices in the hilly parts of the basin do not appear to be causing severe erosion. This may be due to the gradual nature of the onset of the rainy season, in which small rainfall events stimulate germination by seeds and corns in the soil, to the extent that root growth is sufficient to hold the soil when the heavier rains come and foliage dulls the force of the raindrops. Another reason may be that most settlers practice multiple cropping during the several years that their clove trees or coffee bushes are maturing. Peppers, cucumbers, beans, and maize are intercropped, beginning just before the onset of the rains.

Runoff

The most important effect on the project of clearing in the watershed will be that it will alter the runoff characteristics, enlarging and steepening flood peaks and diminishing the flows between rainfall events. With essentially no storage capacity, the project's operation may be seriously affected.

Farming Systems

Cropping Patterns. Initially, farmers with access to second crop irrigation are expected to put in paddy for marketing, with some to attempt a third crop season, consisting of palawija. Experience in Indonesia has shown, however, that the higher returns obtained by vegetables, groundnuts, tobacco and melons gradually cause farmers to switch to those crops. As the road network improves over the next few decades, farmers in the Awo area will find better access to urban markets and the middlemen will be more willing to purchase fragile produce such as tomatoes.

The increased cash flow available to area farmers may be expected to lead to increased mechanization of field preparation. There will be more pressure toward mechanization if the keeping of draft animals becomes more difficult as pasture land is reduced.

Grazing and Fodder. More intensive cropping of lands that now serve partly to support the large herd may leave livestock owners looking for more grazing land. Some owners, faced with higher demand for household labor in the fields (including that of children who do much of the livestock tending) may elect to sell some of their animals.

About 20 percent of the land area of Awota village, located along the southern boundary is unavailable for local use since it has been fenced-off for commercial cattle production by PT Bina Mulia Ternak. Expansion of grazing land for village use would necessarily go farther west and north into the upper catchment. Lack of water may make this upland area unsuitable for buffalo.

The cutting and marketing of fodder (including aquatic weeds) from elsewhere, may support some enterprising individuals.

Area farmers, however, continue to convert to using hand tractors, thus reducing the need for draft animals. There are now at least 80 such tractors owned in the four villages, and many more are seasonally rented-in.

It may be possible to continue to promote the livestock industry as well as developing the project area for irrigated crop land. Results of a study by Fenco (1982)[1] on livestock development for Sumbawa may also be applied to South Sulawesi, where conditions are even better. The study noted that the natural carrying capacity of unimproved pasture land is approximately 0.25 to 0.5 AU (animal units) per ha. Enhanced pasture productivity, with investment of considerable time, management ability and money, can achieve a carrying capacity of up to 2.0 AU per ha.

Continuously cropped land generates crop residue of four to ten tons of useable dry fodder for livestock per ha per year. This fodder can consist of rice straw, soybean and mungbean hays, and maize tops. Further, along with the crop residues available for feed from an irrigated crop area, improved fodder grasses and trees can be grown along bunds and canals, also contributing to the quality and variety of feed generated for livestock. Altogether, an irrigated, continuous cropped area through fodder and feed generation can achieve the same level of carrying capacity at 2.0 AU as an area of improved pasture, with the extra added boons of valuable crop production and an improved quality of water supply.

To illustrate economically, a farm of one ha under a continuous cropping pattern of Paddy/Palawija/Palawija can produce a net financial return from production of over Rp 1,000,000 per year. Employing improved pasture as an alternative use of the land, two adult animals per year can be sustained. Assuming a high herd growth rate of 20 percent per year, that would provide 0.4 cullable animals a year, which at a value of Rp 400,000 per adult animal, would provide Rp 160,000 per ha per year in gross income from livestock. If we add to that figure Rp 10,000 in draft income attainable per season per two adult animals, and sum that over three seasons, we have an additional Rp 30,000 per year, bringing the total gross value of the livestock operation up to Rp 190,000 per year. This level is still less than a fifth of that attainable from the value of the irrigated crop land alone. In fact, as stated earlier, the benefits accruable from improving pasture are also largely attainable at no extra costs from irrigated crop land.

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[1] Sumbawa Water Resources Development Planning Study, Technical Report Volume 9, Agriculture / Livestock, Fenco Consultants, Ltd. (Lavalin International Inc.), 1982, for Ministry of Public Works, DGWRD.

Therefore, where water resources can be developed to improve agriculture, irrigated crop land production should be favored over livestock development because of achieving not only increased crop production, but also enhancing livestock productivity to comparable levels attainable by improving pasture. In areas where water resources can not be developed to support irrigated crop land, livestock and ranch programs could be pursued to convert the marginal productivity of extensive areas of scrub and grassland into economically valued output (meat).

Agricultural Chemicals. The amount of fertilizers and pesticides applied is expected to increase gradually, as a result of increased pest populations, better extension advice, and more sophisticated farmers, able to see demonstrable improved returns with chemical use. The types of fertilizers are not expected to change much over the next few decades, but pesticide selection and formulation will change as new compounds become available.

The introduction of toxic compounds in an area not accustomed to them poses risks of improper storage, handling, mixing, and disposal of chemicals. This is especially true when more toxic compounds or different formulations are introduced. Liquid organophosphate compounds, for example, are rapidly absorbed through the human skin and a few drops of the concentrate can prove fatal. Operators often grow careless when mixing wettable powders, due to the lack of contact risk, but similar carelessness in handling the liquid concentrates can prove fatal. The switch from DDT to Malathion in Pakistan during the 1973 malaria epidemic was not accompanied by adequate training programs and several operators died from contact poisoning.

Pesticides in rural areas often are not sufficiently protected from accidental ruptures of bags or wetting by rains or floods. Such failures result in environmental contamination that usually goes unnoticed, except in the rare instance of mass illness.

The possibility of ecological effects of pesticide use, other than from a major spill or other accident, seems remote, since the chemicals used at present are nonpersistent and there is a trend toward more specific, short-lived compounds. Intensive use of chlorinated hydrocarbons (DDT, toxaptene, chlordane, lindane, etc.) could result in severe impacts on the tambak downstream of the service area, especially on ponds producing shrimp, but their use is very limited so such effects are extremely unlikely.

Biological Resources

Terrestrial Habitat

The most significant habitat change resulting directly from the project will be the conversion of some 31 ha into a pool and weir site. Some qualitative changes will occur in the vegetation along the edge of the pool over a number of years (probably 20 or 30), due to the presence of higher ground water near the pool. This will favor trees that are less tolerant of drought conditions, and may result in a narrow belt of evergreen vegetation along the margin of the weir pool.

The destruction of wildlife habitat in the Awo basin appears likely to continue with or without the project, unless some means is found to prevent illegal land clearing and the official sanctioning of dubious commercial tree crop planting programs. The problem is not limited to the Awo system but occurs throughout South Sulawesi, especially in the Latimojong Range. Whitten, et al. (1987) show that land clearing in Sulawesi often is preceded by selective logging, which involves access roads and creates the initial openings that are followed by cultivators. These may plant annual crops such as maize, cassava and upland paddy, or tree crops, such as cloves and bananas. Annual fields often are left fallow after a few years of cropping or are abandoned altogether. Sometimes they are burned to discourage brush and forest regeneration and maintain grasslands for cattle forage. These conditions certainly exist now in the upstream area along the Awo River.

The gradual but eventually total destruction of habitat is a process going on throughout Sulawesi at varying rates. In the Awo basin, forest degradation is greatest in the middle part of the basin and appears not to have begun in the far upper reaches of the watershed. There are several scenarios under which the irrigation project could augment clearing of the upper basin:

- Persons immigrating to the Awo area or seasonally living there, in hopes of acquiring irrigated land, may find themselves unable to do so and therefore turn to "available" land elsewhere in the region.
- Persons seeking new lands for clearing may find that the improved roads provided by the project offers easier access to the hinterland.[1]

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[1] Note, however, that the Project will not build roads into the hinterland, but will improve access to the service area by upgrading existing roads extending for only about 10 km from the main coastal highway.

- o Entrepreneurs looking for new markets for forest products may see the growing prosperity of the Awo farmers as offering lucrative markets for products of the forest (fuelwood, timber, game) or for fruit crops grown on cleared hillsides.

- o Laborers brought into the area by the construction contractor or entering on their own seeking project work may stay on and clear land for subsistence agriculture and cash cropping.

- o Sport hunters may go farther upstream on improved roads to shoot wildlife.

All of these scenarios have been seen on projects elsewhere in the developing world, where a new project provides improved access to a forested area and word gets around that there is land there for the taking.

Initially, the results of land clearing are habitat destruction and wildlife loss, and subsequently the waste of natural resources, erosion of hillsides, and siltation of streams.

Commercially Important Species. Many tree species in or near the service area, utilized today on a noncommercial basis for fuelwood or lumber, may gain market value as the farm population has more disposable cash and less time for gathering forest products. Some members of the community, probably in the at-risk segment (i.e. those that do not participate directly in project benefits), and new arrivals, may begin to exploit the more accessible forest to sell wood to the target population (those receiving irrigation). This process has already commenced with the establishment of a sawmill at the location of the project water level recorder, immediately downstream of the weir site. The ten or so houses built constitute a small community who have moved here to cut trees and carry sawn wood out on their trucks. If exploitation exhausts the forest resources near at hand, these and other entrepreneurs will reach farther into the interior, making forays themselves or buying from others who cut wood in the watershed. One effect of the project will be to stop the floating of logs down the river, since the weir will essentially block free passage. If tree extraction from the upper watershed remains difficult, the process of cutting trees for commercial sales may be slow. At present, trees even a few kilometers into the watershed forest have so little sale value that colonists clearing land customarily burn all felled trees that they do not need themselves.

Also, the future of the rattan industry in the [illegible] is uncertain. Those collecting commercially important [illegible] in the area already need to go far up into the catchment. Although rattan needs only seven years of growth to be commercially harvestable, the clear stripping the hills of trees has destroyed this industry in the lower foothills, and there reportedly is no systematic attempt at rotating the harvesting areas so that regrowth can proceed. Similar problems exist with processing. Reportedly the rattan from this area is poorly processed and consequently, of inferior quality. One leading exporter of rattan furniture produced in Ujung Pandang stated flatly that the rattan processed around Siwa was useless for export-quality production and that attempts to re-orient the processors to improve the quality had been met with indifference. Thus, this rattan is of low value and is used only for local production of cheap furniture.

Construction of a weir will have an effect on rattan collection similar to that on logging. The river will be blocked and new means to transport the material will have to be found. Rattan will probably have to be trucked or dragged down to the processing area. While this is not an insurmountable problem, it will force the rattan industry to make some adjustments.

Rare and Endangered Species. Project activities are unlikely to affect directly the habitat or populations of any of the five Sulawesi mammals possibly found in the Awo area, considered by the International Union for the Conservation of Nature to be endangered or threatened. The fauna of Sulawesi, despite a century of study, is still believed to contain many species unknown to science, according to Whitten, et al. (1987). Some of these may well inhabit the unspoiled forest and streams in the upper reachs of the Awo basin, although they are unlikely to be limited to that area. The ongoing clearing of the middle watershed is contributing to the gradual depletion of Sulawesi's forests, perhaps squeezing its natural fauna into smaller and smaller areas and leading to the eventual extinction of species, many of them scientifically undescribed or little known.

The Awo area is currently part of a sport hunting area where unidentified large animals are shot at night by hunters traveling on pickup trucks using spotlights to stun and prevent the animals from running away. Improvements to the local roads may increase hunting, leading to further stress on the larger wildlife species. While most of the animals reportedly being hunted are wild deer (still plentiful in South Sulawesi), and "wild" cattle, it may be that these sport hunters are also seeking anoa and babirusa. Thus the sport hunting may have a direct impact on endangered species.

Those hunters using guns are not locals, but are reportedly wealthy businessmen coming mostly from Jakarta (Indonesians are not generally permitted to own any firearms). Thus, any local education program would probably have little immediate effect on hunting practices. An irrigation project, especially a small one, that happens to be located in the area where hunting takes place, should not be held responsible for causing or controlling this ongoing process. It is important, however, that the improved access raods for the project do not exacerbate the situation. Such a situation should be addressed delicately. One danger is that too much attention be focused on the possibility of endangered species occurring in the Awo catchment, since this very attention may result in even more sport hunters descending on the area before any control program (that would have to be ordered by the military and top provincial authorities) could be implemented.

Crop Pests. This group of commercially important species consumes crops in the fields before and after harvest and in storage. No crop is immune, but grains are particularly vulnerable. The ecology of many crop pests is such that their populations decline locally, through mortality, dormancy or emigration, when the food is not available. Multiple cropping of the same food type allows pests to increase their populations geometrically, often reaching highly damaging densities. Many small birds and rodents are able to reproduce at such an early age and so repetitively that a second plant crop supports a whole second generation of pests. Experience in other areas in Sulawesi with technical irrigation indicate that appropriate use of pesticides, biological control techniques, and vigilance on the part of farmers to respond promptly to local outbreaks will largely compensate for any such threats. Birds are rarely the sort of grain pests in Indonesia that they are in some parts of the world (especially Af.ica), but losses to birds are rarely quantified.

Aquatic Habitat

Aquatic Plants. The proliferation of aquatic plants in irrigation systems is a widespread problem in Indonesia and elsewhere. The increased use of fertilizers and the presence of water in drains year-round allows plants to survive the dry season, when they would otherwise dry out and die back. The problem is less severe in the larger canals, where water velocities are rather high and nutrient levels low, than in the drains, where flows are sluggish and all sorts of waste nourishes plant life. In the Awo weir pool, flows are similarly expected to high enough and depth great enough to minimize nuisance growths. Pest plants are of several sorts: floating, emergent, and submerged. All three should be expected in project waterways and all block the effective flow of water. Continual maintenance is necessary to eliminate such effects. Some water weeds, such as Hydrilla verticillata and water hyacinth Eichhornia crassipes can be used as feed for cattle, pigs, ducks and chickens. The grass carp Ctenopharyngodon idella will feed on various types of aquatic weeds and have been used for weed control.

Mosquitoes can be controlled to some extent by introducing mosquito fish (Aplocheilus panchax) into the drainage canals. The increase in canal area will almost certainly produce more mosquitoes unless control measures are established. Supply and drainage canals must be kept free of blockages that might otherwise produce stagnant pools where mosquitoes can breed. When crops are not being irrigated, canals should still be continually flushed or allowed to dry out.

Fisheries/Aquaculture. The weir will form an obstacle to upstream fish movements in the river. In the case of the diadromous species in the river, they will be restricted to that portion of the river downstream of the weir. The status of the permanent freshwater species should remain as at present. Upstream movement in the wet season will occur from pools and other refuges above the weir, including the weir pool itself. Downstream of the weir, the lower water flows in the dry season may make those fish somewhat more susceptible to predation, including harvesting by fishermen. It is unlikely that the amount of animal protein in the diet of local people will be either significantly increased or decreased by the expected changes in flow in the river. This will therefore result in a small loss of habitat for these species, when considered on a regional basis. All of these species are common and widely distributed in Indonesia, and this loss will not affect population status in any case. Also, none of these species are the focus of a commercial fishery.

Under present circumstances, fish harvested from the river probably provide a minor supplement to the amount of animal protein in the diets of local residents, who greatly prefer the readily available marine fish. In the middle reaches of the rivers, fishing provides, at best, the occasional meal to farm families living in the irrigation area. Almost certainly there are no families who rely on such fish as an important food source or source of income. In the downstream estuary reach of the river, fishing is more important as a livelihood, but most fishing families look to the sea or to fish ponds, and the river is a very minor source of fish in the overall scheme.

The project, through reduction of dry season flows, is not expected to significantly affect this situation. At low water levels most remaining fish in the pools in the middle reaches of the river (below the weir and above the estuary) are probably harvested by artisanal fishermen. Any reduction in flow might mean that this would happen earlier in the dry season, but such effect would be negligible in importance.

In the estuary area, any reduction in flow would mean a further intrusion of saline water up the river some short distance. Probably this would result in some increase in the habitat of salt water fish, but might have some unknown, deliterious effect on species seeking mildly saline water for breeding purposes.

Recent years have seen significant development of fish ponds for the culture of milkfish and shrimp. Optimum levels of production are limited by, among other factors, high salinity levels in the dry season. Fish pond operators do not currently draw water from the river in the dry season for purposes of salinity control, since there is already intrusion of seawater well upstream. The project is thus not diverting freshwater for irrigation at the expense of fish pond operators. The project will therefore not negatively affect the operation of fish ponds. An irrigation water supply to the eastern extension area will make available more freshwater to fish ponds from paddy field discharge.

