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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
BATUJAI KIRI IRRIGATION PROJECT
ENVIRONMENTAL ASSESSMENT

VOLUME I

MAIN REPORT

December 1990

PN-AAT-930

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ENVIRONMENTAL ASSESSMENT

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MAIN REPORT

December 1990

Prepared by

HARZA ENGINEERING COMPANY

in association with

Development Alternatives, Inc. Global Exchange, Inc.

PT. Wiratman & Ass.

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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), 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, then 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, the 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 original 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 both 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 was most similar in intent of meaning, to what is known in America as an "Environmental Assessment."

This report for the Batujai Kiri Irrigation Project has been prepared by the SSIMP Technical Assistance Team with the support and assistance of the NTB 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 impacts..." (translation by 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 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 major negative impacts.

Scope of the Report

As a result of an Environmental Scoping Session held in Praya, Lombok, on 20 December 1989, and of subsequent visits to the Batujai Kiri Irrigation Project 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 resources. Information on climate and physiography is also presented, as required by that law (PP 29/1986). An account of the scoping session is found in Appendix C 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 staff gauge readings, automatic water level recorder readings, discharge measurements, and rainfall records. Data on rainfall and stream flow, as analyzed by Sir M. MacDonald & Partners Asia (1986), was also used. Reservoir operation data was obtained directly from NTB PU. Information on climate (including rainfall) was obtained from a report prepared by the Ministry of Transmigration (RePPProt, 1988). The water quality evaluation was based on standard laboratory analyses done at the Water Quality Laboratory in Mataram. Water use estimates were based on household interviews.

- **Land Resources.** Land use definition relied on visual assessment of the study area in conjunction with available maps. Details on soils were obtained from soil maps available from a soils study of Lombok Island, conducted by Crippen (1975). The agricultural 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, Fisheries, Animal Husbandry and Forestry). This was supplemented by appropriate published information on 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), the Household Survey (HHS), and a number of in-depth interviews with study area villagers and officials from rele-

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vant sectoral agencies including the Departments of Village Development, Health, Statistics, Public Works, the Regional Development Planning Board, and both the District and Subdistrict areas' general administrative offices. This information was also supplemented by relevant published information, reports, and manuscripts.

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.

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CHAPTER II

DESCRIPTION OF THE PROPOSED PROJECT

Type of Project

The Batujai Kiri Irrigation Project [1] is one of the surface water projects being studied under the Small-Scale Irrigation Management Project. It is an extension of an existing water storage project which will provide a reliable supply of irrigation water to farmers who now have very low yields and who frequently are unable to cultivate two or more crops per year.

Location of Project

The project reservoir is the result of a dam completed in 1982 on the Penujak River [2] in south central Lombok, approximately 2 km downstream of the main district town of Praya, capital of Central Lombok District, Lombok Island, NTB Province, Indonesia. The service area of 972 ha lies within the villages of Penujak, Bondir, Setanggor, Kabol, and Mangkung in Subdistrict West Praya (see Figure II-1, Project Location Map).

Limits of the Study Area

The study area for this environmental assessment consists of the Batujai Reservoir and its immediate environs, including the southern end of the town of Praya, the irrigation areas of the Batujai Kanan [3] and Batujai Kiri irrigation systems, and the downstream (proposed) Pengga Dam. The reservoir catchment was considered only to estimate reservoir inflow, and the reservoir and its environs were considered to assess the effects

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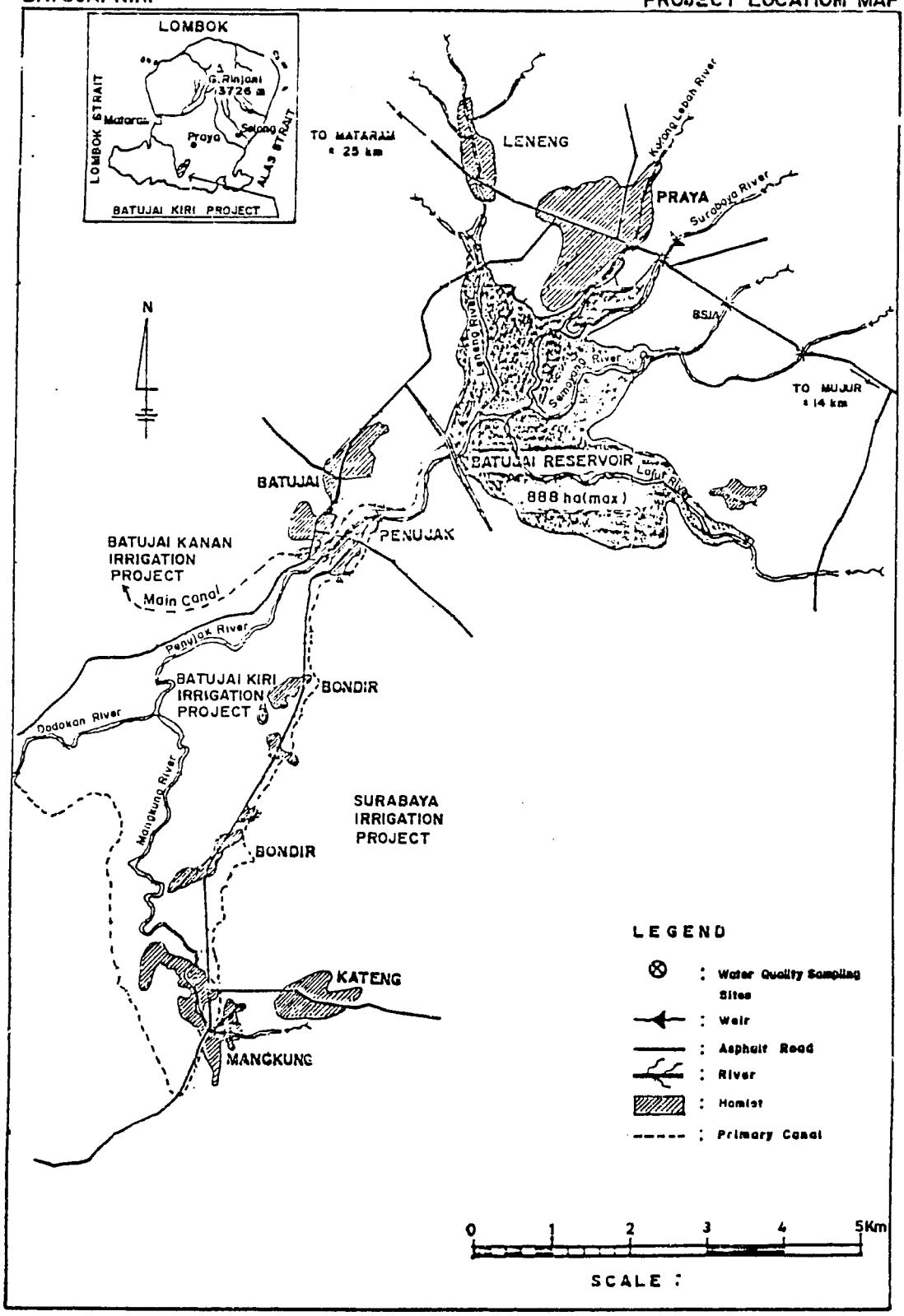
[1] The Batujai Kiri Project is also known as the Batujai Left Bank Scheme. "Kiri" means "left" in the Indonesian language.

[2] The Penujak River is sometimes called the Batujai River.

[3] The Batujai Kanan Project is also known as the Batujai Right Bank Scheme. "Kanan" means "right" in the Indonesian language.

Figure II - 1
PROJECT LOCATION MAP



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of filling the reservoir to capacity. The study area also includes the land and population located within the administrative boundaries of the five villages mentioned above.

Project Life

For planning purposes, the life of the project is taken as 60 years, but there is no reason to believe that the structures, properly maintained, will not function for a much longer time.

Description of the Project

Project Components

Water Supply. The Batujai Kanan Irrigation Project currently diverts most, if not all, of the water available annually from the reservoir. As a result, the cropping intensity is now about 290 %, which is higher than originally planned, and a cropping pattern of paddy/paddy/palawija is obtained over much of the area. Simulations show that this is not sustainable over the long run using a 1 in 5 year criteria. Reallocation of water to Batujai Kiri would force Batujai Kanan to adopt a less intense cropping pattern or to plant palawija instead of paddy in the second season. It is difficult to predict at this time how much land will be affected but it may be up to 250 ha or 10 percent of the second season paddy crop.

There are measures that may lessen this impact of water reallocation. Currently, the Batujai Kanan supply canals are being upgraded to improve efficiency which will result in a savings of water. It is suspected that there is also water wasted in the form of high irrigation return flows. Visual observation of the fields and their drainage to the river indicate that irrigation water could be applied more efficiently to the paddy in Batujai Kanan. The Pengga Reservoir to the south, when filled, will inundate 200 ha of the present 3500 ha Batujai Kanan service area, so that the water formerly used on this 200 ha could, theoretically, be used higher up in the Batujai Kanan system. However, overall, parts of the Batujai Kanan system would have to cut back on its cropping intensity or choice of crops, once the Batujai Kiri system was operating.