Socioeconomic Resources

Economic change, resulting from increased agricultural production, is the primary objective of this project. As such economic benefits are not considered environmental effects. Secondary social effects may be expected from most resource development projects, due in part to social, geographic, and economic division of the population. For the purposes of predicting secondary effects, the local population may be considered in several categories (USAID, 1980):

1. Target Population. This is the group at which the project benefits are directed: in this case, farmers who will receive additional irrigation water.

The farmers with access to the irrigation water are expected to experience substantial gains in net income and in standard of living, which will be reflected in better nutrition, increased purchase of consumer goods, greater demand for education, and increased communication with areas outside the project area. These farmers may be expected to hire out many of the tasks that they now do themsleves. This will tend to distribute the economic benefits beyond the target population.

2. At-risk Population. This group is outside the area of direct project benefits, due to location, occupation, economic status, or whatever reason, but vulnerable to some adverse secondary effect, such as loss of resource, deprivation of an amenity, or even some minor inconvenience.

The members of this group include upland farmers and livestock owners on non-irrigable land, merchants, fishermen, laborers, fish pond farmers, forest product harvesters and other members of the community who do not grow crops in the project service area. The increased prosperity of the target population will benefit this group economically by increasing demands for goods and services.

3. Migrant Population. This category includes immigrants, attracted by labor opportunities or potential markets for goods, and emigrants, whether officially resettled or driven out of the area by other factors.

4. Host Population. This broad group includes most members of the other three, being defined as all persons "living within the area of project influence".

By the above definitions, the groups of greatest interest in a consideration of secondary project effects are the target population, which, in addition to receiving the primary benefits of the project, is likely to experience other effects, and the at-risk population, which, while not in line for primary benefits, may experience positive and/or negative secondary effects. In general, the secondary effects of an irrigation project fall into several categories:

1. Secondary benefits arising from the primary benefits of increased crop production and disposable income.

2. Opportunities to enhance the use of a resource through secondary applications of the project facilities, e.g., reservoir, canals, roads, drainage canals.

3. Potential adverse effects of project construction or normal operation, e.g., demand by the construction work force for scarce local resources, resource contamination, or conflicting demand for the water.

4. Failure of the project to live up to expectations, due to over-optimism of planners, inadequacies of construction or maintenance, or misuse by the local population.

Of the above, the fourth is the most distasteful, because it arises from a fundamental weakness in the planning system: the tendency of technical people to foresee a project as operating in a trouble-free, idealized situation, as opposed to a worst-case condition involving misuse, neglect, and unplanned modifications of the system. To adopt the latter approach would be unnecessarily pessimistic, and irrigation planners increasingly stress combining structural improvements with upgraded management, user education, and periodic review of the project in an attempt to achieve a more foolproof system. In actuality, hoewever, despite continuing efforts toward more effective operation, rural irrigation systems in many parts of Indonesia, as elsewhere, continue to be plagued by abuses at many levels of the system: control gates left open instead of releasing water on schedule, damage to canal banks by livestock, insufficient removal of trash from channels and control structures, and a variety of other factors.

This section on socioeconomic effects deals with both the effect of the project on living conditions and the potential effects of local society on the project. Both sets of effects, especially the latter, form feedback loops; if the practices of the local population compromise the effective operation of the irrigation system, that in turn effects on the health or economic ststus of local people.

The project will have a beneficial effect on the transport network by improving village roads and bridges. With better access, the private sector can be expected to provide better public transport into the area. Greater prosperity and crop surpluses will result in improved and larger market facilities, and electical power.

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Settlement Patterns and Movements

Immigration to the Awo area must be expected to increase during project construction and operation, as it has at other irrigation construction sites in South Sulawesi. Evidently, the hills in the project area already are viewed as open for use by people in neighboring districts and certainly the addition of irrigation will encourage this view. Those who cannot obtain land in or near the service area may move into the interior of the basin until the opportunity occurs to obtain flat land. It is likely that the project will thus indirectly increase population growth and result in further opening of forest areas.

Given past trends, improvements to irrigation can be expected to sustain annual population growth rates of 2.0-2.5 for probably five to ten years as the project develops. Eventually the population can be expected to stabilize at lower rates of increase and higher densities. The scheduling of this transition will partially depend on how much and how rapidly the area converts in the long term to more efficient (and labor saving) mechanization.

Initially there will be increased demand for labor in the project area. The increase in disposable income that is the primary benefit of the project probably will lead to more rapid oveall development as entrepreneurs respond to the increased purchasing power of the farmers. This could lead to some completely new commercial enterprises being started in the region, but more likely the expansion will occur in existing businesses.

Services, Infrastucture and Social Organization

Demand, in general, will increase for services and infrastructure (schools, health clinics, roads, transport, markets and extension services). Witn this increased demand and diversified population the local social structure will become more complex.

Land Ownership and Tax Collection

Although inheritance of land is expected to remain an important means to land acquisition in the service area, it is anticipated that there will be increasing amounts of sharecropping and rental agreements with intensification. There may also be increasing cash sales of land.

As the value of land in the service area increases, then taxes can be expected to increase. Most agricultural land in the area is still registered and classified under the traditional system, and the area has not yet had a modern cadastral survey based on air photographs. Introduction of technical irrigation should result in increased demand for a more modern system of land tenure in the area, and an upgrading of land taxes commensurate with the true value of the land.

Public Health

Vector-borne Diseases. The possible increase in disease vectors, especially mosquitoes, will bring increased risk of malaria and dengue fever, unless control programs are introduced. The addition of year-round surface water to an area frequently results in standing pools and weed-clogged drains where malaria vectors (*Anopheles* and *Culex* mosquitoes) and dengue fever vectors (*Aedes* mosquitoes) breed prolifically. Since such sites often are in and around villages, an increase in the incidence of these diseases may occur unless appropriate preventive measures are undertaken.

The risk of schistosomiasis in South Sulawesi is generally discounted by government planners because the only focus of the disease is in the Lindu Valley. Apparently, the disease has failed to become established in other areas because its snail host, *Oncomelania hupensis*, has not colonized water bodies outside the Lindu Valley, despite its high density there. There is no reason why the Awo Valley should be at any greater risk of the disease than any other area of South Sulawesi, but until more is known about the ecology of *Oncomelania hupensis* in the Lindu area, health authorities in areas experiencing high rates of immigration should remain alert to the possibility of schistosomiasis.

The incidence of gastric and intestinal diseases will cintinue with or without the project of the population fails to adequately boil drinking water.

Upstream hamlets below the weir should see their domestic water supply improved if they draw water from canals, as the settling basin should result in less sediment. The water table should also rise somewhat and result in stable water supplies from wells.

Diversion of much of the river water into canals will lower streamflow. Those now relying primarily on river water for their domestic water supply will probably either seek the water from nearby canals or dig additional shallow wells.

Other Resources

Increased prosperity in the target population may lead to some new house construction and repairs of existing homes. These will require sawn lumber that will have to be obtained from commercial outlets outside the basin, or from the upstream forests. The project will thus indirectly bring pressure to bear for increased harvesting of forests in the upper watershed. In addition, improved vehicular access as far as the hamlet of Dake, which will be provided by the new or upgraded project roads, will make it somewhat easier for forest harvesters to move into the upper basin.

Over the life of the project, the type of domestic fuel used may well shift away from wood toward kerosene or gas, as wood becomes harder to obtain. Until that happens, the local forest will continue to provide the main fuel resource for all households, in direct proportion to the population.

Farm Support Organizations

An important component of the project is to organize farmers into water users' associations. Some farmers in pump-fed irrigated areas already have local associations. Conversion to technical irrigation will be accompanied by incorporating all the farmers with irrigated land into one larger system.

Agricultural extension services to the area can be expected to increase as demand for these services increases. Farmer cooperatives can also be expected to increase.

Regional Development

The project area lacks an integrated, long-term development plan. One potential impact of the SSIMP project could be the development of such a plan. This plan would not be the same as the Management Plan or the Monitoring Plan, as included in this Environmental Assessment, but it could build on the recommendations found in them.

Effects of Project Alternatives

No Action Alternative

The pressure of a gradually increasing population, dependent on a land resource with limited irrigation and an unreliable water supply, would lead to greater poverty and lower living standards. These would induce the younger members of the communities to emigrate in search of wage labor or better farming conditions. Some might turn to exploitation of different resources, such as the forest or the wild fauna.

In time, a village-level irrigation scheme might be implemented, but it is doubtful that local funding could provide a weir and canal system on the scale required for effective utilization of the catchment's surface water resources.

Alternative Irrigation Technologies

Although the pumpage potential of the deeper aquifers in the Awo catchment area has not been determined, it is clear that extraction from the shallow alluvial aquifer that now provides domestic water would exhaust that water resource and deny its relatively pure water to most households.

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Design Alternatives

Weir Sites. The environmental effects of the three alternative weir sites would be roughly equal, differing largely in the effects of canal length. In this regard, the most downstream site would disturb somewhat less land.

Access Road. Employing a route for the access road other than the one now in use would require destruction of more natural vegetation, or farmland, depending on the route selected.

Scheduling Alternatives

Phasing or delaying development of the project would have the same sort of effect as not constructing it at all, except that the presence of the half-constructed project might serve as a greater magnet for immigrants than the present expectation of a future project. If so, the rate of colonization might be greater than without the project.

TABLE V-I
SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS
AWO IRRIGATION PROJECT

ENVIRONMENT COMPONENT	DESCRIPTION OF IMPACT	SOURCES OF IMPACT		IMPACT LOCATION		TIMING OF IMPACT			EXTENT OF IMPACT			REMARKS
		PRIMARY	ASSOCIATED	CATCH-MENT AREA	IRRI-GATION AREA	PRE-CONST.	CONST.	OPER.	UPON?	DURATION	INTENSITY	
WATER AND ATMOSPHERIC RESOURCES Water Quantity	Reduced availability in river below weir	Flow reduced below weir			x		(x)	x	People along river	Long-term	Moderate	Dry years only; water available in canals
	Runoff and drainage	Application of water to service area			x			x	Beneficiary farmers	Long-term	Major	Better control
Runoff	Increased flood peaks	Deforestation		x	x	x	x	x	Irrigation area	Long-term	Minor to Severe	Depends on good control measures
Water Quality	Increased suspended solids/sediments	Deforestation	Erosion	x	x	x	x	x	Canals	Long-term	Moderate to Severe	Not caused by project
	Increased chemical concentration	Agricultural chemicals	Irrigation		x			x	Irrigation area	Long-term	Minor to moderate	Proper use reduces risk of adverse impacts
	Increased nutrient and coliform levels	Livestock and human waste	Sanitation practices		x			x	Surface and ground water	Long-term	Moderate to severe	Possible risk to domestic water supplies
Ground Water	Increased recharge	Percolation of irrigation water			x			x	Ground water	Long-term	Moderate	Good, most years
	Contamination	High use of agricultural chemicals			x			x	Surface and ground water	Long-term	Moderate to severe	Controlled use could minimize effect
Air Quality	Increased fugitive dust	Construction activity			x		x		Irrigation area	Short-term	Moderate	Mitigation involves dust control (road watering)
	Increased smoke	Burning surplus rice straw			x			x	Irrigation area	Long-term	Moderate	Straw burned when intensive cropping leaves no time for natural decomposition
LAND RESOURCES Land Use/Conservation	Erosion/Sedimentation	Upstream logging/deforestation; grazing	Shifting agriculture	x	x	x	x	x	Catchment and irrigation areas	Long-term	Major to Severe	Ongoing. Improved access could accelerate impact if controls are not implemented
Farming Systems	Increased production	Multiple cropping dependable water supply			x			x	Project beneficiaries	Long-term	Very Positive	Main purpose of project
	Conversion to paddy fields	Irrigation			x		x	x	Irrigation area	Long-term	Minor	Most land already converted
	Less grazing land	Multiple cropping		x	x			x	Livestock in irrigation area	Long-term	Moderate	Loss in area but improved quality fodder on waste ground in service area
	Loss of farmland	Construction system	Increased population		x		x	x	Irrigation area	Long-term	Minor	Unavoidable. Small percentage of total area
BIOLOGICAL RESOURCES Terrestrial Habitat	Convert 56 ha to create weir, pool, canals	The Project		x	x	x	x	x	Many landowners	Long-term	Minor	Unavoidable. Small amounts of land needed from many farmers
	Increased pest population	Multiple cropping			x			x	Irrigation area	Long-term	Moderate	Control measures needed
Aquatic Habitat	Proliferation of aquatic weeds in canals and drains	Increased nutrients	Inadequate maintenance		x			x	Irrigation area	Long-term	Minor to severe	Depends on maintenance
	Restriction of fish movement on river	Weir a barrier		x	x		x	x	Fish in river	Long-term	Minor	Upstream fish breeding prevented
	Increased numbers of mosquitoes	Increased breeding area with irrigation			x			x	Resident population	Long-term	Minor to moderate	Malaria and dengue fever may increase
SOCIOECONOMIC RESOURCES Community Income	Increased income	Project operation	Project construction		x		x	x	Residents and migrants	Long-term	Major	Primary benefit of the project
Settlement Patterns and Movements	Increased population immigration	Economic opportunity		x	x	x	x	x	Residents and migrants	Long-term	Moderate	Unavoidable
Community Stability	Disruption of social patterns	Influx of temporary construction workers			x		x		Resident population	Long-term	Moderate to Serious	Mitigation needs contractor and local cooperation
Services and Infrastructure	Increased demmand for services/infrastructure	Improved economy	Increased population		x			x	Resident population and migrants	Long-term	Major	Unavoidable
Land Ownership and Tax Collection	Land sales; more leasing and sharecropping	Intensification of farming	Increased land values		x			x	Beneficiary farmers	Long-term	Moderate	Unavoidable
Public health	Increased disease vectors	More mosquitoes	Lack of vector prevention		x			x	Resident population	Long-term	Minor to Moderate	Control required
Farm Support Organizations	Increased demand/need for farmer organizations	Need to operate the system			x	x	x	x	Project beneficiaries	Long-term	Minor to moderate	Very positive impact

CHAPTER VI

EVALUATION OF ENVIRONMENTAL IMPACTS

Methodology to Identify the Most Significant Impacts

This chapter summarizes the probable major positive and negative effects of this project on the environment. It also points out possible negative effects of the environment on the functioning and efficiency of the project. Virtually all of the likely effects will occur during the operational phase of the project.

The methodology employed to identify the most likely significant impacts is as described in Chapter V. The evaluation of these impacts is likewise based on the following considerations:

- Experience, in retrospect, with similar projects, worldwide;
- Local knowledge of problems with similar projects in Indonesia;
- Detailed knowledge of local conditions and the design of the project, as it fits, or meets those local conditions;
- A best-guess assessment of how the most significant components of the environment and the project are likely to interact, given several scenarios.

If serious negative impacts had been identified during this evaluation, then a more thorough environmental impact study would have been recommended for this project and more detailed site-specific studies conducted.

Water Resources

Downstream Flow. The major objective of this project is the diversion of water from the river and its redistribution over 2,500 ha of irrigated paddy fields. A primary impact of this change will be the decrease of flow in the river. This effect will only be of practical significance in extremely dry years, which may occur on a 1 in 10 year basis. Under these conditions, all of the flow may be diverted to the irrigated areas. These conditions may persist for as long as one month, during which time downstream users who are dependent on the river for water supply for drinking, bathing and/or laundry would be forced to use residual water remaining in pools or to turn to wells and irrigation canals for their water supply. If the Eastern Extension Area of 2,200 ha is eventually irrigated then the upper portion of the Awo River below the weir may go dry for as long as several months in some years, when all water is diverted to irrigation. People along this section of the river, however, will have easy access to the main supply canal for their water needs, and it is relatively easy to dig shallow wells that are adequate for domestic use. The Awo River below the Simpellu River should always have some flow due to irrigation return flows and tributary contributions. At most times, project operation will not have particularly noticeable or detrimental effect upon downstream flow.

Water Quality. Return irrigation flows will undoubtedly contain higher levels of nutrients from fertilizer runoff as well as from human use of the canals for bathing, laundry and sanitary purposes. Water quality in the Awo will therefore be somewhat poorer than at present, especially during the dry season. However, the extent of degradation is not normally expected to be great enough to cause problems for downstream users. In some cases, as along the Lauwa River, water available from the canals will be superior in quality to that which is present in the river itself.

Land Resources

Watershed Management. The project will result in more intensive agricultural use of the land in the service area, but will not otherwise significantly change land use patterns. In the river catchment, land conversion from forest to grassland or mixed dryland agriculture is proceeding rapidly. The project will provide some assistance to the distribution of the forest lands through improvement of road access, and therefore measures should be taken to discourage this process as much as possible. Access to the catchment appears to be also occurring on roads from adjoining watersheds to the west and northeast. The project will not effect the process in that area.

Upstream forest conversion will likely have continuing effects on the project in the future. Forest clearance will result in erosion which will increase sediment load and ultimately affect irrigation system operation through deposition in the weir pool and canals. Clearance will also alter runoff characteristics, thus affecting system operation. It will thus be in the interest of the project to press for increased control of land conversion in the catchment.

Livestock Management. With the introduction of a twice a year cropping system less land will be available for cattle and water buffalo grazing. The result may be overcrowding of present fields or the further deforestation of the lowland hillsides, and increased pressure on the catchment area. Over the long term it is expected that the farmers will turn more and more to mechanization, thus decreasing the need for field animals.

Agriculture Management. Relatively minor amounts of land will be used for construction of the canal system, although some sort of compensation will be expected by the landowners. The main pool will occupy an area of 31 ha, most of which is currently riparian brush or existing riverbed, so no major loss of productive land will occur.

The project is expected to have significant impacts on the farming system, including higher agricultural yields of paddy and palawija crops, increased mechanization (and decreases in numbers of draft animals) and increased use of agricultural chemicals.

Biological Resources

Terrestrial Habitat. The project will result in more intensive agricultural use of land in the service area, but will not otherwise significantly change the downstream terrestrial habitat. Similarly, the project will not have a direct impact on the habitat of the middle and upper parts of the catchment area, except to provide improved road access up to the weir site. Thus, the improved road access will not enter these middle and upper areas, but may indirectly provide the incentive to extend the improved roads higher into the catchment area. Similar to the situation elaborated in the section on managing the watershed, measures should be taken to discourage further improvements to roads and trails leading into the middle and upper catchment area. Any continuation of converting forest to agricultural land or grasslands will have a negative effect on the existing wildlife habitat, and further reduce the areas where endangered species might survive.

Pests and Diseaases. There is a risk that crop pests, aquatic weeds, and disease vectors (mosquitoes) will all increase due to the more abundant water. Monitoring and control programs can offset these risks.

Socioeconomic Resources

Increases in agricultural production will lead to increases in income and an improved living standard. This directly affects the target population, and provides secondary benefits to the at-risk and migrant populations.

Settlement Patterns and Movements. The demand for additional labor can be expected to lead to increases in the population. Some people who temporarily enter the area will decide to permanently settle there.

Services, Infrastructure and Social Organization. Improved living standards and more economic opportunity in the area will probably lead to increased trade and demand for services. There should also be an increased demand for more infrastructure (schools, health clinics, roads, transport, and markets).

Land Ownership and Tax Collection. Increased prosperity should make it possible for area farmers to bear some of the costs of a modern cadastral survey based on air photographs. Taxation rates would also be upgraded accordingly.

Public Health: Vector-Borne Diseases. The project will probably bring with it an increased risk of mosquito-borne diseases, particularly malaria and dengue fever.

Resource Use. Increased prosperity will lead to new house construction and housing repairs, with consequent increased demand for sawn lumber obtained from commercial outlets with sources outside the basin, or from the upstream forests.

Domestic fuel use will increase, and at least at first, the demand for fuel wood will increase.

Farm Support Organizations. Farmers will be organized into water users' associations. Agricultural extension services will be stepped up, and it is expected there will be increased activities of farmer cooperatives.

CHAPTER VII

CONCLUSIONS

The Awo Irrigation Project is a weir scheme to supply irrigation water to 2,500 ha. There is also the possibility of supplying an additional 2,200 ha east of the present project area. Almost all of the proposed service area is already planted in paddy and secondary crops for one or two seasons.

The Awo weir will create a pool, occupying approximately 31 ha. Irrigation water will be released from the pool to the canal system, be distributed to the irrigated paddy fields, and the excess will flow back into the river. The effect of this diversion will be to alter the streamflow regime, especially during the dry and transition seasons (October-January). In very dry years, in particular, this may mean little or no flow in the upper sections of the Awo River just below the weir.

Other potential environmental impacts of the project include additional recharge of the ground water aquifers, generally improved water availability and access to water, some agricultural land being used for project facilities, inundation of 31 ha of riparian scrub forest and riverbed, decreased dry season grazing areas for livestock, possibly improved access for deforestation activities and consequent loss of wildlife habitat, risk of increased crop pests and mosquitoes, and improved economic conditions for the local population. As discussed in the previous chapter, and in the following Environmental Management Plan section, the negative impacts are not serious and in most cases can be mitigated.

Based on these studies, the conclusion of this Environmental Assessment is that the Awo Irrigation Project has no major detrimental impacts which call into question the viability of this project. The project will result in spatial and temporal changes in water distribution which will have limited environmental effects on the local population. The project is therefore environmentally feasible, and the mitigation and mangement of any potentially negative impacts has been adequately addressed in the Management Plan.

APPENDIX A

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Note: Preparers 1 through 11 are faculty at Hasanuddin University; 12 through 17 are members of the Technical Assistance Team under SSIMP.

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APPENDIX B

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APPENDIX C

RECORD OF SSIMP ENVIRONMENTAL SCOPING SESSION

HELD IN UJUNG PANDANG, 14 APRIL 1988

Note: This record was prepared by USAID/Harza shortly after the April 1988 scoping session. Some rearrangements of responses to questions have been done, in order to bring similar topics together. In addition, Harza editors in Ujung Pandang have added a few comments on some of the statements made by the meeting participants.

Introduction

Environmental procedures of the Agency for International Development specify that a meeting of knowledgeable individuals is to be held early in the environmental analysis process, in order to draw upon insights not available to the project environmental staff. Such a meeting, attended by representatives of government agencies, citizen groups and others with local knowledge, may render the environmental staff vital assistance in developing an appropriate study plan. Moreover, the advance familiarity with the project gained at the Scoping Session facilities prompt review of the environmental report when the meeting participants receive it.

The Environmental Scoping Session for the Awo and Salomekko Projects was held at the BAPPEDA offices in Ujung Pandang, South Sulawesi, on 14 April 1988.

The meeting was called to order by Drs. K. Salemo at 08:15 and adjourned at 15:00. An agenda was distributed. Attendance was taken (Appendix D), but a stenographic record was not made. Several participants took notes, however, and this record results from a pooling of notes by Messrs. Ames and Gunawan. The meeting was conducted largely in Indonesian.

Record of the Meeting

After a welcoming statement by BAPPEDA representative Drs. K. Salemo, participants were provided a general description of the projects by Ir. H.A. Yantahin, PU/Ujung Pandang. He indicated the location of each project, the area served and the major project features.

Dr. Peter Ames, Harza Engineering Company, then summarized the objective of the Scoping Session: to elicit from the participants their concern about the potential environmental impacts of these projects. His remarks were translated into Indonesian by John Deuwel (USAID/Jakarta).

Mr. M. Amron (PU/Jakarta) outlined the environmental requirements and procedures of the Government of Indonesia (the AMDAL process), after which Mr. Gunawan Widjaya (USAID/Jakarta) described the roles of various organizations in the preparation of the environmental analysis for these projects.

Ms. Isna Marifa (USAID/Jakarta) explained the four-step process required by USAID and Mr. Ron Greenberg (USAID/Jakarta) explained the role of environmental analysis and review in the project development process.

Mr. Suwarno (PU/Ujung Pandang) described the local agricultural problems that the Awo and Salomekko Projects are expected to solve. He provided further design details about the projects features and some general information about their surroundings.

The next speaker was Mr. D. Noertemtomo (Dit. BPP/Jakarta) who placed the two projects under discussion in the framework of the five SSIMP projects planned for South Sulawesi. With the help of Mr. Amron and others, he laid out on the whiteboard a matrix of impact types versus location, to be used as a record of the scoping discussion (Table C-1 and C-2 of this Appendix).

Discussion of potential environmental effects was divided among four resource categories: water, land, biological, and human resources. For each, Dr. Ames presented a brief summary of the relationship of that resource to typical irrigation development projects. The discussion that followed each summary provided entries for the matrix. If a resource was considered likely to interact with the project being considered, a check was put in one or more columns, depending on whether the effect was expected to be positive or negative, and located upstream (above the dam or weir), in the middle basin (the project service area), or downstream (below the service area). Each check was supplemented with initials to indicate whether the effect was induced by the project upon its environment (PE) or by the environment upon the project (EP).

In general, Dr. Ames noted, the environmental impact assessment is concerned with the effects of the project upon its environment, rather than the reverse. But potential effects of environmental changes upon the projects should be identified, for two reasons: (1) certain conditions of the environment (e.g., changes in sediment load brought about by land clearing) must be taken into consideration by project planners; and, (2) compensatory changes in the project may induce secondary effects on other parts of the environment.

Summary of Areas of Concern

Awo Project

Water Resources. The consensus of the participants was that service area flooding and dry season water availability will be improved by the project (the latter being the primary project benefit), but there is a potential for negative effects on water used in some parts of the service area. Tendencies toward waterlogging and operational losses are expected to be improved in the service area. On the negative side, there is a potential for degradation of water quality in the service area and downstream, due to fertilizers and pesticides in the irrigation return flows.

Land Resources. The project is expected to exert a beneficial effect on the productivity of soils in the service area and downstream; this is the primary objective of the project. Similarly, the effects of sedimentation on middle and downstream areas are expected to be improved. Concern was shown, however, for the impact of land clearing in the upper basin on the project, although Mr. Schoeller noted that the project weir design will permit flushing accumulated sediment from the pool and the canal headworks will take largely sediment-free water.

Biological Resources. The general view was that too little is known of the ecology of the basin to begin predicting areas of impact. It is clear, however, that forest clearing in the upper basin is a major ecological problem that could be affected, positively or negatively, by the project. The potential for outbreaks of crop pests (both insects and vertebrates) exists with the intensification of cropping in the service area. The presence of biota of special interest and the potential for project effects should be investigated. The use of project return flows in fish ponds was considered to have both adverse implications (pesticides) and benefits (fertilizers).

Socioeconomic Resources. Discussion of these topics was led by John Duewel. Within the service area, the project is expected to exert a beneficial effect on settlement patterns, but the potential was recognized for upstream settlements to have adverse effects on the project. In general, the project will be beneficial for social organization, standards of living, and farming systems; these are natural secondary objectives of agricultural improvement. The existing community participation system is expected to benefit the project. The question of project-induced changes in land ownership patterns deserves attention; there appears to be potential for both beneficial and adverse effects. Attention also should be paid to the distribution of water-related diseases, as it may be altered by changes in the availability and quality of water.

Salomekko Project

Water Resources. The project is intended to provide increased water to its service area but this carries the potential for deprivation of water for middle basin users. Mr.Schoeller noted, however, that the release of sufficient water for downstream users would be required of the project and that dry season flows may be improved. Some control of flooding is expected as the project stores high flows. If, in fact, flows are reduced in certain river reaches, this could lower the capacity of the river to assimilate human and animal wastes, thus degrading water qualities. The increase in use of fertilizers and pesticides in the project service area could result in degradation of water quality downstream of the return flows.

Land Resources. The project is expected to have a beneficial effect on soil productivity in the service area (part of the project objectives). A potential also exists for misuse of water resulting in waterlogging of soils, but standard farm management practices are expected to accompany the project, to minimize this possibility.

Overgrazing and continued land clearing in the watershed have increased the extent of erosion and continuation of this situation is expected to result in further increases in sediment load. Concern was shown among participants, but the project planners noted that the dam and reservoir are sized to allow for sedimentation. The project was considered to have potential for both positive on negative effects and land clearing.

Biological Resources. Creation of the reservoir will result in inundating some forest and some pasture land. Concern was expressed that the breakdown of flooded plant matter could cause aquatic weed problems downstream and in the reservoir. Dr. Ames expressed the opinion that the amount and type of vegetation in the area of inundation are such that water quality would not be seriously affected by failure to clear the reservoir area. He noted, however, that there might be salvageable fuelwood resources in the area.

Concern was expressed that intensification of cropping may produce increases in insect and vertebrate pests, as has happened elsewhere.

Socioeconomic Resources. There is a potential for increases in the prevalence of water-related diseases due to increases in standing surface water and to degradation of water quality through reduced stream flows.

Participants expressed the view that the project is likely to exert a positive influence on settlement patterns, farming systems, and living standards; this would be the natural outcome of improved agricultural production.

It was noted that a small burial ground is located on top of one of the hills near the dam alignment. Protection of the graves from accidental destruction by project equipment may require special attention.

Summary of Expressed Concerns

Awo Project

The primary concerns about environmental impacts of this project centered around the availability of the water for downstream residents not direct beneficiaries of the project, the interaction of project development with land clearing activities that are rapidly denuding the upper basin, and the potential for adverse health effects downstream. The ecological characteristics of the region are too poorly known to permit identification of potential effects at this time, but general areas of concern were noted: habitat loss, species of special interest, and increases in pest populations.

Salomekko Project

The relatively small flow of the Salomekko River produced concern for availability of water for downstream users and the quality of that water. Secondary effects on public health also are possible. Land use changes in the basin, although of less concern than in the Awo Project, are also an area of interest, especially regarding the direct effects of reservoir inundation.

Table C-1

Matrix of Potential Environmental Impacts, Awo Project

	Positive Impact			Negative Impact		
	Upstr	Mid	Dwnstr	Upstr	Mid	Dwnstr
<u>Water Resources</u>						
Flooding		PE			PE	
Water Use		PE			PE	
Drainage		PE				
O & M Losses		PE	PE			
Water Quality					PE	PE
<u>Land Resources</u>						
Soil/Land Capability		PE	PE			
Salinity						
Waterlogging			PE			
Erosion				EP	EP	
Sedimentation, reservoir					EP	
Sedimentation, service area		PE	PE		EP	
Construction		PE	PE		PE	
<u>Biological Resources</u>						
Forest	PE			PE/EP		
Pasture						
Fisheries			PE			
Aquatic Biota		?	?		?	?
Plant/Animal Pests					PE	
<u>Socioeconomic Resources</u>						
Water-related Diseases						PE
Pesticide Problems					PE	PE
Settlement Patterns	PE/EP	PE		PE/EP		
Social Organization	EP	EP				
Land Ownership		PE/EP			PE/EP	
Farming System		PE				
Community participation		EP				
Archaeological/Historical						

PE = Project effects on environment
EP = Environmental effects on project

Table C-2

Matrix of Potential Environmental Impacts, Salomekko Project

	Positive Impact			Negative Impact		
	Upstr	Mid	Dwnstr	Upstr	Mid	Dwnstr
<u>Water Resources</u>						
Flooding		PE		PE		
Water Use	PE	PE			PE	EP
Drainage		?			?	
O & M Losses		PE	PE			
Water Quality					PE	PE
<u>Land Resources</u>						
Soil/Land Capability		PE				
Salinity						
Waterlogging					PE	EP
Erosion				EP	EP	
Sedimentation, reservoir					EP	
Sedimentation, service area		PE	PE		EP	
Construction		PE	PE		PE	
<u>Biological Resources</u>						
Forest				PE		
Pasture				PE		
Fisheries		PE	PE			
Aquatic Biota						
Plant/Animal Pests					PE	
<u>Socioeconomic Resources</u>						
Water-related Diseases					PE	PE
Pesticide Problems						PE
Settlement Patterns		PE		PE		
Social Organization		EP				
Land Ownership		PE/EP			PE/EP	
Farming System		PE				
Community participation		EP				
Archaeological/Historical				PE		

PE = Project effects on environment
EP = Environmental effects on project

APPENDIX D

LIST OF SSIMP ENVIRONMENTAL SCOPING SESSION PARTICIPANTS

Ujung Pandang, 14 April 1988

Name	Profession/Position	Organization
Sulsel Province		
Ainuddin Samad	KaKanwil	PU Sulsel
H. Abd. Yantahin	Kasubdin Air	PU Sulsel
M. Said Fattah	KaSie Penyuluhan	PU Sulsel
Suwarno HP	Pelaksana SSIMP	PU/SSIMP
Abd. Wahab	Ka. Tata Usaha	PU/SSIMP
M. Rum Ashar	Staf Sie Pengairan	BAPPEDA
Shahibu Muhsin	Staf	Biro BKLH Office of Governor
Syahrir M.	Kasie Sumber Daya	BAPPEDA
Sofyan Muhammad	Ka.Sub.Dinas	Health Services
Abd. Rasyd D.	Kasub. Dinas	Food Crop Services
Herak Saung	T.G.A	Food Crop Services
K.Salemo	Kabid. Pispra/IV	BAPPEDA
Natalia D.	Staf	Forestry Services
Muslimin Mustafa	Director	Environmental Center (PSL), Hasanuddin University.
Marthen L. Lande	Staf	ditto
Totok Prawitosari	Staf	ditto
Jacob Ampang	Kabid Program	Agricultural Services
Abd. Rahim Azis	Seksi Data	ditto
Jakarta		
Supriyono	Staff SubDit	PU/Irrigation I
Noertamtomo D.	Staf	PU Bina Program/ Pengairan
Isna Marifa	Program Specialist-Environment	USAID
Gunawan Widjaya	ARD/WRAP	USAID
John Duewel	PSC	Bina Program/SSIMP
Ron Greenberg	Mission Environmental Office	USAID
M. Amron	Lintas Sektoral	PU Bina Program/ Pengairan

Harza		
Peter L. Ames	Environmental Specialist	Harza/Chicago
Herb E. Schoeller	Team Leader	Harza/ Sulsel
District		
Abdul Rahimsah	Chief	PU Pengairan, Wilayah II
Mardjo	Chief	PU Pengairan, Ranting Wajo
Mahmud Masri	Kabid Fespra	BAPPEDA, Wajo
Bustamin Betta	Kabid	BAPPEDA, Wajo

APPENDIX E

LIST OF PERSONS CONTACTED

* Dr. Robert G. Morrison, Environmental Management Development in Indonesia (EMDI), Canadian International Development Agency (CIDA), Jakarta.