Major Structures: Water Diversion. The project would primarily consist of the construction of a left bank main canal (classified as a secondary canal), and require only a control structure to divert water from the Right Bank main canal (also a secondary canal) in the vicinity of Penujak. The Left Bank Canal will cross the Penujak River with an aqueduct/siphon upstream of the present ford, then turn south along the existing road from Penujak to Mangkung (Figure II-1). After cross-

ing the Mangkung River with another aqueduct/siphon, it will extend one km south, then bend sharply to the northwest, ending approximately 2 km west of the confluence of the Mangkung and Penujak Rivers. Water from the main canal will be distributed through a network of tertiary and quaternary canals to a service area lying between the main canal and the Penujak River.

There is already a functioning dam and reservoir. The existing primary canal may have to be enlarged to accommodate both left and right bank water requirements.

Delivery System. As noted, the primary canal has already been constructed as part of the Batujai Kanan irrigation project, but it will probably have to be enlarged, pending an engineering evaluation of the current structure. The secondary canal will be both lined and unlined, according to soil type. It will be of standard design, trapezoidal in shape with side slopes of 1:1, 3 to 5 m top width, about 0.5 m bottom width, and 1 to 1.22 m depth at full operating flow of 1.0 to 1.5 m^3/s. It will gradually become smaller as its flow decreases downstream. The tertiary and quaternary canals will be 1.1 to 2.3 m wide.

Drainage System. Excess water will be removed from the fields by a drainage system discharging it into the Penujak or Mangkung River, depending on its point of origin.

Dike Protection for Praya Town. Raising the reservoir to a height of about 92.5 m will be somewhat higher than it normally has been in the past, even though the reservoir was designed to be raised this high. Reportedly, this will create some flooding in residential areas of Praya Town, and make some areas susceptible to floods in the event of heavy rain. The project will investigate this situation during the design phase. It is possible that some dike protection for Praya Town and even some farm land, may be recommended for inclusion into the project.

Construction Support Facilities. Temporary areas for construction offices and living quarters for construction workers will be established along the canal route, but many laborers are expected to be recruited locally and commute from home daily. The contractor's office may consist of a modified truck or trailer, eliminating the need for a fixed supervisory office.

Access roads may be required in order to transport materials and equipment to the areas of canal construction, where a canal is fairly far from the main road. Such roads will be temporary, for the most part, and the land will be returned to its previous use following construction of the canal.

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Pre-construction Period Conditions

The Batujai Kiri Project is an extension of two earlier irrigation projects that left unirrigated some 972 ha of potentially irrigable land. This extension, the Batujai Kiri service area, is one of a number of contiguous areas being provided with water from rain falling on the south slope of Mount Rinjani. Rivers draining Rinjani have been tied together by various diversion schemes, with the result that a given river may contribute water to irrigation projects in other watersheds and receive diverted water and/or irrigation return flows that originated in adjacent watersheds.

The Batujai Kanan Project, to the west of the Project area, was initiated with the completion of Batujai Dam in 1982. It irrigates approximately 3,500 ha [1] on the west side of the Penujak River, extending downstream approximately 30 km. The Batujai Kanan canal lies near the river from Batujai Dam to a point near the village of Penujak 0.3 km downstream of the dam, where it leaves the river to follow the contours that allow it to remain in the higher part of its service area.

The Surabaya Irrigation Project, to the east of the Project area, receives its water from a weir constructed in about 1938 on the Lekong (also known as Surabaya) River about 500 meters from that river's entry into Batujai Reservoir. The Surabaya canal skirts the reservoir to the east and provides water for some 1,200 ha of a service area originally planned for 2,800 ha. The project has suffered from a shortage of water, due in part to diversion of Lekong River water at four upstream weirs.

The Batujai Kiri component of the Batujai-Surabaya Project was conceived as a means of irrigating the area between the existing Surabaya and Batujai Kanan service areas, using water from Batujai Reservoir. Studies of water availability, reservoir operation, topography, socioeconomic aspects, and soils indicate that some 972 ha could be irrigated economically by a canal taking water from the existing Batujai Kanan Canal at Penujak. The Batujai Kiri service area would include approximately 500 ha of the original 2,800 ha proposed for the Surabaya Project.

A "Rapid Rural Irrigation Appraisal" (RRIA) was conducted by NTB Public Works late in 1987 and a "Household Survey" (HHS) by USAID in February 1989. Several subsequent site investiga-

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[1] The area served under the Batujai Kanan system is officially 3500 ha. Because there are known inaccuracies in some of the service area mapping, and because the system is known to be inefficient, as currently operated, the actual area being serviced at this time may be up to 20 % less than 3500 ha.

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tions have been conducted by the Technical Assistance Team's environmental scientist, economist, social scientists and engineers, accompanied by survey teams from NTB PU staff assigned to SSIMP. Information from these surveys and site investigations has been incorporated into sections of this Environmental Assessment, particularly in Chapter IV, "Existing Environmental Conditions," and in the proposed Mitigation and Monitoring Plans.

The environmental studies for this report, following the methodology described above (Chapter I), began in April, 1988, with reconnaissance-level surveys and resumed, after about a year of inactivity, in November 1989, when water quality studies were initiated. These were carried out by the Department of Health's Analytical Laboratory in Mataram.

Construction Period Conditions

Construction plans for the Batujai Kiri Project have not yet been developed. Based on previous SSIMP experience, there will probably be only one main contractor, under the general supervision of PU, with a contract period of approximately 18 month's duration. This contractor may sub-contract out some of the work.

Construction Schedule. No schedule has been completed yet since the contract for the final design has not been awarded. It is expected, however, that the time required to finalize the contract award for final design, and for the contractor to complete the design will be about 12 months. Tendering for construction will then take another 12 months. The earliest possible starting date for construction would be in late 1992.

Equipment Use. Typically, all equipment used in the construction of the project, from shovels to bulldozers, will be provided by the construction contractor and retained by that company on completion of construction.

Mechanical items, such as control gates and hoists, will be purchased from suppliers within Indonesia, but probably not in Lombok. Some of these items are manufactured in Surabaya.

Resource Use: Types of Resources. Construction of the canals will require very little additional rock, gravel, or earth material. The project will require cement for concrete, lumber and plywood for forming.

Cement will be purchased by the contractor on the open market at the nearest possible source (probably Surabaya). Construction lumber and plywood are available in East Java and will also be shipped to Lombok. All these construction materials will be shipped through Port Lembar, located on the west coast of Lombok, not far from the town of Ampenan. Materials

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will be transported from the port to the site by truck, a distance requiring about one hour to traverse.

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

Transportation and Storage. The construction contractor will use motorcycles, trucks, and probably four-wheel drive vehicles on the site. Stockpiles of materials will be maintained near the site in quantities sufficient for meeting the construction schedule. Materials excavated from the canals will be stockpiled nearby for subsequent use on dikes and roads, or where fill is needed.

Waste Disposal. The usual practice in Indonesia is to dispose of solid waste in any convenient depression or water course near the site of consumption. That practice, although environmentally unsound, probably will prevail at the Batujai Kiri site, with or without contract stipulations. It may be possible, however, to force the contractor to cover his trash heap with sand or gravel, which would keep down rats and render it less unsightly. Human sanitary waste will be disposed of in pit latrines, which will be moved, and the pits filled in, at appropriate intervals.

Work Force. Estimates have not yet been completed on the size of the total work force required. Generally, contractors in NTB Province draw their work crews from a large pool of construction laborers available in the province. As noted above, it is expected that many of the unskilled and semi-skilled laborers will be recruited locally. Those crew members coming from outside the area generally come without their families.

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

The amount of water delivered to the service area will vary from year to year and from month to month. The maximum flow in the left bank canal will be about 1.0 to 1.5 m^3/s, but that will depend on the stage in the cropping pattern and the amount of recent rainfall.

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 is organized hierarchically to manage the normal activities of system operation; each level being responsible for different parts of the decision-making process. Responsibilities for system operation begin at the Cabang Dinas office, which normally covers about 25,000 ha of technically irrigated lands in one or more districts. At the next descending level, is the Ranting Dinas office, which normally covers one or more systems totalling about 7,500 ha, followed by 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 existing Cabang Dinas office for Batujai Kiri is in the nearby town of Praya, less than 15 minutes from the project site. The Ranting Dinas is also located in Praya. The Sub-Ranting office will likely be located in the subdistrict administrative center of Penujak, which is within the service area.

Irrigation: Method of Operation. The project is designed to convey water from the Batujai Reservoir and then release it through the 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, but shorter time periods may be adopted for the 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 storage water, and recommends a release 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

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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, and other necessary equipment. 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. 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 Agriculture Extension Services. 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. The staff is expected to include one Sub-Ranting head and gate keepers. In total, there may be about 8 to 12 persons employed to operate the project. 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. 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 reservoirs and technical irrigation systems. The training is expected to consist of evening lectures in the 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). LP3ES has a contract under SSIMP to provide these services.

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 are routed near to hamlets. In the Batujai Kanan service area, which is densely populated, steps have been built every 50 to 100 meters; probably this number of steps is also appropriate to the Batujai Kiri area, at least near 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 near 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.

Most of the villagers in the Batujai Kiri service area have already had some experience with community-based water users' associations, in relation to their domestic water supply. They have been assisted by the Australian-sponsored Rural Water Supply and Sanitation Project, which has emphasized community management. It is expected that with this experience, villagers can adapt to community managed irrigation systems.

In order to assist villagers in the Batujai Kiri 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, laundering, and livestock watering.