* Dr. George Green, Environmental Management Development in Indonesia, Canadian International Development Agency, Jakarta.

* Mr. Nabiel Makerim, Deputy Assistant Minister, Ministry of Population and Environment, Jakarta.

* Mr. Gempur Adiyan, Staff Deputy Assistant Minister, Ministry of Population and Environment, Jakarta.

* Mr. Henri Reichart, World Wildlife Fund, Jakarta.

* Dr. Peter Neame.

* Ir. Mardjono Notodihardjo, Department of Public Works, Jakarta.

APPENDIX F

GLOSSARY AND ACRONYMS

Agraria/Pertanahan	Directorate General of Land Affairs
AID	Agency for International Development
AMDAL-Analisa Mengenai Dampak Lingkungan	Environmental Impact Assessment
ANDAL-Analisa Dampak Lingkungan	Environmental Impact Study
BangDes-Pembangunan Desa	Directorate of Village Development, under the Department of Home Affairs
BAPPEDA-Badan Perencana-an Pembangunan Daerah	Regional Development Planning Board, under the Department of Home Affairs
BIMAS-Bimbingan Massal Swasembada Bahan Makanan	Mass Guidance for self-sufficiency in foodstuffs, a farm input-credit package program
BKLH-Biro Kependudukan dan Lingkungan Hidup	BPE-Bureau of Population and Environment
BULOG-Badan Urusan Logistik	National food logistics body
Bupati	Head of a district (Kabupaten)
Cabang	Branch office
Camat	Sub-District head
Dalam Negeri	Ministry of Home Affairs
Desa	A village
DGWRD	Directorate General of Water Resources Development
DOLOG/SUB DOLOG-Depot Logistik	Provincial food logistics body

DPUP-Dinas Pekerjaan Umum Propinsi	Provincial Public Works Services
Dusun	A village administrative sub-area
EIS	Environmental Impact Study
EA	Environmental Assessment
EMP	Environmental Management Plan or Environmental Monitoring Plan
GOI	Government of Indonesia
Golongan	A class/division, as in a subdivision of irrigation area for rotating and spreading planting dates
Gotong Royong	Cooperative work effort by villagers; mutual self-help
HHS	Household Survey
HYV	High Yielding Variety (rice)
Hutan Lindung	Protected forest status
INMAS-Intensifikasi Massal	Massive Intensification, a farm input program
INPRES-Instruksi Presiden	Presidential Instruction, a general program for rural development
INSUS-Intensifikasi Khusus	Special Intensification, a farm input credit program for groups of farmers with improved infrastructure facilities
Juru Pengairan	Irrigation Sub-foreman for O & M in the Sub-district (Ranting Dinas)
Kabupaten	District
Kanwil-Kantor Wilayah	Provincial office of a Ministry
Kecamatan	Administrative Sub-district
Kehutanan	Forestry services
Kepala Desa	Head of a village
Kesehatan	Department of Public Health
Ketua P3A	Head of the Water Users' Association

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Kontak Tani	Leader of a farmer group who is in contact with extension service; a key farmer
KSDA-Konservasi Sumber Daya Alam	Agency for the conservation of natural resources
KUD-Koperasi Unit Desa	A village cooperative
KUPEDES-Kredit Umum Pedesaan	A village credit cooperative unit
KUT-Koperasi Usaha Tani	A Farmer Cooperative
LKMD-Lembaga Ketahanan Masyarakat Desa	Organization for Self-Reliance of the village community (Village community development committee)
LP3ES-Lembaga Penelitian Pendidikan dan Penerangan Ekonomi dan Sosial	Indonesian non-governmental organization with expertise in organizing water users' associations
LMD-Lembaga Masyarakat Desa	Village Development Council
Lompo	A sawah complex
Malar/Pekasih/Ulu-ulu	Irrigation foreman appointed by village
Mantri	Local official in charge of a specific service, kejuron or kemantren in his administrative service region
NEPA	(US) National Environmental Policy Act
O & M	Operation and Maintenance
Padi	Stalk paddy (rice), unthreshed paddy which is harvested and can be tied into bundles with part of the stalk
Pagar Hidup	A living fence; row of trees
Palawija	Non-rice food crops, secondary crop, such as maize, cassava, soybeans
Panggung	A house usually made of wood with its floor elevated one or two meters above the ground
PB 36, PB 42	Paddy seed varieties
PELITA IV	Indonesia's Fourth Five-Year Development Plan

PEMDA-Pemerintah Daerah	Regional Government (District, Sub-District)
Pengairan	Irrigation; generally used in reference to the irrigation division of DGWRD-Directorate General Water Resources Development
Perkebunan	Perennial crops; estate (usually tree) crops services
P3A-Perkumpulan Petani Pemakai Air	Water users' association
Pertanian	Ministry of Agriculture
Pertanian Tanaman Pangan	Food crops services
PKK-Program Kesejahteraan Keluarga	Women's Group for Family Prosperity Program
PPL-Penyuluh Pertanian Lapangan	Field Extension Agent
Peternakan	Livestock Services
RRIA	Rapid Rural Irrigation Appraisal
RT-Rukun Tetangga	A village sub-unit of about 25 households, usually living as a hamlet
Sawah	Wet paddy bunded field
Sederhana	Non-technical (simple) irrigation
SSIMP	Small-Scale Irrigation Management Project
Tambak	Brackishwater Fish pond
Tingkat I-TK I	First level of government administration (usually Provincial)
Tingkat II-TK II	Second level of government administration (usually Kabupaten and Kotamadya
USAID	United States Agency for International Development

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Directorate General of
Water Resources Development
Ministry of Public Works
Republic of Indonesia

United States
Agency for
International
Development

Small-Scale Irrigation Management Project (SSIMP)

FINAL REPORT
AWO IRRIGATION PROJECT
ENVIRONMENTAL ASSESSMENT

VOLUME II

EXECUTIVE SUMMARY
ENVIRONMENTAL MANAGEMENT
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Prepared by

HARZA ENGINEERING COMPANY

in association with

Development Alternatives, Inc.

Environmental Studies Center
Hasanuddin University

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PT. Wiratman & Ass.

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PART I

EXECUTIVE SUMMARY

Introduction

The Awo Irrigation Project will provide reliable irrigation to 2,500 hectares (ha) of land in Wajo District (Kabupaten) of South Sulawesi Province by constructing a weir on the Awo River and a system of canals to carry water to the fields.

The system design provides for a possible future extension to irrigate an additional 2,200 ha, east of the currently proposed service area.

Experts from Indonesia and the United States have reviewed the project plans and concluded that it will accomplish its primary objectives, but that some environmental effects might result. This environmental assessment, prepared under the laws of Indonesia and the United States, explores the potential effects of the project on human and natural resources and recommends actions to mitigate adverse effects and enhance benefits.

Sponsoring Agencies

The project is sponsored by the Ministry of Public Works of the Government of Indonesia and the Agency for International Development of the Government of the United States.

Objective of the Environmental Assessment

The major objective of this environmental assessment is to inquire whether there are any probable major negative impacts of this project on the environment. This report also assesses negative impacts of the environment on the function and efficiency of the project. Once harmful effects are identified, a plan is provided to mitigate these major negative impacts.

Scope of Report

Priority issues were identified as a result of an Environmental Scoping Session and these issues have been organized into four basic categories: water resources, land resources, biological resources, and socioeconomic and cultural resources. This is the scope of the report.

Description of the Proposed Project

Location

The Awo Irrigation Project is near the east coast of South Sulawesi Province, Indonesia, about 50 kilometers (km) northeast of the district capital of Sengkang. The weir and canal headworks will be on the Awo River, approximately 20 km from its mouth.

Limits of the Study Area

The study area for this environmental assessment consists of the entire river basin of the Awo River. It also includes all of area and population of the villages of Awota, Lompo Loang, Lauwa, and Bulete.

Project Components

Irrigation Structures: Water Diversion. Water will be diverted from a pool formed by a weir on the Awo River. The weir will be about 6 meters (m) high, with a crest elevation of 24.0 m above sea level and a crest length of 62 m. It will be constructed of stone masonry consisting of river cobbles in a matrix of mortar. A canal headworks structure at the south end of the weir will pass water to a sedimentation basin and then to the main canal.

The pool formed by the weir will fluctuate in size according to flow: at the normal surface elevation of 24.0, the pool will extend about 2.0 km upstream and cover an area of approximately 31 ha. During the five-year flood[1], with about 2.7 m of water depth over the spillway, the pool will extend 2.5 km upstream and cover 66 ha.

Conveyance System. All primary and secondary canals will be lined to reduce seepage, minimize the width of land taken up by the canal, and control canal erosion. The canal will cross the tributary streams on embankments with culverts or on concrete flumes. A single primary canal will carry irrigation flow along the right bank of the river (looking downstream) to a division structure about 10 km from the intake. This canal has a conveyance capacity varying from 7.5 m^3/s at the headworks to 4.6 m^3/s at its last division structure. The average width at the water surface is 9 m and the approximate water depth is 2 m. From the primary canal one secondary canal will carry flow across the Awo River on an 80-m-long aqueduct to irrigate lands on the left bank. This secondary canal system is approximately 10.5 km long with a maximum conveyence capacity of 2.1 m^3/s and a maximum width of 5 m. It provides water to a net irrigated area of

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1. The flood that has a probability of one in five of being equaled or exceeded in any year.

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approximately 1,300 ha. The left bank canal will follow the north and northwest edge of the existing cultivated area, i.e., the edge of the alluvial lands.

At the end of the primary canal a division structure will supply irrigation water to a secondary canal which continues eastwards for another 6 km to irrigate the eastern 700 ha of the service area. This canal has a maximum capacity of 1.1 m^3/s and a maximum surface width of 3.5 m.

The remaining 3.5 m^3/s of design capacity in the primary canal is to be used in the future to irrigate the Eastern Extension Area. The 500 ha of service area lying along the primary canal route will be served by tertiary canals fed directly from the primary canal.

Delivery System. The service area is divided into approximately 60 tertiary blocks, each of less than 50 ha. Each of these blocks is supplied by a tertiary canal fed either from the primary or secondary canal system. To provide maximum operating flexibility, the design capacity of each tertiary canal will be sufficient to irrigate each tertiary block as a single golongan. Thus the project golongan system can operate between individual tertiary blocks or within the teriary blocks. The tertiary canals will be approximately 1 m wide. These canals will generally be unlined.

Quaternary canals will distribute the irrigation water from the tertiary canals to the paddy fields. Those canals will be appriximately 0.6 m wide and will be unlined.

Drainage System. The primary drainage system for the proposed scheme will be the existing drainage network consisting of the Awo River and its tributary streams. Some of these streams have had dikes erected by the local farmers to provide supplemental irrigation at present, but this has led to drainage problems. It is proposed to re-open these channels and in some instances to re-route them. About 25 km of new primary drains will also be provided.

Support Facilities: Roads. About 22 km of existing village roads in the project area will be upgraded to all-weather gravel roads, with short new spurs to the river, workers' camps, and borrow areas.

Several new bridges will be included in the road upgrade. One crossing of the Awo River will be constructed as an integral part of the aqueduct for the left bank secondary canal. A second major river crossing will be built on the road between the hamlets of Bocco-Bocco and Setangange. A number of short-span bridges will be built across tributaries of the Awo River.

Buildings. Project offices and housing for the project operating staff will be built in the area.

Construction Period Conditions. Construction of the Awo Project will be accomplished by five separate contractors, under the general supervision of PU. The work is expected to be completed over a period of about two years. Two local contracts will be tendered prior to the other contracts so that roads, bridges, and buildings are available for use by PU and the other contractors as early as possible during the irrigation system construction. Three internationally tendered contracts will cover construction of the weir and aqueduct, left bank system, and right bank system.

Resource Use: Materials. The materials required by this project are relatively simple: cement, stone, sand, earth, and some lumber and plywood for forms and miscellaneous construction.

The estimated volume of each of the main construction materials needed for the project is as follows:

Material	Volume
Cement	320,000 bags
Sand	130,000 m^3
Gravel	2,400 m^3
Stone for Masonry	100,000 m^3
Excavation	400,000 m^3
Fill	190,000 m^3

Excavation and fill materials will be obtained from, and used in, localized areas along the canal alignments. Sand, gravel, and stone will be obtained in borrow areas in and along the Awo River, primarily within the weir pool area. Cement, lumber, reinforcing steel, etc. will be purchased by contractors on the open market.

Energy. The project construction will require both electrical energy, provided by generators on site, and gasoline and diesel fuel for powering vehicles and heavy equipment.

Transportation and Storage. Small stockpiles of materials will be maintained near the weir and other major structure sites, in quantities sufficient for meeting the construction schedule.

Waste Disposal. All waste generated by the construction process will be removed from the site except human waste. Sanitary facilities at the workers' camps will consist of pit latrines. These will be moved periodically and the abandoned pits filled in. Solid waste from the camps will be buried in the vicinity.

Work Force: Characteristics. The work force for the overall project is expected to comprise about 1,000 persons at its peak. About 600 will be laborers; 300 will be drivers, masons, carpenters, and other semi-skilled workers; and the rest skilled workers, foremen, and management.

The work force probably will include male and female members. Most of the skilled and semi-skilled workers are expected to be men. Laborers and many of the semi-skilled workers are expected to be drawn from the immediate local area. Additional semi-skilled labor, skilled labor, and management personnel will probably move to the area from other areas in South Sulawesi and from construction company offices elsewhere in Indonesia.

Worker Accommodations and Facilities. Work crews will live at home if recruited locally or live in temporary shelters adjacent to the work area if they come from a significant distance. Several camps are likely to be established by the various contractors because of the dispersed locations of construction areas.

Some permanent buildings, of brick timber, and concrete, will be constructed under the second contract. These will include offices, workshops, and residences for the PU management-level and permanent operating personnel.

Operation Period Conditions

Division of Responsibilities. Established GOI policy provides that PU assume responsibility for operation and maintenance of diversion facilities, primary and secondary canals, tertiary offtakes, and the first 50 m of each tertiary canal. Water users' associations (WUA's) and their members are responsible for operation and maintenance of tertiary canals, quaternary boxes, and quaternary canals.

Method of Operation. The project is designed to divert water from the Awo River, through the primary and secondary canals, to meet the crop water demands determined for each tertiary block. Water delivery at the tertiary offtakes is normally continuous over a period of time. To limit peak demands of the tertiary offtakes, delivery to blocks within each tertiary unit will probably be rotated on a schedule determined by the WUA. Diversions are typically adjusted every two weeks for projects in SulSel, but shorter time periods may be adopted for the Awo project to improve water use efficiency during drier months.

Resource Use. The main project impact on resources will be the redistribution of water in the area, which is the purpose of the project. There will be little energy used in operation of the manually controlled system. Some fuel will be needed for operation of project vehicles. Small quantities of sand, gravel, stone, cement, and other building materials will be used on a continuing basis for routine maintenance.