CHAPTER III

ALTERNATIVES TO THE PROPOSED PROJECT

No Action Alternative

If the project is not implemented, current land use and cropping patterns would remain relatively stable. There is no existing irrigation system beyond that of simple drainage ditches, in the Batujai Kiri area, and there is little or nothing that local villagers could be expected to do to develop any irrigation on their own. Probably nothing could be done to improve cropping intensity without the project since there is no other water source that could support two-crop farming for 60 to 80 percent of the service area in most years.

The population density of the area is already very high, although due to continuous outmigration and some effectiveness of the national family planning program, the annual growth rate is probably between 1.5 to 2 percent. This growth rate may decrease more as the area is likely to continue to experience a steady outmigration of individual working age adults and whole households, moving out permanently, or living as circular migrants working elsewhere. More people may turn to the transmigration program as an option. Although without the project, population density would continue to increase, the population of the area has probably reached, or come close to, the limits possible under the current system of farming. Unless some major development were to occur nearby to provide non-agricultural employment, it is likely that the Batujai Kiri area would remain one of subsistence farmers, the majority living at or below the estimated poverty line.

Without the project, the Batujai Kanan service area would continue to benefit from a cropping intensity higher than originally planned. Most of the water available from the Batujai Reservoir would continue to be diverted solely into the Batujai Kanan service area.

Alternative Irrigation Technologies and Water Management

Water Sources

Two basic water sources are present in this region: surface and ground water. Studies for this project indicate that the annual flow of the Penujak River, stored in the Batujai Reservoir, is sufficient to meet project objectives. Average

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annual yield is estimated at 120 MCM; the average annual irrigation demand for Batujai Kiri and Kanan (4272 ha) is taken as 40 MCM. (A quantitative analysis of reservoir operation is presented in the next chapter - see Table IV-2).

A study of water availability for increasing the supply of water to the Surabaya Canal indicated three possible avenues of approach: 1) additional high-level diversions from other rivers, 2) small reservoirs on tributaries of the Lekong River, and 3) pumping from Batujai Reservoir into the Surabaya Main Canal. A Lombok-wide water balance by Sir M. MacDonald & Partners Asia (1986) indicated that other projects have higher priority claims on these upstream waters. No dam sites were found that could store more than about one MCM of water and even those would flood productive paddy fields. Pumping from the reservoir would normally reduce the amount of water available to the Batujai Kanan and Kiri Projects. Elmore (1989), in his study of water availability for the Batujai areas, found that there was insufficient water for the Batujai systems if water were diverted/pumped to the full Surabaya service area.

Ground water supplies, on the other hand, are sufficient for most domestic demand during the wet season and for some households during the dry season, but could not possibly provide sufficient dry season irrigation water for more than a few hectares.

Improved Water Management

A review, and if necessary, strengthening of the local system of water distribution and control is part of this project. Community organizations (water users' associations) will be developed. This organizing will be accomplished by the Department of Public Works and the non-governmental organization, LP3ES.

Since there is no existing canal system over most of Batujai Kiri area, and pumping is impractical here, there are no existing, formally organized water users' associations to manage irrigation (although there are some water users' associations to manage domestic water supplies). There is very little that farmers can now do to control water distribution and there is little pressure to form such organizations. Overall, if there is no project, there are severe constraints to improving management.

Location Alternatives

Project Structures

Dam. The Batujai Dam is the only means of storage available to this project, as shown above. Adjustments in the design or

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layout of the existing dam spillway, and headworks have been considered, but they would involve expenditures not commensurate with the scale of this project.

Primary Canal. It may be possible that it will not be necessary to enlarge the existing primary canal. The project intends to study alternative land preparation schedules to see if staggering land preparation might be adequate to compensate for the small size of the existing primary canal.

Other Canals. Placement of irrigation canals is largely governed by the location of the service area relative to the water source (in this case, the right bank main canal), the configuration of the service area (in the case of secondary and tertiary canals), existing irrigation systems, and local topography. These factors are interrelated and combine to restrict the alternatives available for the project layout.

In the final analysis, canal design, routing, and sizing decisions are made on the basis of economic criteria, within internationally established guidelines for the design of reliable irrigation systems, but with local constraints always taken into account in matters such as control structures and system maintenance.

Auxiliary Structures: Roads. Topographic considerations basically dictate the placement of the access roads. Access roads will be built next to the main and secondary canals, thus restricting alternative routes.

Service Area

Selection of the service area has been based on the boundaries of existing irrigation systems, water availability, existing cropping patterns, soils, topography, and the areas currently used as rainfed paddy fields.

Scheduling Alternatives

There is basically only one schedule worth considering for this small-scale irrigation project: to bring the entire system on line as soon as possible. The small size of this project precludes phased development. Simultaneous construction of the conveyance system is preferred, depending on labor availability, to bring project benefits as soon as possible.

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CHAPTER IV

EXISTING ENVIRONMENTAL CONDITIONS

Methodology

The methodology employed in the study relies upon USAID guidelines, and a checklist developed from the initial Scoping Meeting, held 20 December 1989, in Praya, Lombok. Assessment of the boundaries of the irrigation area was based on land survey maps developed for the engineering design. The study area population is based on the administrative boundaries of villages located (at least partially) within the boundaries of the irrigation area and includes, in addition, the existing water supply reservoir.

Socioeconomic information, and some of the information presented on domestic water use, agriculture, forest use, wildlife, fishing, etc., were collected through field interviews, surveys of the local population, and from government offices. 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 internal memos and reports. Several design layouts, prepared by PT Cita Prisma, were used, as well as maps prepared by PT Amythas in their work with Sir M MacDonald & Partners Asia, who prepared an Environmental Evaluation Study for the Nusa Tenggara Agricultural Development Project (1990) that included the Batujai Kanan and Kiri service areas. The 1975 Crippen Water Resources Development report for Lombok also provided useful background material on climate, soils, and land capability.

Climate

The major influence on the climate of Lombok is the Inter-Tropical Convergence Zone (ITCZ). The wet season results from northwesterly winds that bring moisture from the tropical seas north of Lombok. About 80 percent of Lombok's annual rain falls during this time. During the dry season, the trade winds shift to southeasterly, and are predominantly dry. The wet season usually falls between November and April. In some years the monsoon rains may start as early as October, while in others there is little rain until December.

Temperature. Temperatures range from warm to hot, with few extremes. The average daily minimum temperature ranges from 19.7 °C in August, to 23.7 °C in April, and the average daily maximum temperature ranges from 27.6 °C in August to 31.7 °C in May.

Relative Humidity, Wind Velocity. Ambient relative humidity (RH) ranges from a monthly average of 69 percent in October to 74 percent in March.

Winds are generally moderate in the region. The minimum monthly average wind speed of 2.5 km/hr occurs in April, and the maximum average of 5.0 km/hr occurs in October.

Rainfall. The Batujai Kiri project area has a tropical wet climate characterized by average monthly rainfall of 16 to 281 mm, and a yearly average of about 1454 mm, nearly all of it falling within a seven-month period. Between 1950 and 1988, annual rainfall varied between 382 mm and 3145 mm, with a monthly high of 631 mm in December 1987. The rainy season lasts roughly from November through May. The five-month dry season lasts from June through October. Monthly rainfall data for the Penujak climatological station are summarized in Table IV-1.

Air Quality. Air quality in the region is generally good, although some air pollution occurs due to paddy and palawija straw burning after each harvest.

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Table IV-1

Monthly Rainfall (In mm) in the Batujai Kiri Study Area, 1950-1988

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1950	489	182	96	85	21	211	23	92	12	216	282	256	1968
1951	241	465	86	92	0	111	0	0	0	0	53	120	1189
1952	201	181	181	0	47	0	0	0	0	34	249	148	1041
1953	107	163	184	72	90	0	17	0	0	0	195	376	1204
1954	267	52	110	323	105	3	0	62	0	70	131	315	1458
1955	250	336	192	160	150	244	226	36	10	136	163	267	2220
1956	329	156	68	60	131	133	89	72	25	55	121	267	1509
1957	324	418	245	0	76	2	92	6	0	0	81	194	1442
1958	83	284	92	43	37	65	47	16	0	36	29	370	1104
1959	274	169	292	51	115	56	0	0	14	0	152	384	1507
1960	327	129	177	176	145	0	83	0	3	76	226	84	1430
1961	251	212	101	151	1	1	1	1	1	57	153	1	961
1962	280	352	61	301	3	4	21	0	0	49	46	330	1449
1963	483	52	200	32	0	15	0	0	0	6	5	156	949
1964	114	66	127	61	8	0	0	0	35	192	255	125	985
1965	485	103	134	74	5	0	0	0	0	0	135	163	1119
1966	137	180	172	62	112	16	0	0	0	43	150	353	1225
1967	348	23	175	10	0	0	0	0	0	33	37	318	947
1968	343	293	130	131	170	139	207	56	0	16	122	471	2050
1969	65	82	336	154	155	0	0	0	3	11	2	140	950
1970	573	187	144	79	173	13	0	0	93	37	361	237	1897
1971	262	374	106	57	184	5	0	0	17	156	64	200	1427
1972	193	161	342	117	142	0	0	0	0	0	196	274	1425
1973	263	155	264	152	349	0	30	38	99	56	25	377	1809
1974	315	214	128	0	212	19	39	25	93	360	438	165	2008
1975	134	187	219	94	214	9	22	4	74	209	233	117	1516
1976	123	48	67	7	13	3	0	14	0	15	48	44	382
1977	277	375	158	41	0	0	0	0	0	0	9	116	976
1978	530	256	262	57	354	482	116	123	19	82	366	478	3145
1979	184	264	155	66	254	39	0	11	0	0	160	156	1289
1980	375	172	122	182	30	0	47	30	0	7	325	351	1644
1981	364	245	31	110	163	35	0	10	47	43	496	274	1818
1982	305	139	140	134	0	0	0	0	0	12	12	335	1077
1983	250	224	68	72	206	3	0	0	0	104	217	87	1231
1984	266	179	360	206	200	0	0	0	169	74	165	188	1629
1985	57	389	351	89	39	109	53	0	0	0	157	87	1331
1986	305	157	136	125	0	770	44	0	3	25	72	254	1394
1987	610	351	122	152	170	31	0	0	7	7	194	631	2275
1988	187	180	347	90	46	12	0	9	0	155	262	193	1483
Mean	281	209	172	100	107	52	30	16	19	61	165	242	1454

Note: Historic monthly rain reported for Penujak Station has been infilled in order of preference from: Paya, Puyung, and Pengga Feasibility Studies, Sir M. MacDonald & Partners, Asia.

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Topography and Geology

Topography. The project irrigation area is contained within the valley formed by the Penujak and Mangkung rivers. The area is bordered by a road to the north and east, the Penujak River to the west, and by foothills to the south. The Penujak River flows approximately from north to south, and the Mangkung River flows east to west into the Penujak, splitting the service area. A string of knolls runs along the northeast road near to where most of the hamlets are located. The terrain, which undulates from north to south, is gently sloping from the borders of the irrigation area to the river beds.

Most of the road is at an elevation of 80 m asl (meters above sea level), whereas the Penujak River drops to 57 m at its lowest point within the irrigation area.

The existing Batujai Reservoir lies just outside the irrigation area to the north. Its maximum and minimum elevations are 92.5 and 87 m asl, respectively. The reservoir's catchment area of 169 km^2 is located in Lombok's central plain and is incised by a network of irrigation schemes. The headwaters of the catchment area lie on the slope of Mt. Rinjani at an elevation of approximately 1,000 m asl.

Geology. The bedrock underlying about 70 percent of the island is volcanic breccia and is derived most probably from Mt. Rinjani (Crippen, 1975). In the Batujai area, this breccia underlies Tanah Malit clay and overlies the older tertiary deposits of the Southern Mountains. The Crippen Study (1975) concluded from drill hole investigations of the subsurface breccia that the Batujai area had little aquifer potential. This breccia though, can provide a very stable foundation; however, the overlying expansive clay, which is typically 1 to 3 m in depth in the area, is too unstable to support structures directly.

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Water Resources

Major Surface Water Bodies

The project area (Figure IV-1) lies wholly in the catchment of the Penujak (also known as the Batujai) River, tributaries to which drain part of the south slope of Mt. Rinjani. Upstream of the Batujai Reservoir (which generally is considered the start of the Penujak River) the main rivers are the Leneng, the Surabaya, the Semayang, and the Lajut.

The Surabaya River is the largest tributary to the Batujai Reservoir. Its watershed (above the Surabaya weir) is approximately 60 km^2, but upstream weirs divert nearly half the flow into other basins. On the other hand, the Lajut River (which enters the Batujai Reservoir east of the district administrative town of Praya) receives some water from irrigation runoff from the Jurang-Sate service area, to the north of the reservoir.

The Batujai Reservoir, located near Praya, has a surface area of approximately 890 ha at its maximum elevation of 92.5 m asl. The live storage volume, ignoring sedimentation, is approximately 24.8 MCM. At its minimum operating elevation of 87.0 m asl, the reservoir is reduced to 100 ha and 1.3 MCM.

Downstream of the reservoir, the first major tributary to the Penujak river is the Mangkung, which enters from the east, draining an area that includes part of the Surabaya Irrigation Project Service area. About one kilometer downstream of the confluence, the Penujak turns northwest. Approximately 15 km downstream of the bend, the river passes the site of the proposed Pengga Dam. That dam, which will create a reservoir comparable in size to the Batujai Reservoir, is intended to provide water to some 3,590 ha lying on both sides of the Penujak River between the Batujai Kanan service area and the Straits of Lombok (see Figure IV-1).

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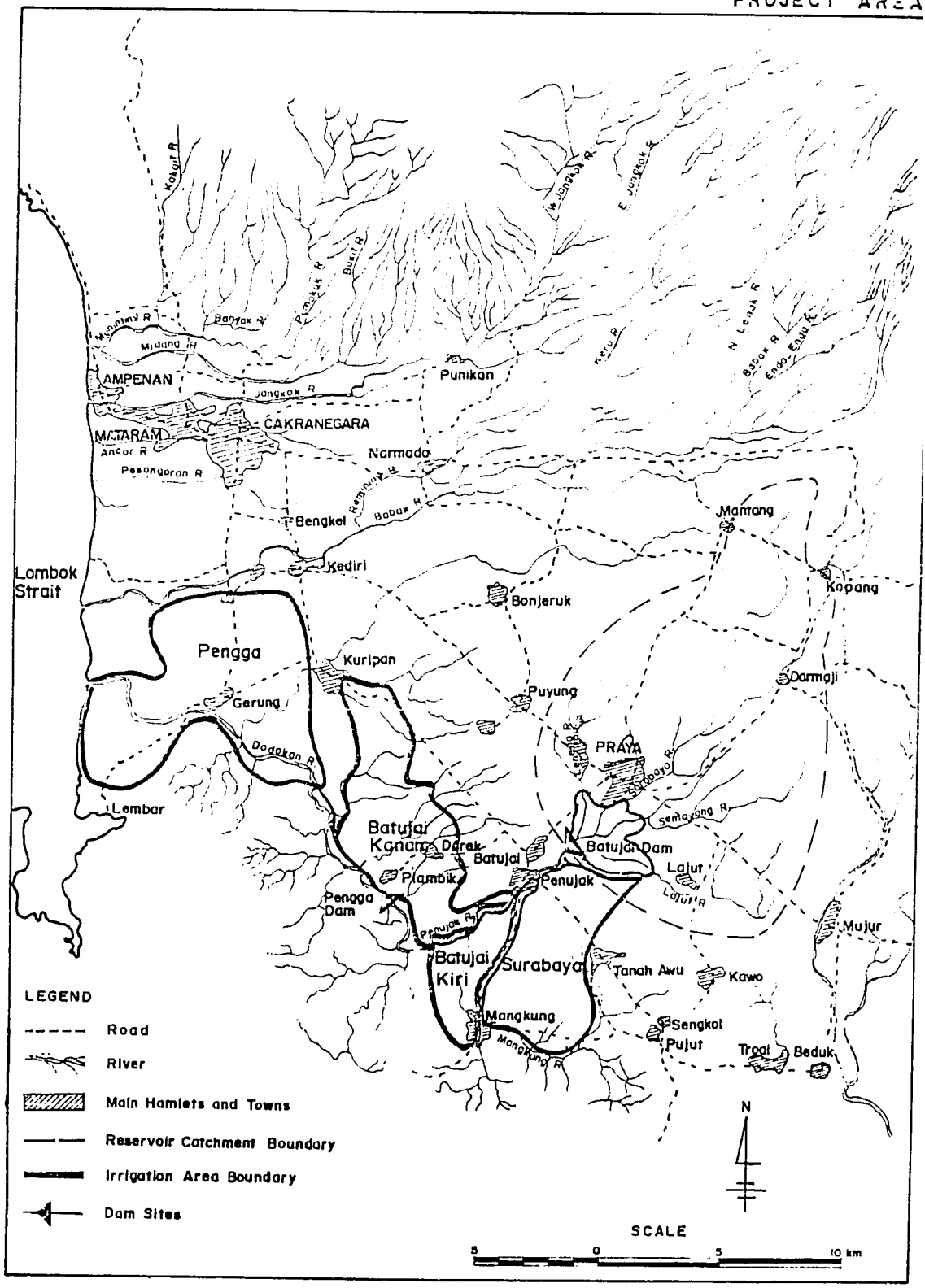
Figure IV - 1
PROJECT AREA



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Streamflow

Penujak River flow is dependent on the operation of the Batujai Reservoir, which diverts water to the Batujai Kanan canal system, and makes downstream releases and spills. There has been some flow in the canal every month in most years since 1983, when the reservoir was filled (Table IV-2). The highest flows are January through June, tapering off from July to October, before increasing during November prior to the first paddy planting. The canal supplied between 52 and 63 MCM/yr between 1984 and 1989.

Releases to the Penujak River depend on rainfall. Spill is typically high during the period January through April, although high flows can occur as late as June. There is usually little or no release to the river for the remainder of the year until December. Between 1984 and 1989 (a relatively wet period), annual releases to the river have ranged between 67 MCM and 139 MCM. Once or twice a year, the river inundates its banks by more than 2 m in floods during the rainy season. Villagers report the Penujak River is reduced to standing pools during August and September. There is some recharge to the river during the dry season via springs and from Batujai Kanan irrigation return flows.