Chemical inputs will gradually increase with intensification of agriculture, but Indonesian farmers generaly apply fertilizer at rather low rates, about 300 kg/ha. Pesticide use also tends to be at rates below those recommended by pest control specialists; presumably factors such as cost, labor input, and the inability to measure precisely the amount dispersed enter into the situation.

Labor Force. The basic operation and maintenance of the tertiary and quaternary system will be performed by the WUA's and their members, with advice and some logistic support from PU and the Agriculture Department. Most area farmers have basic agricultural skills in rainfed paddy culture and palawija crops, but will require some training for effective intensification of cropping.

Operation and maintenance of the primary and secondary system will be performed by the PU staff described above. Initially, the staff is expected to include two managers, a dam tender, and about 15 gate keepers.

Training Programs: Operating Work Force. PU will provide its local staff with orientation training for operation and maintenance of the system. This will also include training in the keeping of flow records. Training will be conducted during the final months of project construction and during the turnover period.

Farmers. Extension training will be provided to farmers who are not accustomed to irrigation systems. The training is expected to consist of evening lectures in the villages or hamlets, supplemented, with field advice by extension agents through the Contact Farmer system.

Alternatives to the Proposed Project

No-Action Alternative

If the project is not implemented, some advances in cropping intensity might be expected through irrigation schemes at the local level, either by weirs on tributary streams or by privately-owned or village-owned pumps. However, as the younger farmers, unable to obtain sufficient irrigated paddy fields locally, some would seek land elsewhere. It is likely that the Awo area would remain one of subsistence farmers, more or less locked in a low-medium living standard.

Water Supply Alternatives

Ground Water Utilization. Ground water depths and quantity have been examined in the Awo service area. It has been evident that cost and reliability of ground water use are not as favorable as using the abundant river water for irrigation.

Improved Water Management. Water conservation and improved on-farm management are parts of the extension package for the Awo project, but good management cannot provide rain water when the natural supply is unreliable.

Siting Alternatives

Structures: Diversion Weir. The selected weir site has resulted from exploration of several alternatives on the basis of geotechnical considerations and canal costs. Until late in 1988, the weir was to be placed at a site near the hamlet of Dake, just downstream of an island that divides the river into two channels. The present site, 1.7 km downstream of that point, has the advantage of shortening the canals as well as providing an adequate foundation for the weir. Another site, 1.4 km downstream of the selected site, was also studied, but found to require a lateral dike to prevent overflow into paddy fields on the right bank. Even with the dike, the weir pool would inundate about 5 ha of paddy fields on the left bank. Exploratory drilling downstream indicated that the increasing depth of river bed alluvium would cause foundation problems if the site were moved farther.

Canals. A single right bank canal to transport all of the irrigation water to the upstream end of the service area, where the left bank would be supplied by bridging the river with a flume is proposed. The cost of such a bridge is relatively high, due to the depth of the river bed gravel and cobble, but the crossing becomes more attractive if combined with a road bridge for access to the left bank. The road crossing is required for effective operation of the system. A separate left bank offtake from the weir is not attractive because of the topography.

Other canal routing alternatives have been evaluated on the basis of economics, reliability, and ablility to serve an effective subcommand area.

Auxiliary Structures. The existing access road to the site, which runs through the right bank service area from the Sengkang-Siwa-Palopo coast road has been selected as most appropriate, and other new routes would be excessively expensive to construct. A bridge across the Awo for access to the upper part of the left bank is required; otherwise access to the left bank area will be cut off during rainy season flooding of the Awo River.

Service Area. The selection of area to be served by the project has been based on existing land use, topography, and soils.

Scheduling Alternatives

There is basically only one schedule worth considering for a small-scale irrigation project: to bring the entire system on line as soon as possible. The question of whether the weir and the conveyance system are constructed simultaneously or in tandem will depend on labor. Simultaneous construction is preferred, bringing project benefits sooner, and has been adopted for the Awo Project.

Existing Environmental Conditions

Climate

The project is located in an area of tropical moist climate, with an annual rainfall averaging about 2,500 mm. Major rainfall events occur in every month, but are most frequent in March - July. Temperatures range from a monthly average minimum of 26.0 degrees Celsius (C) in June to a monthly average maximum of 28.5 degrees C in February.

Topography and Geology

The catchment area above the weir site is composed of steep, strongly dissected ridges, reaching more than 3,200 meters in elevation at the headwaters. The coastal plain, containing the service area, is flat or gentling undulating. The service area extends from 24 m in elevation at its upper end, to less than 8 m at the lower end.

The flat coastal plain is composed of sedimentary material. The mountainous area includes a variety of sedimentary and volcanic rock types, with small areas of limestone and marl.

Water Resources

The Awo River is the main body of fresh water in the area, there being no lakes and only a few very small ponds. It drains a basin with a total area of 400 km^2, approximately 240 km^2 of which lies upstream of the project weir site. The Awo is a perennial river with an annual discharge of 350 to more than 600 million cubic meters at the weir site. The mean half-monthly discharge of the Awo rarely falls below 3.5 m^3/s and exceeds 50 m^3/s in wet years.

Water quality in the Awo is fairly good, with low to moderate concentrations of most major ions and nutrients. Most parameters are well within recommended water quality limits. Moderate to high levels of bacterial contamination are common, restricting its direct use as drinking water supply.

About 60 percent of households in the project area draw their domestic water from wells throughout the year. The remainder use the Awo River and other surface water sources.

Land Resources

Land Use. The majority of the upper catchment is covered with dense tropical deciduous forest. There are some smaller areas in the middle reaches of the upper catchment which have been cleared, and are now largely grassland and scrub. Some areas along the river upstream of the weir site are being used for a combination of annual and perennial crops (mixed dry land).

This same combination of mixed dryland agriculture is common in the gently rolling hills of the western part of the lower catchment, where extensive clove plantations have been established. The proposed service area of 2,500 ha is practically all rainfed paddy fields. There are minor areas of fish ponds and mangrove swamp at the mouth of the river.

For the 400 km^2 watershed as a whole, forest occupies approximately 53%, mixed dryland agriculture 25%, rainfed paddy fields 15% and scrub forest/grassland 6%, with minor amounts of coastal fish ponds and mangrove.

Soils. Most of the flat service area is comprised of dark gray alluvium, with the main material consisting of clay deposits. Soils in the mountainous zone are a complex of podzols and regosols which originate from sandstone and tuff. These soils are generally highly erodable.

Erosion and Landslides. Erosion is not a serious problem in the far upper catchment, since the forest cover is still fairly complete in most places. Moderate to heavy erosion is found on lower slopes where mixed dryland agriculture is practiced, and where grassland is repeatedly burned to provide access to young grass for cattle forage.

Agriculture: Cropping Patterns. Paddy is the most extensively cultivated crop in the service area, being planted in the wet season with the onset of rains. Roughly 1,900 ha are planted in paddy, with an additional 480 ha planted in mixed crops including mungbean, soybean, and maize. Paddy yields average about 2.6 tons of dried paddy per hectare (t/ha), while mungbean production averages 400 kg/ha.

Following the wet season, pump-irrigated paddy is attempted over approximately 550 ha, and secondary crops are planted over 750 ha. The main secondary crop planted is mungbean, with additional amounts of soybean and maize. Yields of up to 2.9 t/ha of paddy are attainable in pump-irrigated areas during the wet season, and 2.7 t/ha in the subsequent dry season.

Cattle still provide the main source of draft power for field preparation. Approximately 80 2-wheel tractors are reported owned in the villages, with others brought in as rentals, so that up to 40 percent of the land preparation is performed by tractors.

Fertilizers are widely used, but at relatively low rates, well below those recommended by the agricultural specialists. Pesticides are used, including insecticides and herbicides, but application rates are again low relative to recommended rates.

Biological Resources

Terrestrial Vegetation. The natural climax vegetation formation of the Awo catchment is tropical seasonal evergreen forest, which still covers much of the upper watershed. The coastal plain has been cleared for agricultural purposes, and clearing is currently progressing into the rolling foothills and up into the middle reaches of the Awo. In these latter areas, the forest is being replaced by grassland and/or scrub.

Fauna. Published studies of fauna in neighboring regions of Sulawesi and interviews with local residents gives an idea of the animal life to be expected in the wilder areas of the upper Awo catchment. There are probably deer, wild pigs, macaque monkeys, but bats and rodents are the most diverse and abundant groups. Monitor lizards and python are not uncommon. The bird fauna are diverse, including several species of birds of prey, fruit-eaters, numerous insectivores, and seed-eaters.

Endangered Species. Five mammal species at risk of extinction may be found in the upper catchment area. These are the Sulawesi tarsier, the Sulawesi civet, the babirusa, and the lowland and mountain anoa. The middle Awo catchment area is part of a large sport hunting area. Most of the game that is hunted are deer and "wild" cattle, but some babirusa and anoa may also be hunted.

Freshwater Biology and Fish Populations

The Awo River is host to a variety of micro- and macrobenthic organisms which are generally characteristic of these types of rivers. Fish present include a wide range of introduced or widely distributed species including tilapia and carp. Some migratory species such as mullet, freshwater prawn and eels are also likely to be present in the river. There is some artisanal fishing, but no commercial fishery. Overall, fish caught in the river remains a rather unimportant food source and the Bugis population continues to prefer marine fish as the main source of protein in their diets.

Estuaries and Coastal Mangrove

The estuary of the Awo River can be considered to extend upstream as much as 5 km, the reported limit of brackish water occurrence during the dry season. Much of the original mangrove vegetation in the area has been converted to fish ponds for milkfish and shrimp production.

Socioeconomic Resources

Population. The four villages of Awota, Lompo Loang, Lauwa, and Bulete contain approximately 22,000 people, living in about 4,400 households, of which 41 percent are estimated to have land in the project service area. The population has been growing at a rate of 1.8 percent during the 1980s and population density is now

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92 persons/km^2, ranging from 46 persons/km^2 in Awota to 168 in Bulete.

The population of the area is principally of working age, with 63 percent between the ages of 15 and 54 years, with only 30 percent aged less than 15 years and 7 percent aged 55 years and older. The Department of Statistics reports widespread attendance of children in primary schools (94 percent). The government has also provided many adult literacy programs in the area, so that the majority of the population aged approximately 7 to at least 35 years are literate and fluent in Indonesian.

The majority of the population are ethnic Bugis, who are Muslim. The village of Lompo Loang has a hamlet of ethnic Torajanese (Christian), who settled there in 1969.

Public Health and Water-Borne Disease. Health data from the main health clinic in Bulete, supported by informal interviews with village leaders, show that malaria and dengue fever are not seen as major problems in the area. Gastric and intestinal diseases (gasteritis, diarrhea, and cholera), are a problem, with the incidence rate higher during the dry season when the quality of domestic water decreases.

Existing Irrigation Organizations. There are more than 15 pumps in the four villages, used to irrigate at least 750 ha of paddy fields, in small commands averaging 50 ha in size. Most of these pump-irrigated commands have leaders--the pump-owners and water distributors (mandor). In Awota, there is a village-controlled system with a formal organizational structure, including two subunits and offices. Water user fees are collected, typically 15 to 25 percent of the harvest yield.

Most of the farmers in the rainfed paddy field complexes (lompo) are not formally organized. However, traditional ceremonies (mappanarang) are held in the villages prior to the beginning of the paddy planting, which promote cooperation in agricultural work. Many farmers participate in loosely structured farmer groups (kelompok tani), in contact with the government-sponsored agricultural extension service.

Potential Environmental Impacts

Background

Assessment of the impacts of irrigation projects such as this are usually based upon information from a number of sources, including published literature, expert opinion, local knowledge of conditions, and baseline biophysical and socioeconomic monitoring. As part of the Environmental Assessment process for the Awo project, an environmental scoping session was held in Ujung Pandang in April 1988 to permit comment by local and regional agencies on the plans for the project. This meeting identified a number of potential issues which are discussed in this report. The major environmental issues identified for the Awo project were:

- o availability of river water for downstream users
- o project interaction with watershed clearing
- o adverse health effects on downstream users

Water Resources

Since mean half-monthly flows for an average year range from 10 to nearly 40 m^3/s, in most years there will be only a limited effect on downstream flow, and then only in the dry season. It is only in particularly dry years, which may occur on a 1-in-10 year basis, that irrigation requirements would exceed river discharge, thus stopping flow in the river for a period of perhaps one month. During this period, sufficient water would remain in pools in the river for most purposes. However, most people will use of the water in irrigation canals or wells during such times. The land provided with irrigation may eventually be expanded to include the Eastern Extension Area (2,200 ha), in which case a portion of the Awo River may go dry for several months at a time in very dry years.

Families living farther away from the river and closer to the new canals may be expected to use these water sources for laundry and bathing. Buffalo will probably be taken to the nearest canal for watering. Designated locations for stock watering will be provided for this purpose.

Thus, the impact of low river flow on domestic water use is expected to be minimal, even if the project is expanded into the Eastern Extension Area. Overall, the water table is high (below the weir), and it is relatively easy to dig shallow wells if families prefer a water source next to their houses, rather than getting water from nearby canals.

Runoff and Drainage. The application of irrigation water, even under carefully controlled conditions, will result in increased flow in drains and then in the tributary streams into which they discharge. There also is likely to be a somewhat greater domestic waste water flow into the same drains, due to wider distribution of water in the canal system.

Water Quality: Upstream. No water quality changes are expected to result upstream of the weir as a direct result of the project. Continued opening up of the forest, whether aided by the project or not, will increase the load of dissolved and suspended solids but is not likely to cause any other significant water quality changes in the river.

Service Area. Wet season water quality downstream of the weir will not be significantly changed as a result of diversion at the weir or irrigation return flows, since the assimilative capacity of the river is high. During the dry season, when the flow in the first three or four kilometers downstream of the weir will be reduced by 20 to 80 percent (or cut off entirely in especially dry periods) waste water discharges from drains containing human and animal wastes may cause some contamination. Irrigation return flows farther downstream, while containing some human wastes, will be of better quality than the flows from the more upstream areas, where the irrigation component is proportionately less. The extent of possible contamination cannot be estimated on the basis of available flow information, but its effect on the local population probably will not be serious if, as expected, people turn to the local canal system and wells for domestic water.

The volume of agricultural chemicals in the return irrigation flows is not likely to be large enough to cause toxicity problems, since the majority of such input will be phosphate and nitrate nutrients. These may cause algal blooms in drains or where the river is sluggish.

Ground Water: Quantity. The project may cause a slight increase in ground water recharge, due to percolation of irrigation water at the time of year when surface water is not now available. Households that do not dig wells at present may find the water table within reach.

The other side of this question, raising the water table to the surface, thus causing waterlogging and soil salinity problems, also has been of possible concern. The drainage system is designed to prevent waterlogging by removing excess surface water. Soil and water salinity is already naturally high in the far downstream estuarine area, but the project should have neither a negative nor a positive effect on this region.

Quality. Some contamination of groundwater may occur in areas of exceptionally high fertilizer use, but the effect would be largely one of taste. It is unlikely that, even with maximum project development, this will be a problem. Contamination by pesticides is a greater likelihood, not as much from normal crop applications, but from careless storage, formulation or accidental spills.

Land Resources

Land Use and Capability. Within the service area little change in basic land use is expected; land now in agriculture will remain in agriculture and any hillier land will probably remain in pasture, brush or tree crops. Some marginal land that is now considered too sloping for rainfed paddy fields may be leveled and terraced when irrigation becomes available. Some farmers on the fringes of the service area hope to do just that and take advantage of available irrigation. Others hope to use pumps and take water from canals to provide water to the higher ground, as they already do to a limited extent.

Land clearing in the basin upstream of the weir, already proceeding at a pace causing some alarm in the Forestry Department, may be accelerated by the project, due to improved access to markets and to sources of supply. A number of farmers who do not live in the area have permission to cut and burn large trees and to raise crops in the upstream area, using shifting cultivation techniques. Others regularly burn the grasslands to provide access to fresh-sprouted grass for their cattle. There is no reason to believe that clearing in the watershed will be controlled in the near future, unless firm controls are implemented by local and regional government agencies.

Proper application of irrigation water in a system with effective drainage does not cause soil waterlogging, the fear of soil scientists who have observed salinization in areas where water tables have risen. Salinization is most likely to occur in areas of low relative humidity and hence high evaporation, when irrigation applications are excessive and drainage poor. These conditions are not expected to occur in the Awo service area.