Water Quality

Water samples were taken from seven sites in and around the Batujai Kiri irrigation area (Figure IV-2). The locations of the samples were as follows:

1. Dodokan River just downstream of the juncture of the Penujak and the Mangkung Rivers.

2. Mangkung River just upstream of its juncture with the Penujak River.

3. Mangkung River in Sub-area (Dusun) Mangkung, of Mangkung Village, just upstream of the highway bridge.

4. Well on the bank of the Penujak River in Penujak Village, just upstream of the highway bridge.

5. Penujak River in Penujak Village, just upstream of the highway bridge.

6. Batujai Kanan primary irrigation canal, immediately below the dam.

7. Leneng River upstream of the main hamlets of Leneng Village and the Batujai Reservoir.

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Table IV - 2
Releases at the Batujai Reservoir, 1984-1989

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Batujai Kanan Irrigation Canal Flows (MCM):													
1984	2.25	3.37	2.10	4.06	3.90	3.54	2.52	0.47	0.89	6.22	6.32	16.28	53.12
1985	17.89	3.34	2.70	5.29	5.43	2.13	0.30	0.00	0.00	0.00	3.32	6.65	51.65
1986	6.53	8.66	5.20	7.31	7.06	7.50	4.59	0.87	1.17	0.32	3.12	6.04	62.77
1987	6.76	7.10	7.25	6.39	6.39	6.46	4.00	2.57	1.05	2.26	4.42	2.00	57.19
1988	7.02	5.39	6.22	6.36	7.35	6.77	4.34	2.00	0.78	0.00	4.51	7.33	60.37
1989	6.08	5.71	4.82	7.17	4.77	3.26	2.59	0.01	0.61	0.33	7.38	3.56	53.44
Means:	7.76	5.26	4.90	6.40	5.90	4.39	3.12	0.93	0.75	1.72	5.46	8.18	56.42
Penujak River Spills (MCM):													
1984	57.30	23.30	22.30	22.66	5.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	133.32
1985	0.00	42.30	52.01	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	5.65	101.96
1986	20.61	2.37	15.38	14.99	0.00	13.26	0.54	0.00	0.00	0.00	0.00	0.00	67.15
1987	46.31	12.82	0.62	0.00	11.38	0.00	0.00	0.00	0.00	0.00	0.00	17.30	89.63
1988	41.96	38.40	26.00	12.33	0.00	0.00	0.00	0.00	0.00	0.00	6.50	0.36	125.55
1989	35.14	28.11	28.09	1.71	0.00	15.70	0.11	3.14	0.71	0.00	0.00	2.46	112.17
Means:	33.74	24.13	25.23	8.62	2.36	4.83	0.11	0.77	0.12	0.00	1.08	4.40	105.38

Source: Department of Public Works, Praya, 1990; compiled by the NTB TA Team.

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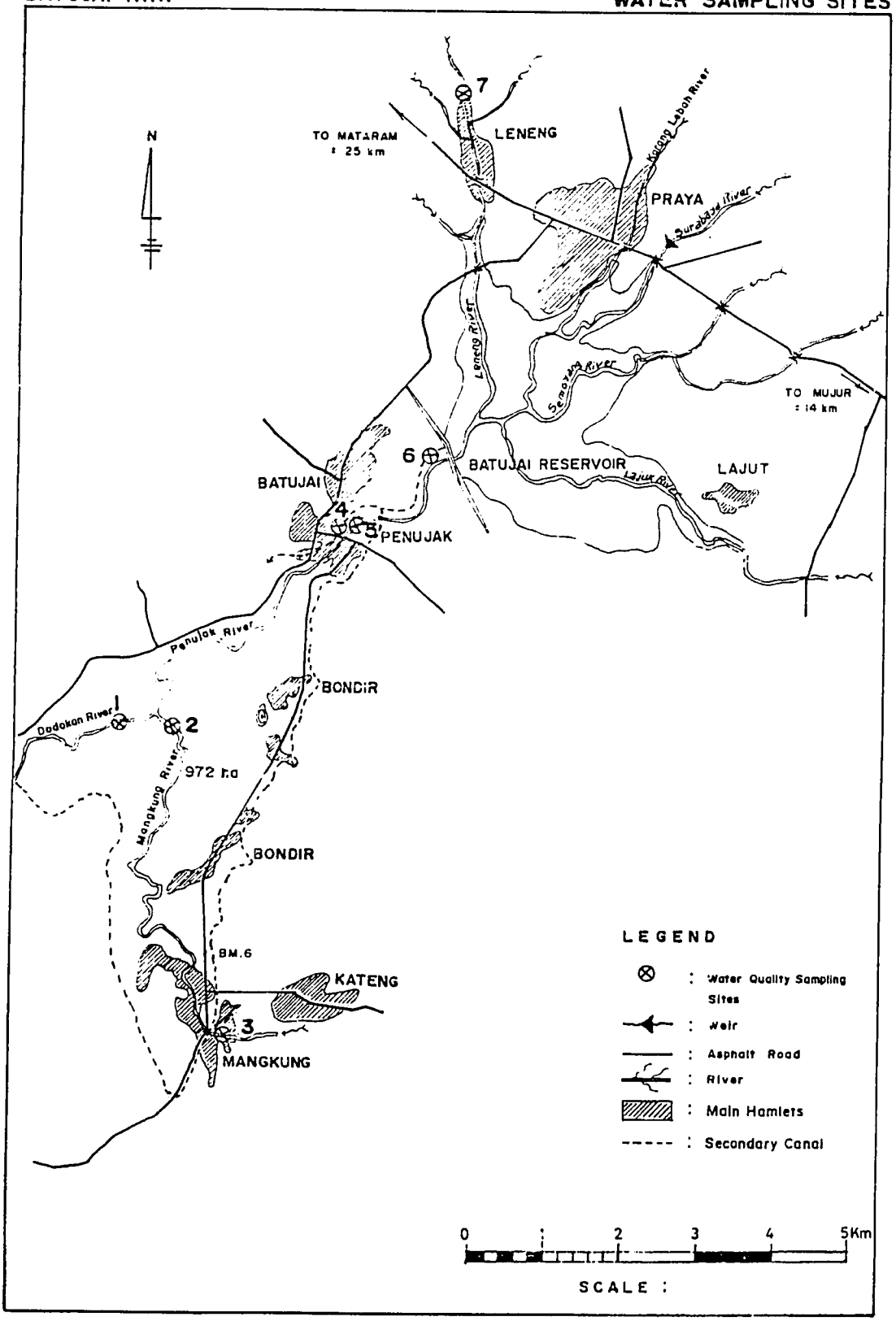
SSIMP
BATUJAI KIRI

Figure IV - 2
LOCATION OF WATER SAMPLING SITES



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Water samples were taken on 21 December 1989, and again on 3 January 1990, when water was flowing in the river and in the Batujai Kanan irrigation canal. The samples were analyzed for a broad range of parameters to permit characterization of standard physical and chemical properties. In addition to the laboratory analyses, certain measurements (pH, temperature) were made in the field.

The results of field measurements and laboratory analyses conducted at the Department of Health's Laboratory in Mataram, are displayed in Table IV-3. For the parameters measured, all samples taken from locations in the rivers were within acceptable levels for livestock, fisheries and agriculture. Turbidity was high in the river during the time of sampling and would have been undesirable for drinking water. The levels of nitrate (NO_3) were high at all sites and for Site 4, was at toxic levels, especially for infants, where consistent levels above 10 mg/l can cause infantile methemoglobinemia (blue baby). It is hypothesized that the high values of nitrogen were due to excessive runoff of fertilizers from the land at the time of sampling.

The one well sampled (Site 4) produced water chemistry measurements quite different from those of the river, even though it is located on the riverbank. Its source of replenishment is presumably ground water. The extremely high levels of alkalinity, chloride, and nitrate found in this sample make the water unpleasant or unsafe as a drinking water source. Although this well may not be representative of all wells in the area, it does indicate the degree of contamination possible. The coliform levels were within acceptable limits for all samples, however it is recommended that all water be boiled before drinking.

Table IV-3
Water Quality in the Batujai Kiri Project Study Area

Parameter	Sampling Sites 1	2	3	4	5	6	7	Domestic Standard
pH	7.37	7.46	7.60	7.35	7.36	6.96	6.70	5.0-9.0
Dissolved Oxygen (mg/l)	6.0	6.1	5.7	6.9	5.0	6.1	6.7	> 6.0
Conductivity (mmho/cm)	230	170	365	2,440	230	162	156	<1250
Temperature (°C)	29.3	25.5	27.4	30.2	29.9	27.7	27.0	
Color Pt-Co Scale	126	110	133	5	126	120	16	
Turbidity (NTU)	100	91.6	73.5	0.46	150	140	33.6	
Alkalinity (mg $CaCO_3$/l)	53.34	109.27	115.13	351.13	67.72	36.66	40.72	<1000
Sodium (mg/l)	12.1	13.8	17.6	115.3	12.2	7.5	11.0	
Potassium (mg/l)	22.4	11.9	19.5	27.5	21.7	19.3	16.3	
Calcium (mg/l)	22.05	43.53	35.95	186.50	19.16	12.13	11.46	75-200
Magnesium (mg/l)	19.60	35.78	31.71	176.36	15.43	11.70	10.56	30-150
Sulphate (mg/l)	237.03	168.46	251.00	219.36	251.26	114.96	100.67	50-400
Chloride (mg/l)	37.76	94.36	69.93	950.14	54.83	21.16	18.03	25-600
Total Phosphorus (mg/l)	0.75	0.52	0.72	0.39	1.13	0.57	0.59	0.3-2.0
Ortho-Phosphate (mg/l)	0.40	0.46	0.50	0.29	1.02	0.42	0.50	
Nitrate Nitrogen (mg/l)	2.92	2.59	2.15	14.22	3.59	1.57	1.61	<10
Ammonium (mg/l)	0.017	0.015	0.025	0.039	0.032	0.031	0.026	
Total Kjehldahl Nitrogen (mg/l)	3.13	4.31	7.70	4.04	2.25	2.55	2.43	
Total Solids (mg/l)	716	433	543	1556	723	342	313	<1500
Total Dissolved Solids (mg/l)	250	313	366	1590	430	270	226	<1000
Total Volatile Solids (mg/l)	560	253	633	763	576	263	243	
Volatile Dissolved Solids (mg/l)	203	196	213	1320	343	213	170	
Total Coliform (MPN/100 ml)	350	1220	960	960	1410	230	460	<10000
Fecal Coliform (MPN/100 ml)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	<2000

Note: Samples taken on 27/12/89, and on 3/1/90.

Sources: Health Laboratory, Department of Health, Mataram;
Government Decree No. KEP-02/MENKLH/I/1988.

Ground Water

Ground water supply is limited to primarily shallow hand dug wells within the Batujai Kiri area. These wells are 1.0 to 11.0 m in depth, with most less than 6 m deep. The locations of the wells were mapped in 1987 by the Rural Water Supply and Sanitation Project (RWSSP), located in Praya. Sites are displayed in Figure IV-3 for the irrigation study area. The performance of the wells varies by season. In the wet season the ground water level is close to the surface and water is easily available from all wells. During the dry season the ground water level drops to the bedrock breccia underlying the soil layer. Some wells continue to supply water at a reduced rate, while others become dry.

Well performance from those village sub-areas (dusun) in the irrigation area is given in Table IV-4. About 60 percent of the wells yield only intermittently or at very low levels, and 30 percent do not yield water during the dry season. Along the Penujak and Mangkung rivers there are wells that are fed by springs; these usually supply water on a permanent or low-yield basis. During the dry season the springs are more reliable than the rivers and may be the only natural source of water. The RWSSP has been actively building shallow wells in the area, and has added about 25 additional wells not counted in the original survey.

There appear to be few deep aquifers in the area from which water can be pumped. This type of ground water is usually associated in Lombok with limestone deposits or folds in the underlying bedrock, whereas the geology of the project area is mostly consolidated volcanic breccia.

There is an experimental program to pump water by solar power in Mangkung Village, just south of the irrigation area, along the main highway. Its capacity is reportedly enough to guarantee sufficient domestic water supplies for much of the main settlement of that village. Another bore hole well is located within the irrigation area in Bondir Village, but its yield is small.

Figure IV - 3
WELL LOCATIONS

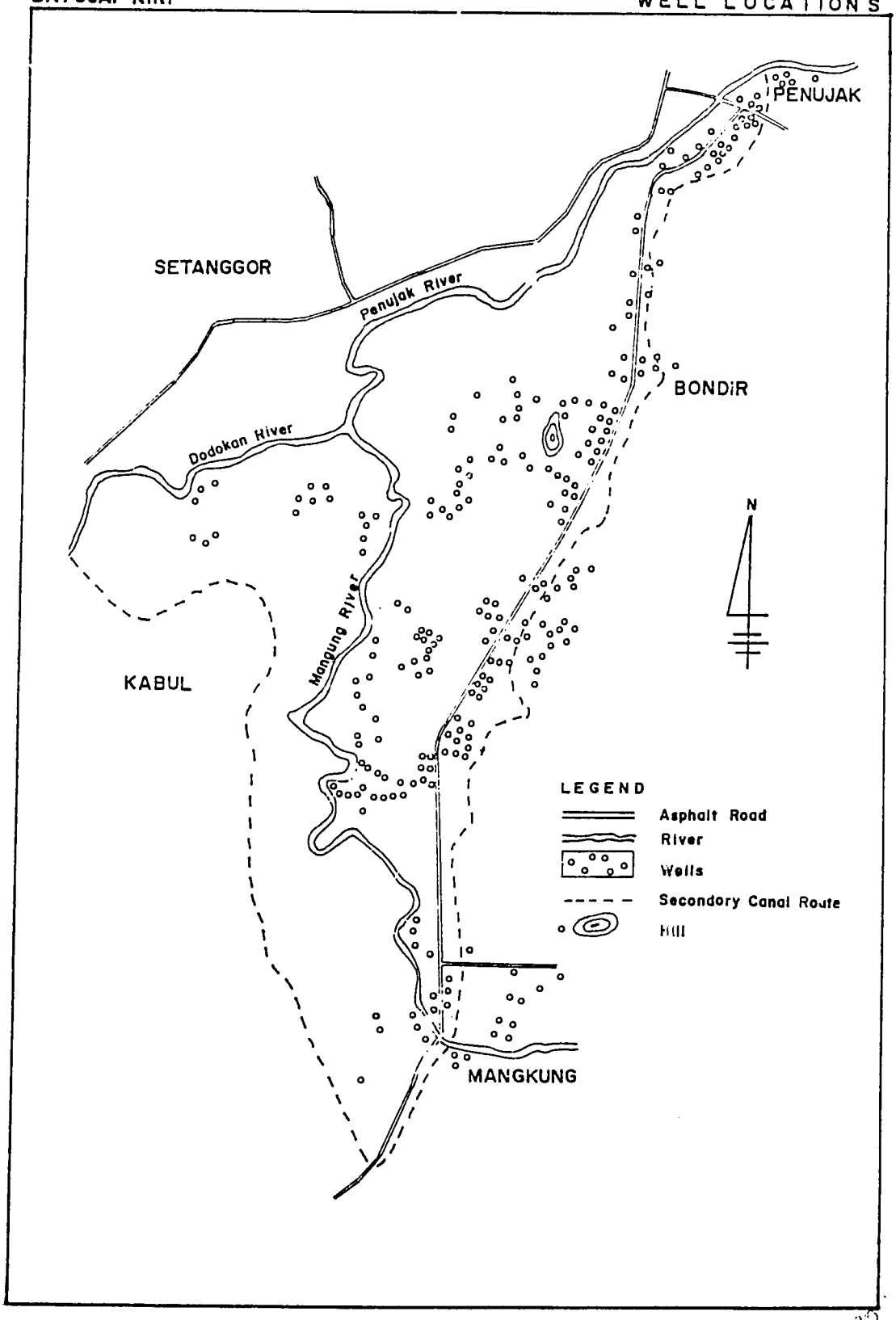

Table IV-4
Well Numbers and their Performance,
Batujai Kiri Irrigation Area

Location		Well Performance			
Village	Sub-Area (Dusun)	Drying	Low Yield	Permanant	Total
Bondir	Bare Belak	5	2	10	17
	Bare Belak Bat	0	0	1	1
	Bawah Gunung	2	1	3	6
	Bonder	11	1	3	15
	Buras	1	0	5	6
	Jarang Are	1	2	16	19
	Kelantik	4	0	3	7
	Kubur Pudak	0	0	3	3
	Lamet	6	0	4	10
	Lamet Kentawang	1	0	1	2
	Masvuring	5	0	14	19
	Perempung	7	2	22	31
	Sangko	1	0	9	10
	Sangkung	7	2	2	11
	Tengak	1	2	1	4
	Ular Naga	7	0	10	17
	Subtotal:	(39)	(12)	(107)	(178)
Penujak	Andong	0	4	5	9
	Kange	1	2	3	6
	Tenandon	15	0	3	18
	Turu	10	2	0	12
	Subtotal:	(26)	(8)	(11)	(45)
Mangkung	Mangkung Daya	1	3	1	5
	Mangkung Lauk	1	1	12	14
	Pelah	0	2	9	11
	Subtotal:	(2)	(6)	(22)	(30)
Setanggor	Kelebuh	0	1	12	13
	Tanak Rarang	0	2	14	16
	Subtotal:	(0)	(3)	(26)	(29)
GRAND TOTAL:		87	29	166	282

Source: Rural Water Supply and Sanitation Project (RWSSP), 1987.

Water Demands

Agricultural Demand. The field crops in the Batujai Kiri irrigation area rely solely on rainfall, as the source of water. As a result, cropping patterns are adjusted to what is available during any one season, usually a wet season paddy crop, sometimes followed by a palawija crop. As a means of comparison, the Batujai Kanan irrigation area has received irrigation water from the Batujai Reservoir since 1982. During that period its cropping pattern has expanded to two paddy crops and one palawija crop per year for most of the service area. Presumably, Batujai Kiri would develop a similar demand for water if it was made available, although limits on the project water availability will prevent these "demands" from being realized.

As discussed above, the ground water supply fluctuates seasonally and is just sufficient for drinking water during the dry season. Ground water surveys (Crippen, RePPProt, and RWSSP) indicate there is little additional ground water potential in the area, and therefore it is not a likely source of irrigation water.