Erosion and Soil Movement. Continued land clearing and hillside agriculture in the Awo basin is almost certain to produce a higher sediment load in the river, probably reaching carrying capacity at some times of year.

Runoff. The most important effect on the project of clearing in the watershed will be changes in the runoff characteristics. Flood peaks will be higher and shorter and the flows between rainfall events will be lower. With essentially no storage capacity, the project's operation would therefore be seriously affected.

Biological Resources

Impact of the Project on Habitat: Terrestrial. The only significant habitat change resulting directly from the project will be the conversion of some 31 ha of existing river and riparian habitat into a pool and weir site.

Aquatic. As aquatic habitat, the weir pool will possess some value for bathing and laundry washing, and could be used for livestock watering. The river is, and will remain, a rather unimportant source of fresh fish to the local population.

Impact of Changes in Habitat on Project. The destruction of wildlife habitat in the Awo basin appears likely to continue with or without the project, unless some means is found to prevent illegal land clearing and the official sanctioning of dubious commercial tree crop planting programs. In the Awo basin, forest degradation is greatest in the middle reaches of the upper catchment and appears not to have begun in the far upper reaches of the watershed.

Species of Special Interest: Rare and Endangered Species. Project activities are unlikely to affect directly the habitat or populations of any of the five Sulawesi mammals possibly found in the Awo area considered by the International Union for the Conservation of Nature to be endangered or threatened. The Awo area is currently identified as part of a sport hunting area where unindentified large animals are shot at night by hunters travelling on pick-up trucks, using spotlights to stun the animals and prevent their running away. Improvements to the local roads may increase this practice, leading to further stress on the larger wildlife populations.

Commercially Important Species. Many tree species in or near the service area, utilized today on a noncommercial basis for fuelwood or lumber, may gain market value as the farm population has more disposable cash and less time for gathering forest products. Those collecting commercially important rattan in the area already must go far up into the catchment. Rattan needs only seven years of growth to be commercially harvestable in a managed environment, but clear stripping the hills of trees destroys this industry.

Grazing and Fodder. The more intensive cropping of lands that now serve partly to support the large livestock herd will leave the livestock owners looking for more grazing lands. New grazing lands, if opened, are likely to be in the upland fringes of the service area, where the lack of water may make them unsuitable for buffalo. About 20 percent of the land area of Awota Village, located along the southern boundary, is unavailable for local villager use since it has been acquired for commercial cattle production by PT Bina Mulia Ternak. Expansion of grazing land for village use would necessarily go farther to higher ground to the west and north, into the upper catchment. Area farmers, however, continue to convert to using hand tractors, thus reducing the need for draft animals.

Agricultural Chemicals. The overall amount of fertilizers and pesticides applied is expected to increase gradually. The types of fertilizers are not expected to change much over the next few decades, but pesticide selection and formulation will change as new compounds become available.

The introduction of toxic compounds in an area not accustomed to them poses risks of improper storage, handling, mixing and disposal of chemicals. The possibility of ecological effects of pesticide use, other than from a major spill or other accident, seems remote, since the chemicals used at present are nonpersistent and there is a trend toward more specific, short-lived compounds. Intensive use of chlorinated hydrocarbons (DDT, toxaptene, chlordane, lindane, etc.) should be discouraged since that could result in severe impacts on the fish ponds downstream of the service area, especially on ponds producing shrimp.

Pest Species. Three types of pest populations may be expected to share project benefits with the farmers: crop pests (mostly insects, birds, and rodents), aquatic plants, and disease vectors (principally mosquitoes). An increase in cropping intensity may be expected to favor populations of insect and vertebrate pests.

Pest plants are of several sorts: floating, emergent, and submerged. All three should be expected in project waterways and all block the effective flow of water, producing stagnant pools that allow mosquitoes to breed freely.

Socioeconomic Resources

Target Populations. The farmers with access to the irrigation water are expected to experience substantial gains in net income and in standard of living, which will be reflected in better nutrition, increased purchases of consumer goods, greater demand for education, and increased communication with areas outside the project area.

At-risk Population. This group, by definition limited to people that do not receive direct benefits from the project in the form of irrigation water but are living in the study area villages, includes upland farmers and livestock owners on non-irrigable land, downstream paddy farmers not receiving irrigation, tambak farmers, fishermen, merchants, craftsmen and mechanics, laborers, and other members of the community who do not grow paddy. The increased prosperity of the target population will benefit this group economically by increasing demands for goods and services.

Settlement. Immigration to the Awo area now taking place must be expected to increase during project construction and operation. Evidently, the hills in the project area are already viewed as open for use by people in neighboring districts (kabupaten) and certainly the addition of irrigation will encourage this view. Those who cannot obtain land in or near the service area may move into the interior of the basin until the opportunity occurs to obtain flat land.

Social Organization. Unlike the short-term visitors who come and go, the settled communities with rainfed and pump-irrigated paddy fields in the Awo project service area already have a high degree of cohesion. The project, which will involve increased group activities (e.g., irrigation system maintenance) will tend to increase that cohesion.

Farming Systems - Cropping Patterns. Initially, farmers with access to second crop irrigation are expected to put in paddy for marketing, with some to attempt a third crop season, consisting of palawija. The increased cash flow available to area farmers may be expected to lead to increased mechanization of field preparation. There will also be more pressure toward mechanization if the keeping of draft animals becomes more difficult.

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Public Health

The major public health effect of the project will be the possibility of increased aquatic habitat for disease vectors such as mosquitoes. If not properly controlled, this could ultimately result in a higher incidence of malaria and dengue fever.

In some parts of the project area, gastrointestinal diseases are more frequent in the dry season when water availability is restricted. The project may alleviate this situation by providing more water of higher quality in the supply canals.

Other Resources

Increased prosperity in the target population may lead to some new house construction and repairs of existing homes. These will require sawn lumber that will have to be obtained from commercial outlets outside the basin.

Over the life of the project, the type of domestic fuel used may well shift away from wood toward kerosene or gas, as wood becomes harder to obtain. Until that happens, the local forest will continue to provide the main fuel resource for all households, in direct proportion to the population, which seems to be increasing slowly.

Effects of Project Alternatives

No Action Alternative. The pressure of a gradually increasing population, dependent on a land resource with limited irrigation and an unreliable water supply, would lead to greater poverty and lower living standards. These would induce the younger members of the communities to emigrate in search of wage labor or better farming conditions. Some might turn to exploitation of different resources, such as the forest or the wild fauna.

In time, a village-level irrigation scheme might be implemented, but it is doubtful that local funding could provide a weir and canal system on the scale required for effective utilization of the catchment's surface water resources.

Alternative Irrigation Technologies. Although the pumpage potential of the deeper aquifers in the Awo catchment area has not been determined, it is clear that extraction from the shallow aquifer that now provides domestic water would exhaust that water resource and deny its relatively pure water to most households.

Design Alternative Weir Sites. The environmental effects of the three alternative weir sites would be roughly equal, differing largely in the effects of canal length. In this regard, the most downstream site would disturb somewhat less land.

Access Road. Employing a route for the access roads other than those now in use would require destruction of more natural vegetation, or farmland, depending on the route selected.

Scheduling Alternatives. Phasing or delaying development of the project would have the same sort of effect as not constructing it at all, except that the presence of the half-constructed project might serve as a greater magnet for immigrants than the present expectation of a future project. If so the rate of colonization might be greater than without the project.

Evaluation of Environmental Impacts

Water Resources

Downstream Flow. The major objective of this project is the diversion of water from the river and its redistribution over 2,500 ha of irrigated paddy fields. A primary impact of this change will be the decrease of flow in the river. This effect will only be of practical significance in extremely dry years, which may occur on a 1-in-10 year basis. If the Eastern Extension Area of 2,200 ha is eventually irrigated then the upper portion of the Awo River below the weir may go dry for as long as several months in some years, when all water is diverted to irrigation.

Water Quality. Return irrigation flows will undoubtedly contain higher levels of nutrients from fertilizer runoff as well as from human use of the canals for bathing, laundry and sanitary purposes. However, the extent of degradation is not normally expected to be great enough to cause problems for downstream users. Water available from the canals will usually be of superior quality to water taken directly from the river.

Land Resources

Watershed Management. The project will result in more intensive agricultural use of the land in the service area, but will not otherwise significantly change land use patterns. In the river catchment, land conversion from forest to grassland or mixed dryland agriculture is proceeding rapidly. The project will provide some assistance to the distribution of the forest lands through improvement of road access, and therefore measures should be taken to discourage this process as much as possible. Access to the catchment appears to be also occurring on roads from adjoining watersheds to the west and northeast. The project will not effect the process in that area.

Upstream forest clearance will result in erosion which will increase sediment load and ultimately affect irrigation system operation through deposition in the weir pool and canals. Clearance will also alter runoff characteristics, thus affecting system operation. It will thus be in the interest of the project to press for increased control of land conversion in the catchment.

Livestock Management. With the introduction of a twice a year cropping system less land will be available for cattle and water buffalo grazing. The result may be overcrowding of present fields or the further deforestation of the lowland hillsides, and increased pressure on the catchment area. Over the long term, it is expected that farmers will turn more and more to mechanization, thus decreasing the need for field animals.

Agriculture Management. Relatively minor amounts of land will be used for construction of the canal system; some sort of compensation will be expected by the landowners. The main pool will occupy an area of 31 ha, most of which is now riparian brush or riverbed, so no major loss of productive land will occur.

The project is expected to have significant impacts on the farming system, including higher agricultural yields of paddy and palawija crops, increased mechanization (and decreases in numbers of draft animals), and increased use of agricultural chemicals.

Biological Resources

Terrestrial Habitat. The project will result in more intensive agricultural use of land in the service area, but will not otherwise significantly change the downstream terrestrial habitat. Similarly, the project will not have a direct impact on the habitat of the middle and upper parts of the catchment area, except to provide improved road access up to the weir site. Measures should be taken to discourage further improvements to roads and trails leading into the middle and upper catchment areas.

Pests and Diseases. There is a risk that crop pests, aquatic weeds, and disease vectors (mosquitoes) will all increase due to the more abundant water. Monitoring and control programs can offset these risks.

Socioeconomic Resources

Increase in agricultural production will lead to increases in income and an improved living standard. This directly affects the target population, and provides secondary benefits to the at-risk and migrant populations.

Settlement Patterns and Movements. The demand for additional labor can be expected to lead to increases in the population. Some people who temporarily enter the area will decide to permanently settle there.

Services, Infrastructure, and Social Organizations. Improved living standards and more economic opportunity in the area will probably lead to increased trade and demand for services. There should also be an increased demand for more infrastructure (schools, health clinics, roads, transport, and markets).

Land Ownership and Tax Collection. Increased prosperity should make it possible for area farmers to bear some of the costs of a modern cadastral survey based on air photographs. Taxation rates would also be upgraded accordingly.

Public Health: Vector-Borne Diseases. The project will probably bring with it an increased risk of mosquito-borne diseases, particularly malaria and dengue fever.

Resource Use. Increased prosperity will lead to new house construction and housing repairs, with consequent increased demand for sawn lumber obtained from commercial outlets with sources outside the basin, or from the upstream forests. Domestic fuel use will icrease, and at least at first, the demand for fuel wood will increase.

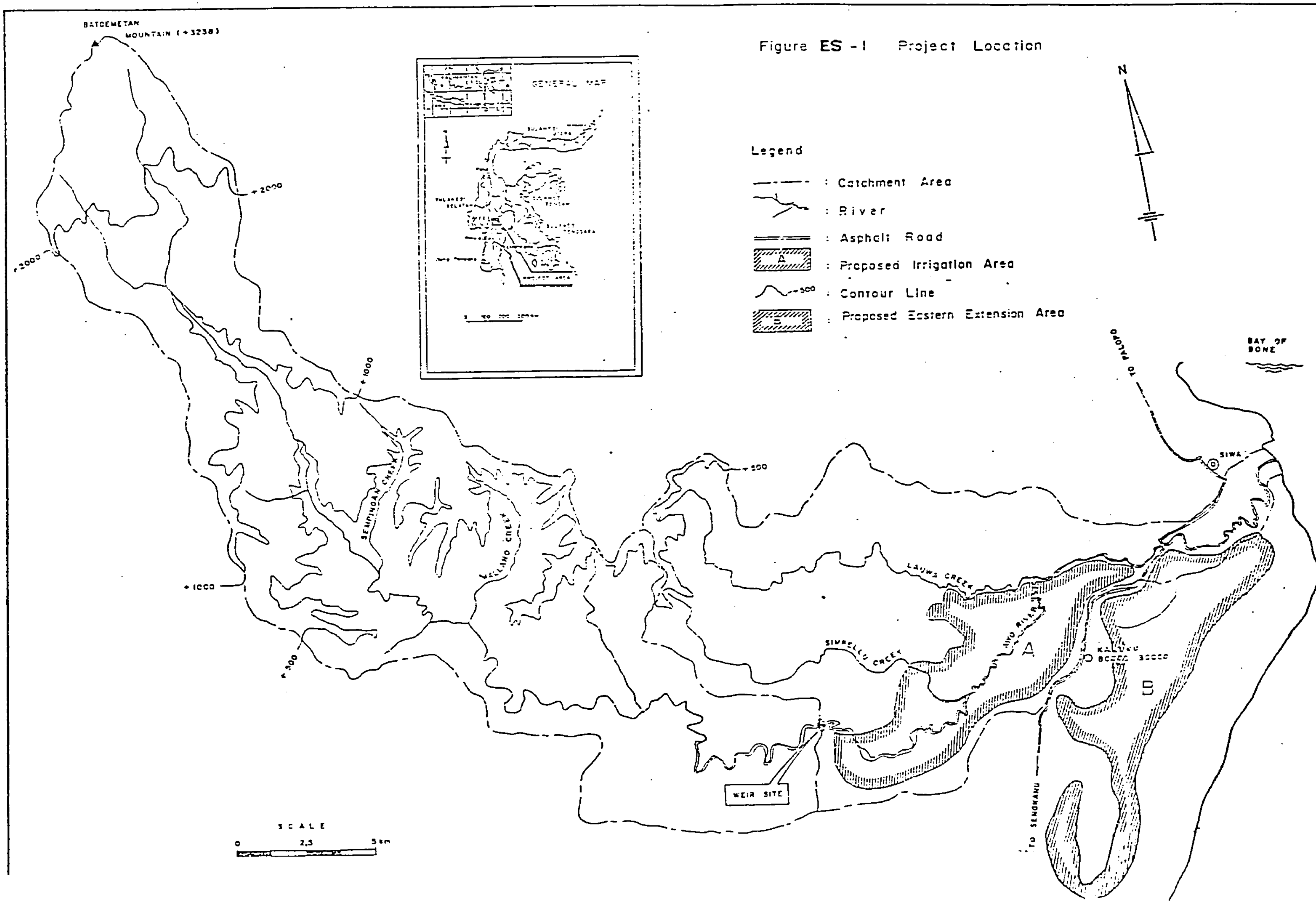
Farm Support Organizations. Farmers will be organized into water users' associations. Agricultural extension services will be stepped up, and it is expected there will be increased activities of farmer cooperatives.

Conclusions

The Awo Irrigation Project is a weir scheme to supply irrigation water to 2,500 ha. There is also the possibility of later supplying an additional 2,200 ha east of the present project area. Almost all of the proposed service area is already planted in paddy and secondary crops for one or two seasons. The project will boost the service area's cropping intensity, currently 160 %, to 200 %, and substantially increase yield per hectare.

Environmental impacts of the project include: altered streamflow during very dry years, additional recharge of the groundwater aquifers, generally improved water availability and access to water, some agricultural land being used for project facilities, inundation of 31 ha of riparian scrub forest and riverbed, decreased dry season grazing areas for livestock, possibly improved access for deforestation activities, risk of increased crop pests and mosquitoes, and improved economic conditions for the local population. Possible adverse effects are addressed by the Environmental Management Plan.

Based on the present studies, the conclusion of this Environmental Assessment is that the Awo Project has no major detrimental impacts which call into question the viability of the project. The project will result in spatial and temporal changes in water distribution which will have limited environmental effects on the local population. The project is therefore environmentally feasible, and the mitigation of any potentially negative impacts has been adequately addressed in the Management Plan.