Domestic Demand. According to estimates made by respondents during the SSIMP-conducted Household Survey (1988), the population living in the Batujai Kiri irrigation area takes about 80 percent of its domestic water volume from wells during the wet season, and slightly less during the dry season. Additional domestic water needs, such as bathing and laundering, utilize both wells and the rivers, the percentage distribution being determined by the relative availability of water by season. There is a decrease in well usage and an increase in dependency on river water during the dry season, presumably because 40 percent of the wells either go dry, are of poor quality, or have minimal yields during that time.

Domestic water use has been estimated (RWSSP) to be at an absolute minimum of 15 liters per capita per day (l/c/d), but more typically averages 25 to 30 l/c/d. As a point of comparison, the World Health Organization (WHO) recommends 60 l/c/d. The substandard water use levels in the project area probably reflects the low availability of water during the dry season.

An estimate by RWSSP of per capita use of wells puts the figures at 15 people per private well, 40 people per low yield well, and 75 people per communal, permanent yield well. Springs and pools in the river help augment the well supplies during the dry season. In the Batujai Kanan area the population readily uses the irrigation canals for their domestic water needs.

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Livestock Demand. During the wet season livestock utilize the surface water in the fields as well as the rivers. During the dry season, water for livestock drinking and bathing comes from the rivers and a few springs. At the height of the dry season, in August and September, the rivers are reduced to near-stagnant pools fed only by springs, irrigation return flows and, at least for the Penujak River, from an occasional release from the reservoir. This situation, while presenting some inconvenience to livestock owners, appears to be sufficient at the present livestock population density. The fact that there is more than 12 km of riverbeds in the area in which to disperse the cattle may explain this. In the Batujai Kanan area, livestock have access to irrigation canals, which considerably lowers their dependence on the rivers.

Land Resources

Land Use

The prevailing use of land within the Penujak basin is agriculture, with some areas devoted to agricultural support activities. Some parts of the upper watershed contain substantial patches of secondary forest, but most of the truly primary forest on Mt. Rinjani lies above the limits of the Penujak watershed.

Within the project irrigation area, the basic uses of land are agriculture, pasture (often including fallow paddy and palawija fields), gardens, brick and pottery making sites, hamlets and infrastructure (mostly roads). Only a minute fraction comprises natural habitat, consisting of ravines and riverbanks. There are a few rocky knolls which are largely brush covered, or planted in upland gardens. This limited woodlands, as well as trees planted along paddy field bunds and around hamlets as "living fences", and the trees along roadsides, provide much of the locally consumed fuel wood.

Soils and Erosion

Soils in the Batujai Kiri irrigation area are described in a report by Crippen (1975). They are typically the heavier grumosolic clays that are classed as Typic Mazaquarts due to their generally dark color and because they do not form a granulated surface in the dry season. It is thought that these soils, known as "vertisols", have developed as a result of weathering of the underlying andesitic and basaltic breccia, or from marine deposition. This type of soil is characterized by heavy clays that expand and become sticky when wet; when dried, it becomes hard and forms wide cracks in the ground surface.

Analysis of this soil type by Crippen (1975) revealed a high proportion of silt content (20 to 55 percent). Exposure of this soil to erosion can wash the silt into rivers and create sedimentation downstream. Most of the river sediment is colloidal, from watershed erosion.

The majority of vertisols are on relatively gentle slopes which are from 0 to 5 percent. Almost nowhere in this area does ponding occur naturally, though it is caused artificially by the construction of bunds for paddy cultivation. In spite of the fact that most of the vertisols have been terraced, active erosion continues in most areas. The low permeability of the soil (0.02 to 0.92 mm/h) causes considerable overland flow in the wet season. The water carries with it large amounts of soil which has been brought into suspension after being vigorously puddled by water buffalo and cattle. The degree of erosion is most where the soils have a high silt content, apparent lower permeability, steeper slopes and less cohesion.

Agricultural Practices and Production Levels

Cropping Pattern and Intensity. Paddy is the most extensively planted crop in the project area, being cultivated only in the wet season in the rainfed Batujai Kiri area. Over the period of November up until January, almost all the proposed service area is planted to paddy. Harvest of the wet season crop follows in March to April. In addition to paddy, a second season crop of soybean is cultivated in less than half the project area in the dry season, from April up until July. Cropping intensity is presently estimated at 140 percent (Table V-5).

By contrast, in the adjacent Batujai Kanan service area, which is already served by irrigation, cropping intensity is reported to be as high as 270 percent for a paddy/paddy/palawija pattern, according to area agriculture and irrigation offices (Table V-5). Hydrology studies by the TA Team based on meeting full crop water requirements on a 1:5 criterium place the sustainable cropping intensity in Batujai Kanan at about 200 percent.

According to the district agricultural office, there are also limited plantings of permanent and plantation crops in the irrigation area such as coconut, kapok, cotton, sugar, tobacco, banana, and coffee. Current farming in the project area can be described as low-input and risk-minimizing. Without secure supplies of water, farmers are understandably reluctant to make expenditures for the water complementary inputs recommended in the paddy intensification packages.

Table V-5

Current Cropping Patterns and Intensity
In Project Area

SYSTEM/ Crop Pattern	Average Area by Season Wet (ha)	Dry 1 (ha)	Dry 2 (ha)	Percent of Command Area
BATUJAI KIRI				
Paddy/	524	--	--	54 %
Paddy/Palawija	418	418	--	43 %
Average Area:				
Cultivated:	942	418	0	
Uncultivated:	30	554	972	
Totals:	972	972	972	
BATUJAI KANAN*				
Paddy/	600	--	--	17 %
Paddy/Paddy/	2,500	2,500	--	71 %
Paddy/Paddy/Palawija	400	400	400	11 %
Average Area:				
Cultivated:	3,500	2,900	400	
Uncultivated:	0	600	3,100	
Totals:	3,500	3,500	3,500	

Cropping Intensity of Batujai Kiri: 140 %
Cropping Intensity of Batujai Kanan: 194 %

* Cultivable areas according to TA hydrology studies on a 1:5 calculated sustainable basis.

Paddy. In the project area, there are basically two strategies applied in cultivation of paddy: direct seeding of paddy (a technique called Gogo Rancah, commonly known as "GORA"), or the more traditional transplanting of paddy. The choice of these cultivation strategies is related to the condition of the land, with direct seeded paddy cultivated in the drier locations of the project area.

The direct seeded approach (i.e., "GORA") attempts to capitalize on the limited soil moisture available over a season by undertaking early land cultivation followed by direct seeding with the onset of rains. Under this system, paddy is left to grow to maturity without going through the more common seedling and relocation phases associated with the traditional transplanted paddy. The early planting results in earlier than normal harvests, which also facilitates getting a palawija crop started while there is still some soil moisture remaining from the wet season. But in order to make the early direct seeding of paddy possible, farmers must engage in land preparation before wet season rains are available to soften the dense soils. This requires intensive hand labor in breaking up and readying the soil, reportedly up to 100 labor days/ha. Land preparation for "GORA" starts as early as September/October with direct seeding executed with the onset of rains, usually within the period of November through December.

In contrast, transplanted paddy starts with nursery and land preparation, beginning with the rains, and the transplanting of seedlings does not take place until December or January, roughly 20 to 30 days after the start of the nursery period. The nursery area usually occupies 4 to 5 percent of the area to be transplanted. Seeding of paddy occurs at rates of 50 to 60 kg/ha cultivated. Most farmers plant pest-resistant, high-yielding varieties of paddy seed and often use seed of the same stock source for many seasons before acquiring new seed. Land preparation for the transplanted areas involves plowing, harrowing and puddling. The dominant source of draft power is the water buffalo. Tractor use is not common, with only 3 tractors reportedly used in the proximate Batujai Kanan irrigation area. Land preparation and seeding employ family, exchange, and hired labor.

Fertilizers and agrochemicals, while used by almost all farmers, are applied at rates of less than the 275 kg/ha recommended by the Department of Agriculture. Urea makes up two-thirds of the bulk of fertilizer applied, while the remainder is made up of triple-super-phosphate (TSP) and potassium chloride (KCl). Fertilizer is sometimes incorporated into the soil at land preparation and normally applied 2 to 3 times (usually broadcast by hand) during plant development. Agrochemicals (pesticides and herbicides) are reportedly used by the majority of farmers in the area, albeit at low levels. Pesticides used include diazinon, sevin, furadan and zitosin. During the plant growth stages, weeding is done by hand.

Harvest and post-harvest activities are carried out by hand, again employing family, exchange and some hired labor. The paddy plant is cut with a sickle and moved to a threshing area. Separation of the grain from the stalk is usually accom-

plished by beating the bunched panicles against a rack or barrel. The separated grain is winnowed and then sun dried before bagging for storage.

Table IV-6 presents typical seed, fertilizer, agrochemical, and labor inputs per ha for paddy production in the project area.

Table IV-6

Typical Farm Input Use
Under Without-Project Patterns

Farm Input	Unit	Transplanted Paddy	Direct Seed Paddy	Soybean
Seed	kg/ha	51	53	45
Fertilizer				
Urea	kg/ha	230	215	0
TSP	kg/ha	90	60	0
KCl	kg/ha	30	5	0
Agrochemical	l/ha	3	2	1
Rat Poison	kg/ha	0	0	0
Labor	work days	205	245	75
Draft	team days	14	0	2

Source: HHS Farm Survey, 1988; and discussions with local agricultural officials, 1989-90.