BATCEMETAN MOUNTAIN (+3238)
Figure ES - I Project Location
GENERAL MAP
Legend
: Catchment Area
: River
: Asphalt Road
: Proposed Irrigation Area
: Contour Line
: Proposed Eastern Extension Area
N
+2000
+1000
+500
SEMPINOAN CREEK
KALLINO CREEK
LAUWA CREEK
SIMPELLU CREEK
A
B
KALUKU
TO PALOPO
BAY OF BONE
SIWA
TO SENGKANG
WEIR SITE
SCALE
0
2,5
5km

TABLE ES–1
SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS
AWO IRRIGATION PROJECT

ENVIRONMENT COMPONENT	DESCRIPTION OF IMPACT	SOURCES OF IMPACT		IMPACT LOCATION		TIMING OF IMPACT			EXTENT OF IMPACT			REMARKS
		PRIMARY	ASSOCIATED	CATCH-MENT AREA	IRRI-GATION AREA	PRE-CONST.	CONST.	OPER.	UPON?	DURATION	INTENSITY	
WATER AND ATMOSPHERIC RESOURCES												
Water Quantity	Reduced availability in river below weir	Flow reduced below weir			x		(x)	x	People along river	Long-term	Moderate	Dry years only; water available in canals
	Runoff and drainage	Application of water to service area			x			x	Beneficiary farmers	Long-term	Major	Better control
Runoff	Increased flood peaks	Deforestation		x	x	x	x	x	Irrigation area	Long-term	Minor to Severe	Depends on good control measures
Water Quality	Increased suspended solids/sediments	Deforestation	Erosion	x	x	x	x	x	Canals	Long-term	Moderate to Severe	Not caused by project
	Increased chemical concentration	Agricultural chemicals	Irrigation		x			x	Irrigation area	Long-term	Minor to moderate	Proper use reduces risk of adverse impacts
	Increased nutrient and coliform levels	Livestock and human waste	Sanitation practices		x			x	Surface and ground water	Long-term	Moderate to severe	Possible risk to domestic water supplies
Ground Water	Increased recharge	Percolation of irrigation water			x			x	Ground water	Long-term	Moderate	Good, most years
	Contamination	High use of agricultural chemicals			x			x	Surface and ground water	Long-term	Moderate to severe	Controlled use could minimize effect
Air Quality	Increased fugitive dust	Construction activity			x		x		Irrigation area	Short-term	Moderate	Mitigation involves dust control (road watering)
	Increased smoke	Burning surplus rice straw			x			x	Irrigation area	Long-term	Moderate	Straw burned when intensive cropping leaves no time for natural decomposition
LAND RESOURCES												
Land Use/Conservation	Erosion/Sedimentation	Upstream logging/ deforestation; grazing	Shifting agriculture	x	x	x	x	x	Catchment and irrigation areas	Long-term	Major to Severe	Ongoing. Improved access could accelerate impact if controls are not implemented
Farming Systems	Increased production	Multiple cropping dependable water supply			x			x	Project beneficiaries	Long-term	Very Positive	Main purpose of project
	Conversion to paddy fields	Irrigation			x		x	x	Irrigation area	Long-term	Minor	Most land already converted
	Less grazing land	Multiple cropping		x	x			x	Livestock in irrigation area	Long-term	Moderate	Loss in area but improved quality fodder on waste ground in service area
	Loss of farmland	Construction system	Increased population		x		x	x	Irrigation area	Long-term	Minor	Unavoidable. Small percentage of total area
BIOLOGICAL RESOURCES												
Terrestrial Habitat	Convert 96 ha to create weir, pool, canals	The Project		x	x	x	x	x	Many landowners	Long-term	Minor	Unavoidable. Small amounts of land needed from many farmers
	Increased pest population	Multiple cropping			x			x	Irrigation area	Long-term	Moderate	Control measures needed
Aquatic Habitat	Proliferation of aquatic weeds in canals and drains	Increased nutrients	Inadequate maintenance		x			x	Irrigation area	Long-term	Minor to severe	Depends on maintenance
	Restriction of fish movement on river	Weir a barrier		x	x		x	x	Fish in river	Long-term	Minor	Upstream fish breeding prevented
	Increased numbers of mosquitoes	Increased breeding area with irrigation			x			x	Resident population	Long-term	Minor to moderate	Malaria and dengue fever may increase
SOCIOECONOMIC RESOURCES												
Community Income	Increased income	Project operation	Project construction		x		x	x	Residents and migrants	Long-term	Major	Primary benefit of the project
Settlement Patterns and Movements	Increased population immigration	Economic opportunity		x	x	x	x	x	Residents and migrants	Long-term	Moderate	Unavoidable
Community Stability	Disruption of social patterns	Influx of temporary construction workers			x		x		Resident population	Long-term	Moderate to Serious	Mitigation needs contractor and local cooperation
Services and Infrastructure	Increased demmand for services/infrastructure	Improved economy	Increased population		x			x	Resident population and migrants	Long-term	Major	Unavoidable
Land Ownership and Tax Collection	Land sales; more leasing and sharecropping	Intensification of farming	Increased land values		x			x	Beneficiary farmers	Long-term	Moderate	Unavoidable
Public health	Increased disease vectors	More mosquitoes	Lack of vector prevention		x			x	Resident population	Long-term	Minor to Moderate	Control required
Farm Support Organizations	Increased demand/need for farmer organizations	Need to operate the system			x	x	x	x	Project beneficiaries	Long-term	Minor to moderate	Very positive impact

PART II

AWO IRRIGATION PROJECT

ENVIRONMENTAL MANAGEMENT PLAN

Environmental management, as applied to development projects, is a process of identifying and evaluating future interactions between a project and its surroundings, and then taking actions that minimize adverse effects and enhance beneficial ones. Environmental impacts can be considered as falling in two general categories:

1. Unavoidable Adverse Impacts. These are adverse side effects that are so closely tied to project effectiveness that not much can be done to ameliorate them. Often the unavoidable adverse impact is the residual of a more serious impact that has been lessened through an effective mitigation program.

2. Manageable Effects. These are direct or indirect project effects, adverse or beneficial, that lend themselves to improvement through careful action. Sometimes a potentially adverse situation can be turned into a project benefit through wise use of financial or other resources.

Type of Actions

The approach to managing an environmental effect varies with the type and degree of effect, its time and place of occurrence, and the stage of project development at which it is recognized. Ideally, the process of environmental impact assessment is a continuous one that permits mid-course corrections in project planning. More often, an environmental assessment is a one time affair, conducted during a pre-feasibility or feasibility study, at a time in project development when only superficial changes in project design are possible. In this project, however, sufficient latitude exists to permit planners to address all of the major environmental concerns.

Mitigation actions may be divided into those directed at changing some aspect of the project, such as design, construction method, or operation, and those directed at changing the environment so as to avoid or lessen a project effect or to increase a benefit. Within these two groups of actions, a further distinction may be made between those that must be implemented during project construction, in order to be effective, and those that take place during project operation.

Proposed Management Plan

Responsibility. As soon as the construction is completed, the management and monitoring plans will be the responsibility of PRIS and BAPPEDA in the district (BAPPEDA, Tk. II). It will be supervised by the Environmental Department of the Ministry of Public Works under Indonesia's Environmental (AMDAL) law. Oversight is provided by the Ministry of Population and Environment. It is recommended that other government agencies be involved in implementing the management plan of the project. These agencies include the Extension Services of the Departments of Food Crops and Livestock, the Departments of Forestry and Health, the National Board of Lands (Badan Pertanahan Nasional, formerly Agraria), the Agrarian Taxation Office (IPEDA/PBB), that part of Public Works responsible for village water supply (Cipta Karya), and regional government (PEMDA) at and below the district level, including the Bupati and Camat, and their delegated staff.

The Department of Public Works and BAPPEDA should develop a detailed Plan of Action, working together with the sectoral agencies. This would include detailed timing within the annual budget cycle, and detailed budgets from regional (APBD), national (APBN), and to a limited extent, foreign donor-assisted funding sources.

The areas of project effects that are most appropriate for mitigative measures include those that were stressed by participants at the scoping session including downstream flow effects and land clearing in the basin.

Construction Phase

Adverse environmental impacts during construction should be temporary. Increased noise, traffic and dust are unavoidable, although in the case of dust, its effect can be lessened by watering the roads when necessary. The contractor should be prepared to supply his laborers with all those necessities that are not readily available from the local villages. In any case, firewood must not be taken from outside those areas that need to be cleared for construction. The contractor must keep the labor camp in a sanitary condition, otherwise pests, disease and hazardous wastes could result.

Some land will be removed from agricultural use to make way for canals and their associated works. Fair compensation should be negotiated with the affected landowners before construction begins, otherwise future delays could be encountered.

Water Resources

Downstream Flow. Users of the Awo River will not be completely deprived of water for bathing, laundry and livestock watering in most years. River flow simulations show that under very dry year conditions, perhaps one year in ten, the Awo River below the weir and above the junction with the Simpellu tributary will go dry for up to three months. This is assuming that all land is being irrigated including the Eastern Extension Area (total area of 4,700 ha). Villagers along this section of the Awo River however, will have easy access to the main irrigation canal and therefore water should be readily available. Thus, given the availability of water from the canals or from wells, no special mitigation measures are seen as necessary, to provide drinking water. Special provisions in the design of the canal system should allow for bathing, washing and water buffalo watering. In addition wells can be easily dug if higher quality water is required than what is available from the canal.

Consideration will be given to establishing a minimum flow in the river downstream of the weir. As in other Public Works irrigation projects, the Provincial Public Works office will discuss the level of minimum flow required with the district irrigation committee. These discussions should take place over the next two years as an integral part of the preparation of project operation and maintenance procedures. The USAID/Jakarta environmental officer will take an active role in the discussions. Once the project moves into the operation phase, the irrigation committee, assisted by the local water users' association representatives, will evaluate and monitor the adequacy of the minimum river flow.

Canal Bank Protection. Even with some flow in the river assured at most times, many livestock owners are likely to take their buffalo and cattle to the canals for bathing and wallowing. Some will place their animals in drains, since buffalo show a definite preference for mud over clear water. In the interests of protecting the canal banks from damage by livestock, a two-pronged program is needed:

1. A vigorous program of education of adults and young in the farm population to instill respect for the canal system and the realization that damaging the canals is contrary to the interests of farmers and the community. This must be backed up by enforcement, with penalties (perhaps in the form of labor) for violators.

2. Alternative stock watering places should be provided in the form of basins receiving a small flow of water from the canal. The pools, built to established PU specifications, must be adequate in number, location, and volume to meet the demand for livestock watering.

Bathing and laundry steps leading down the banks into the canals, and footbridges over the canals will also help prevent canal bank destruction as well as provide access to freshwater.

Water Quality. No mitigation program appears needed to maintain water quality at or above present levels, but periodic sampling should be performed (see Monitoring Program) to ensure that degradation to unacceptable levels does not occur.

For those rare occasions when a portion of the river does go dry, the Monitoring Program may show that it is necessary to release an occasional flow of water from the weir to flush accumulations of drainage water when it is heavily contaminated with fertilizers, pesticides or animal waste products. The agricultural extension unit and the water users' associations should collaborate on a program of farmer training in the proper handling and use of pesticides.

Land Resources

Watershed Management. Protection of the watershed is very important to preserve the water resources currently planned for agriculture irrigation. All logging activities should be kept out of the far upstream catchment area in the Latimojong Mountains. Logging in the middle catchment should be strictly controlled or stopped, and there should be a reforestation program for areas already cut. In addition, clearing of the lower hillsides for clove and other tree crops should cease. These activities promote potentially serious erosion and water control problems if they continue unabated.

The improvement of access roads to the project areas, especially the weir will improve access for loggers unless preventative measures are taken. Road traffic can be regulated at the gates, at the junction of the access roads with the main highway, to deny access to trucks carrying out unauthorized wood and rattan.

It is recognized that most of the population depends on fuel wood for their domestic needs. Efforts should be made to find alternative sources of wood other than the forests. One possible alternative would be the planting of living fences (pagar hidup) which would provide fuel wood, as well greater control over livestock. The people that depend on forestry activities (perhaps 65 households in Awota) should be helped to find alternative sources of income.

Of course most measures to control deforestation cannot be effective without commitment and enforcement by the government at all levels. Although there is little that the Public Works Department can do to prevent continued incursions of colonists into the upper basin, or the reclassification of forest land to tree crop land (cloves, cacao, and now, candlenut and cashews), care should be taken that the construction and operation of the weir do not make the situation worse. PU should meet with members of the Forestry Department, the tree crop program (Perkebunan) of the Department of Agriculture, and with District Wajo and SidRap officials (BAPPEDA, the two Bupati, and if necessary, the military), to ensure that the project is integrated with regional economic development. A realignment of development and enforcement priorities of the other agencies may be necessary if this basin is to be protected for successful irrigation development.

The extensive use of horses and motorcycles for access to uncleared forest and for contact with sources of amenities once colonists are established renders the use of traffic barriers inappropriate for preventing entry into the classified forest areas. Moreover, the number of colonists already there would render such barriers socially and politically unacceptable.

Although restriction of access is not the answer, there is a need for local governments to cease to sanctify illegal colonization by providing amenities such as improved roads, electricity, and schools to illegal colonists. The Department of Public Works, the Department of Forestry, and officials of the Districts bordering the basin should work together to develop plans to inhibit further incursions into the protected forest. Possible measures might include:

1. **Education.** Local and regional education is needed at the adult level, through social groups, farmer associations, extension agents, and village sub-area (dusun) governments, to spread the word that further clearing will not be tolerated.

2. **Posting.** The administrative borders of the forest should be redrawn, as recommended in the RePPProt report. The new borders should be clearly and densely marked so that violators (if literate) will know that they are subject to ejection.

3. **Enforcement.** A forest officer should patrol the areas of the revised forest and direct violators to evacuate their cleared areas within a set period, say two weeks. At the end of that time, a team of enforcement agents should check the area, destroy and burn any structures and cut down any domestic vegetation.

4. **Assistance.** The district government and the Department of Transmigration should assist ejected colonists in finding other lands. If not, they are likely to attempt forest incursions elsewhere.

5. **Revegetation.** The Department of Forestry should immediately replant the cleared area with assorted native trees.

Livestock Management. Substantial additional fodder will be required for the area's livestock population during the period of the second paddy or palawija crop. Rather than relying on local enterprise to find and develop new grazing lands, PU should work with the Livestock Department to determine grazing needs, potential sources, and, if needed, possible methods of achieving herd reduction.

Grazing fees could be implemented and enforced, in order to convince farmers that the keeping of livestock is not without costs, even if that cost is measured in terms of resource consumption. Such fees, which appear not to have been previously instituted in the region, should be kept low.

Care must be taken not to overgraze, which could increase erosion. Community education and development of an enforced grazing land and livestock watering policy should be the responsibility of the Department of Agriculture and Livestock, and be assisted by nongovernmental organizations. Mechanization of paddy tilling, now practiced to some extent in the project area, should be encouraged through agricultural extension services and perhaps easy credit for machine purchases. This can promote a lessening of dependence on pasture animals. Deforestion of new land for grazing should be discouraged for the reasons mentioned in the previous section (Watershed Management).

Agriculture Management. Although the use of pesticides and chemicals is not projected to significantly harm the general environment, even with increased usage, it would be wise to regularly test for them as part of the recommended water quality monitoring program (see Monitoring Program). Some of the chemicals can have acute or persistant health effects on the farmers using them. The Department of Agriculture should regulate what chemicals are used and provide training in safe handling and disposal practices.

Biological Resources

The longer growing season and higher cropping densities resulting from this irrigation project will encourage increases in pest populations unless adequate control measures are instituted. The Department of Agriculture should work closely with the farmers to improve pest management procedures.

Pest Management. A program of integrated pest management has been successfully implemented elsewhere to control insect populations. Use of biological control and biocides together is the best means of avoiding developed resistance in pest populations. Crop rotation and the use of resistant plant hybrids are also effective measures.

Rats are natural inhabitants of rice fields and villages. Their numbers can be held in check by a persistent poisoning and trapping program, as well as better storage of grain. Land management, that restricts the types of food available to the rats at any one time, is also effective.

Aquatic plants that grow in canals and drainage ditches can be controlled in various ways. Weeds can be physically removed, and in some cases be fed to farm animals or used as mulch. Some species of fish feed on certain aquatic weeds, and therefore might be raised in the canals. The proper use of herbicides can also help control weed proliferation.

Mosquitoes will breed in the canals and drainage ditches if there is stagnant water. If the canals are kept free of weeds and debris then the flow of water will make it difficult for mosquitoes to reproduce. Insecticides used judiciously for serious outbreaks can also be helpful. In some locations mosquito fish can be introduced into the canal as a control measure.

Endangered Species. Along with protection of the watershed, there should be an attempt to protect endangered species and their wildlife habitat. Similar protection measures to those appropriate to protecting the watershed apply (see section MA-4,5). Additionally, steps should taken to discourage sport hunting, which poses a particular threat to the larger endangered species--the anoa and babirusa. As the main sport hunters come from outside the area--principally from Jakarta--they must register or report to local military posts for permission to hunt, and frequently to rent guns. Probably the local military posts could become the logical control points to limit sport hunting, working jointly with the Department of Forestry.

Socioeconomic Resources

Services and Infrastructure. Improved living standards, more economic opportunities and a larger population will increase demand for services and infrastructure (schools, health clinics, roads, transport, and markets). Some medium- and long-term planning activities are needed if services and infrastructure are to keep pace with irrigation components of the project.

BAPPEDA should work together with the Departments of Education, Health, and District Public Works to develop local medium- and long-term plans. The Bupati of Wajo District and area government (PEMDA) would play an important role in ascertaining the need and timing for any increase in services and infrastructure, and coordinating various development plans in the Awo project area.

Farming Systems. Improvements in irrigation of the Awo service area will lead to increased demand for agriculture extension services. The Department of Agriculture (Food Crops) will work together with Public Works, PEMDA, LP3ES and local farmers to encourage a shift to cropping patterns that maximize returns with the secure agricultural water supply. The Department of Agriculture should incorporate the need for increased agricultural extension services into its new five-year plan (PELITA V). This whole process is likely to require several decades. During this time it is likely there will be increased demand for cooperatives and extension of credit for technical inputs.

Land Classification, Land Values, and Land Ownership. With the advent of agricultural intensification upon completion of irrigation construction, it is expected that the irrigated service area land will be reclassified to a higher value. Land values will probably increase even before the irrigation system is completed. It is expected that some farmers will seek to acquire certificate title to their land. It may be that the government will organize a special cadastral land survey so that the whole service area will be converted to the modern land title system, and that the government will register land under this system.

Land Taxes and Water Users' Fees. The government should expect to receive increased income from land taxes once the value of the irrigated area has been increased. If water users' fees are eventually initiated, the government can expect to receive an increase in operation and maintenance funds from this source.

Organizing Water Users' Associations and Irrigation Committees. Conversion of the service area to operation under one irrigation system will require a higher level of organization than currently exists among local water users' associations. Local farmers will also have to work more closely with local government to operate and maintain the system. The Department of Public Works has contracted a non-governmental organization, LP3ES, to assist in this process.

Health Problems. The PU staff should alert local health officials to the possibility of increased malaria and dengue fever risk in the project service area. Since there is no comprehensive malaria or dengue control program present in the region, little action is likely to be taken beyond perhaps establishing the existing incidence of malaria and dengue fever, against which project induced changes could be measured.

In addition to increased risk of mosquito-borne diseases, the risk of an increase in other water-related diseases will depend on how the population uses water from the canal system. The Department of Health, through its regular PUSKESMAS clinics and its various infant-child health programs can educate mothers, in particular, about the importance of boiling water and inoculating children against preventable water-borne diseases.

Management Plan Components: Timing and Costs

Public Works will construct the "water resources" mitigation structures as part of the system development. Other government agencies, as mentioned above, will be principally responsible for their own extension programs and ongoing activities. In most cases programs and extension services (see Figure MA-1) should commence about the time the irrigation system is constructed (beginning about mid-1991). It is expected that construction of the irrigation system will take about 24 months to complete. By this time there should be a livestock management plan, a catchment area management plan, and a public health plan in place.

It is expected that any increase in services and infrastructure will be gradual, and probably occur after 1992. It is expected that changes in land classification, land values, land ownership, land taxes and possibly an initiation of water users' fees will occur after farmers have had several harvests to adapt to intensification.

The organizing of water users' associations and irrigation comittees will probably comence in late 1990 when the non-governmental organization, LP3ES, begins to work with PU staff, local government, and the existing water users' associations.

Table MA-1 summarizes the estimated costs of the management plan components. Those costs borne by the Department of Public Works have been factored into the costs of construction of the project. In the cases of costs for other government agencies, most of the recommended mitigating activities should incur no special costs and should come under regular operating costs.

Table MA-1

MANAGEMENT PLAN COMPONENTS AND ESTIMATED COSTS

Item	Participating Entities	Estimated Cost (Rp)
General Coordination of Sectoral Agencies	BAPPEDA, and District Government	No Special Cost
Water Resources:		
Bathing and Laundry Steps in Canals (Rp 750,000/unit x 15)	PU Sulsel	11,250,000 (1)
Foot Bridges over Canals (Rp 2,750,000/unit x 24)	PU Sulsel	66,000,000 (1)
Livestock Watering Sites in Canals (Rp 4,500,000/unit x 8	PU Sulsel, and Extension Services of the Departments of Agriculture (Food Crops) and Livestock	36,000,000 (1)
Land Resources:		
Land Use: Livestock Management	PU Sulsel, with Departments of Livestock and Forestry	No Special Cost (2)
Biological Resources:		
Watershed Management	PEMDA, the Bupati and Camat, and the Department of Forestry	No Special Cost (3)
Endangered Species Protection	PEMDA, local military posts, and the Department of Forestry	No Special Cost (3)

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Table MA-1 (cont.)

Item	Participating Entities	Estimated Cost (Rp)
<u>Socioeconomic</u> <u>Resources</u>:		
Services and Infrastructure	BAPPEDA Tk II, District Government	No Immediate Costs (4)
Farming Systems	Department of Agriculture	Regular Operating Costs (5)
Land Ownership, Land Registration, and Land Values	National Board of Lands (Badan Pertanahan Nasional) and Agrarian Taxation Office (IPEDA/ PBB), with district government	Special Costs (6)
Land Taxes and Water Users' Fees	Agrarian Taxation Office, National Board of Lands, district government and Public Works	No Special Costs (7)
Organizing Water Users' Associations, and the Irrigation Committee	Public Works, Agricultural Extension Services, and assisted by LP3ES	No Special Costs (8)
Public Health	Department of Health	Regular Operating Costs (9)

Notes to Table MA-1:

(1) Cost is included in irrigation system construction contract.

(2) Establishing a land use and grazing policy would be part of the community development activities that would occur while the water users' associations are being organized. Inputs from the Departments of Livestock and Forestry would consist of their field staff attending village meetings.

(2) This assumes a series of policy decisions would be made and enforcement initiated. Village meetings would be held to educate the communities involved. Funding should be included in the annual budget (DIP) of the Forestry Department (or Public Works), and confirmed by BAPPEDA Tk. II.

(3) This assumes a series of policy decisions would be made and enforcement initiated. Funding should be included in the annual budget of the local military posts, and the Department of Forestry, and confirmed by BAPPEDA Tk. II.

(4) Regional government would be expected to increase the number of schools, health clinics and other services as the population increases. No immediate or special costs are envisaged.

(5) Development of new irrigation is usually accompanied by an intensification of agricultural extension services. It is expected that increased staffing by the Department of Agriculture will occur. Funding increases will be required in the annual budget of the Department of Agriculture, and the amount should be confirmed by BAPPEDA Tk. II.

(6) Survey of the land and the necessary administrative costs of providing registered (certificated) title to land would partially be borne by the farmers and partially by the respective agencies involved in this task. Adequacy of funding to be confirmed by BAPPEDA Tk. II.

(7) Increased revenues from land tax collection would result, but the system for collecting land taxes is already in place. Collection of water users' fees would presumably be shared by the water users' associations and existing tax collecting systems.

(8) Costs for the LP3ES contract with Public Works is covered by GOI/USAID project costs.

(9) The Department of Health should monitor developments in this area and adjust their programs and services accordingly. Adequacy of funding in annual Health Department budget to be confirmed by BAPPEDA Tk. II.

PART III

AWO IRRIGATION PROJECT

ENVIRONMENTAL MONITORING PLAN

General Considerations

Environmental monitoring is one of the most difficult components of project development to accomplish. Although continued data gathering is a logical follow-on to the environmental program carried out during planning, design, and construction, and may be mandated by law (as it is in Indonesia), operating agencies seldom are receptive to the idea of further studies. The reasons for this reluctance are not difficult to identify:

1. Whereas project design and construction often is funded from external sources, the local agencies bear the burden of operating costs. The local agency rarely is able or willing to allocate funds to what its managers see as an unproductive program.

2. The operating agency usually has its expertise concentrated in the area of its primary responsibility (e.g., agriculture) and lacks expertise in some of the areas required for environmental monitoring.

3. Administrators tend to dislike "open-ended" programs that do not relate directly to the primary mission of their agency.

4. Environmental monitoring programs tend to impinge on the spheres of responsibility of several agencies (e.g., forestry, fisheries, public health), and so tend to inflame interagency jurisdictional disputes.

Some of the above factors may be absent in South Sulawesi Province and Wajo District, but one must anticipate that some parts of the proposed monitoring program will encounter resistance on the part of responsible agencies. The program proposed is a minimal one, however, that will provide data useful for integrated resource management in the project area.

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Proposed Monitoring Program

Water Resources

Program Objective. The monitoring of water quality will determine the suitability of water in the Awo system for the various uses to which it is directed. This will be especially important for avoiding adverse health effects that might arise from the domestic use of canal water.

Location. Five to ten sample sites on the Awo River should suffice for this program. The following are the minimum locations, but more may be necessary:

1. At the headworks of the main canal.
2. At the aqueduct/bridge crossing, immediately downstream of the weir.
3. At a point downstream of where the Simpellu River enters the Awo River.
4. At a point downstream of where the Lauwa River enters the Awo River.
5. At the point where the Awo-Bulete River crosses the Trans-Sulawesi Highway.

Methods and Equipment. A competent water quality laboratory, will be needed for analyses. Field meters properly calibrated should be used to measure electrical conductivity, pH, and dissolved oxygen. A hand thermometer will suffice for temperature readings. It would be advisable to establish a staff gauge at each site, in order to obtain flow measurements.

Standardized data sheets must be used for recording all field data, including conditions at each site, flow, and personnel, as well as the analytical data for the sample. Parameters to be analyzed should include total suspended solids, sulfate, nitrate nitrogen, ammonia, nitrogen, phosphate phosphorus, salinity (expressed as chloride ion), alkalinity (expressed as calcium carbonate), and fecal coliform bacteria. Although pesticides are not currently forseen as a problem, some testing for pesticide residues is recommended, due to the significant increase in usage that is anticipated as a result of the project.

An attempt should always be made to determine flow at each site, even if it is only a general estimate. If a staff gauge is present at the site, its reading should be recorded at the time of sampling.

Schedule. Water quality should be tested twice a year, once during the dry season and again during the wet season. The sampling should be coordinated with other environmental monitoring (e.g., land use), in order to establish linkages in the system.

Implementing Agency. It is recommended that the Department of Public Works assume primary responsibility for water quality testing, although it may wish to contract out the required testing of water samples.

Land Resources

Program Objective. The principal reason for monitoring land use changes in the project area is to detect changes that are caused by the project, or those that might affect project operation. Changes might include increased erosion due to deforestation and overgrazing, water quality decline in the return flows, or farming practices.

Location. Land use should be monitored periodically throughout the Awo River catchment, including all tributaries.

Methods and Equipment. Aerial photography and satellite imagery are the usual tools for land use study. To avoid the cost of periodically photographing the catchment, the surveillance should use satellite imagery. Satellite imagery is provided by the United States Landsat Data Center to any foreign government making a formal request for imagery of its own territory. Imagery is available in Indonesia through BAKOSURTANAL or the Indonesian National Institute of Aeronautics and Space, Division of Applied Remote Sensing. An image of the entire catchment would cost about 500 US dollars. If this should prove infeasible, four test quadrangles of about 25 ha should established and visited periodically on foot. In any case, some ground checking is needed. No special equipment other than hand-held cameras will be needed for the field reconnaissance. The field team should note signs of land clearing, new trails or roads, and erosion.

Schedule. This survey of land use changes should be conducted annually, with field checking of sample areas at least every third time. Reports should be submitted to all interested agencies, including Forestry and Agriculture.

Personnel. A trained watershed management specialist or remote sensing specialist will be required for this program. It is difficult to retain the same individual for many years on a program requiring only a few weeks of work every year, but as interest in land use increases in the Forestry and Agriculture Departments, trained specialists may become more readily available.

Implementing Agency. It is recommended that the Planning Section (P3SA) of Public Works in SulSel Province be principally responsible for overall monitoring of watershed protection, but that it work closely with the Department of Forestry, and local government (PEMDA).

Biological Resources

Objectives. Monitoring of biological resources will be performed on an as-needed basis, i.e., when a problem of an ecological nature such as an outbreak of insect, rodent, bird pests, or disease occurs or there is reason to believe that project activities are affecting biological resources. The objective of such a study program would be evaluate the problem, identify causes, and develop solutions.

Location. Biological resources in any part of the catchment could interact with the irrigation project, but those of the upper catchment are of greater interest from a conservation viewpoint. Pest problems may be expected anywhere in the agricultural production system, from planting to storage and marketing. Diseases that are related to water-borne vectors or are otherwise water-related may occur at any time. Diseases to maintain vigilence against include schistosomiasis, malaria, dengue fever, and diarrhea/gastroenteritis.

Methods and Equipment. Each sort of ecological monitoring problem will require its own methods and equipment. When a problem arises that requires surveillance, the program must be tailored to that problem.

Schedule. Care should be taken that monitoring of a biological resource is not terminated too soon to evaluate the effectiveness of solutions applied to the particular problem.

Personnel. Some ecological problems that may arise will require highly specialized knowledge. Assistance for such problems should be sought elsewhere in Indonesia, or outside the country if no expertise can be found in Indonesia.

Socioeconomic Resources

Integration of Local and Regional Planning. Any program of environmental monitoring of socioeconomic conditions would serve only to supplement the analysis of project effectiveness which will accompany this development on a long-term basis. It is assumed that the Agriculture Department, the subdistrict, and local bodies will monitor agricultural production and support systems so as to ensure project effectiveness and correct any shortcomings that may arise. The project staff also should be aware of peripheral problems arising from water use, land use changes, or economic changes. The effects of upgrading the agricultural system will be so profound, in terms of income and lifestyle of the target population, that adjustments may have to be made in another sector of the local economy. The subdistrict and the provincial government must be alert to increased demand for health services, education, and transportation system changes, and the need for electricity at the local level, in order to integrate the irrigation project into regional development. Presumably BAPPEDA will act as the lead agency in this regard.

No special studies are envisioned to monitor the socioeconomic conditions, beyond those already in place among local agencies, but it is hoped that the accumulated data will be examined periodically to evaluate cause-effect relationships among the complex network of social and economic elements.

Within 18 months of the Project Assistance Completion Date (PACD) of September 1994, USAID, in cooperation with the Department of Public Works, and as part of its overall project evaluation, will conduct a review of the Environmental Management and Monitoring Plans and make recommendations for any adjustments deemed necessary.

Table MO-1

MONITORING PLAN COMPONENTS
AND ESTIMATED COSTS

Item	Participating Entities	Estimated Cost (Rp)
General Coordination of Sectoral Agencies	BAPPEDA, and District Government	No Special Cost
<u>Water</u> <u>Resources</u>:		
Water Sampling and Analysis (Rp 4,000,000 for approx. 5 sample sites X 3 samples per site X 2/Yr)	Public Works (SulSel P3SA)	8,000,000 (1)
<u>Land</u> <u>Resources</u>:		
Land Use Reconnaisance (satellite imagery)	Public Works (SulSel P3SA)	5,000,000 (2)
<u>Biological</u> <u>Resources</u>:		
Monitoring Pests, Diseases and Problems	Public Works, Health, Forestry, Agriculture, and Other Sectoral Agencies	No Special Costs
<u>Socioeconomic</u> <u>Resources</u>:		
Monitoring Social Change, Needs, Conditions	BAPPEDA, Health, Education, and Other Sectoral Agencies	No Special Costs

Notes:

(1) These estimates are provisional. Quotes on costs from different laboratories vary widely. We would expect price quotations from competent laboratories to be relatively close to this estimate. Please note that this type of analysis is limited to the <u>basic</u> water quality parameters. Any testing for fertilizers, pesticides, and other sophisticated chemicals would have to be done in Java or Singapore,

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and the costs would be substantially higher (at least by a factor of ten).

(2) Estimated cost of acquiring a satellite image for a small catchment such as this is about US $ 500 (around Rp 900,000). The sum mentioned above includes funds for hiring someone to interpret the image and for the costs of administration and report preparation.