Secondary Food Crops (Palawija). Soybean is the dominant secondary food crop currently grown in the project area with plantings in lowland areas in the dry season. Cultivation practices are primitive. In the case of soybean, seeding occurs by broadcasting at a rate of about 45 kg per 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. Due to plant susceptibility to insects, limited amounts of pesticide are applied by a few farmers. Also, there are a few farmers also reporting use of herbicide.

The crop is harvested by cutting of or pulling up the plant. The seed is beaten out of the pods, and then separated,

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cleaned and dried. Soybean cultivation is considerably less labor intensive than paddy cultivation. Table IV-6 above presents typical input use per ha for soybean 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 Household Survey (1988), data provided by the area agricultural offices, and discussions held with government officials and non-government specialists. The project Household Survey indicated average paddy yields of 2.5 t/ha, and soybean yields of 375 kg/ha, with these levels of production confirmed in discussions with area officials. These low yields are attributable to the dry conditions in the area, the low levels of input use, and limited crop management practices. By point of comparison, yields in the irrigated Batujai Kanan service area are 4.4 t/ha for paddy, and 1.3 t/ha for soybean.

Average annual food crop production for the 972 ha project area under existing conditions is approximately 2,400 tons of dried paddy, and 160 tons of soybean.

Livestock. Livestock are kept in the study area for draft power, for transport, for cattle fattening for ultimate sale as meat, as a means to store wealth, and for local consumption purposes--usually for religious or ritual occasions, such as weddings. Large and medium-sized livestock in the study area villages consist mostly of goats, water buffalo, and Bali cattle, while there are very few horses.

Estimates vary according to the source of data on the actual number of livestock in these villages. One estimate, based on village statistics (Table IV-7) indicates an average of fewer than 0.5 head of large draft livestock (water buffaloes or Bali cattle) per household.

A different source of data (Household Survey, 1988), indicated an average of 1.0 head of draft livestock per household over the Surabaya-Batujai joint survey area, consisting mainly of water buffalo. This figure may be somewhat misleading since more than 75 percent of the farm households interviewed during the survey owned no large livestock. Among the 25 percent of respondents who did own draft livestock, all owned and/or managed between 2 to 8 head, with a preference towards water buffalo. One farmer, whose cattle have been excluded from the above average, reportedly owned and/or managed about 25 head of cattle. Of those who participated in the Household Survey who owned draft livestock, most owned land in mid-upstream areas that were semi-irrigated. Most of these areas were in the neighboring proposed Surabaya Lift Scheme area rather than in

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the purely rainfed areas of the Batujai Kiri service area. Almost none of the farmers interviewed who had land in the Batujai Kiri service area had any draft livestock.

As more than 75 percent of the farmers from the Household Survey are without direct access to draft power, they must either prepare their fields by hand (Using, usually, the "GORA" system), or make some arrangements to hire livestock to do their plowing. Reportedly, occasional draft shortages occur. When asked during the Household Survey, local farmers felt that the livestock population had been declining over the past 20 years. These farmers cited such reasons for this decline as due to: 1) a decline in forage grazing areas due to cultivation of previously open areas; 2) intensification of cropping on existing bunded fields, thus reducing fallow periods and the possibility of using this land for grazing; and, 3) a decline in net draft livestock demand, mostly due to the recent expansion of the "GORA" land preparation and planting technique.

With intensification of production occurring with the introduction of technical or semi-technical irrigation, it can be expected that there will be a greater demand for draft livestock. The area will also require more stringent control measures on the already large population of largely free-ranging and destructive goats. Currently, most draft livestock are reportedly quartered near house compounds when paddy fields are under cultivation. They are then closely supervised when grazing on waste land, or kept in corrals and fed with grasses that are cut and carried. When farmlands become fallow in the dry season, livestock are left to more or less freely graze in these areas and then returned each night to the guarded compounds. Future draft livestock holdings and livestock management and breeding practices will require monitoring.

Table IV-7

Livestock Population
in the Project Area Villages, 1986

Administrative Unit	Buffalo	Cattle	Horses	Goats*	Totals
Subdistrict Praya Barat	4,384	3,473	352	7,553	15,762
Project Villages:					
Penujak	225	15	84	1,536	1,860
Bondir	300	-	11	1,450	1,761
Mangkung	584	623	10	1,124	2,341
Setanggor	250	100	16	161	527
Kabol	825	166	1	448	1,440
Totals for the Five Villages:	2,184	904	122	4,719	7,929

* Some of these "goats" are undoubtedly sheep.
Source: Mantri Statistik, Kecamatan Praya Barat, Kecamatan Praya Barat Dalam Angka, 1986, Table 5.4.

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Biological Resources

Terrestrial Habitat and Wildlife

The predominant terrestrial habitat types in the project service area are various forms of agricultural land, principally rainfed paddy and pasture. Because of the intensive use to which such lands are put, the habitat varies seasonally and from year to year. The periodic drying of the fields limits the species that can inhabit them to those that are drought resistant or can migrate from other areas. The cultivation of monocrops and use of pesticides further reduces the variety of plants and animals to be found.

Most of the woodlands are small isolated groups of trees close to rivers and houses, and are usually managed as gardens (kebun). As a habitat for animals these woodlands are fair to poor, and are too small to be attractive to many of the larger mammals. The levels of succession and diversity are also low.

Rare or Endangered Species. An exhaustive search for rare or endangered animals or plants in the study area does not appear warranted, due to the extensive habitat alterations that have taken place and the dense human population. All of the animals listed as "Rare, Endangered, or Threatened" by the International Union for the Conservation of Nature and Natural Resources (IUCN) for Indonesia, following such designation by the Indonesian Government, require special types of habitat or are isolated on small islands.

Pest Species. Despite the large area of land devoted to agriculture in the region, the Department of Agriculture reports that there have been no recent serious or widespread outbreaks of crop pests. The government's integrated approach to pest management may be partially responsible for this.

Fresh Water Biology and Fisheries

Aquatic Weeds. The Batujai reservoir supports a dense growth of water plants along most of its perimeter. The Department of Fisheries estimates that these weeds may cover up to 6 percent of the reservoir surface area of 1000 ha (wet season area). The plants commonly found in the reservoir are listed in Table IV-8. Of these plants water hyacinth (Eichornia crassipes) is the dominant species. Water spinach (Ipomoea aquatica) also grows in the reservoir and is commonly cultivated as an agricultural crop, but it can not compete with water hyacinth. Growth of these weeds is promoted by fertilizer, livestock dung and domestic sewage that is carried in by five rivers and runoff from land around the reservoir. The high suspended solids

content of the reservoir waters limits phytoplankton and zooplankton densities and therefore fisheries productivity. The water weeds do provide habitat for the fisheries, however water hyacinth is not eaten by any of the fish species present in the reservoir.

The presence of water plants may accelerate the process of sedimentation in the reservoir. To date, the only control measure used by the Department of Public Works is the removal of the weeds by hand. Using the water weeds to make paper products is under investigation by PU officials in Praya.

The rivers were not surveyed for aquatic vegetation. However, a leafy spinach-like plant, known as "kangkung", was being raised in one 500 m section of the Penujak River. Filamentous algae was observed growing on the river bottom in the lower portions of the irrigation area.

Table IV-8

Aquatic Weeds in the Batujai Reservoir

Names of Aquatic Weeds in: English	Indonesian	Scientific/Latin
Water hyacinth	Enceng Gondok	Eichhornia crassipes
Water spinach	Kangkung	Ipomoea aquatica
Salvinia	Apung apung	Salvinia molesta
Hydrilla	Ganggang	Hydrilla verticilata

Benthic Fauna. Although not studied in any detail, the various study teams have observed a variety of micro- and macrobenthic organisms such as amphipods, small molluscs and various aquatic insects (stoneflies, caddisflies, dragonflies, midges, etc.) in the river. Attached algae of various species are also likely to be present.

Fisheries. Since its filling in 1982, the reservoir has developed a large and varied fishery. During the statistical year 1988/1989, reportedly 313,300 kg of fish were taken from the reservoir. Table IV-9 displays the type of fish, composition, weights, and prices for a year's period. Mujair (Tilapia mossambica) and Tawas (Puntius gonionotus) are the most important species making up about 90 percent of the catch. The third most important species, Nila (Tilapia nilotica), was only introduced into the reservoir in 1988. The Department of Fisheries maintains a hatchery in Praya and annually releases more

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than a million fry of Nila, Tawas, Karper (Cyprinus carpio), and Lele (Clarious batrachus). None of these species are indigenous to Lombok.

For the past two years the reservoir fishery has been reportedly above 300 t/yr (305 tons in 1987-88), averaging approximately 425 kg/ha. This figure, while high, is not unusual for shallow nutrient-enriched lakes into which exotic fish have been introduced. Lake Tempe, in South Sulawesi Province, sustains a fishery of about 600 kg/ha/yr. It is calculated that the fishery has a present value at landing of Rp 150 million, and Rp 170 million at market. If averaged over the 600 fisherman reported fishing in the reservoir, then a per capita fisheries income of Rp 250,000 per year is generated. Probably many fisherman have other sources of income and do not depend solely on fishing for a livelihood.

Table IV-9

Fish Catch and Shellfish Production:
Proportions, Weights and Prices
in the Batujai Reservoir, 1988/89

Common Name	Scientific Name	Production (ton)	Percent of Catch (kg)	Weight Range (gm)	Price From Fisherman (Rp/kg)	Price at Market (Rp/kg)
Mujair	Tilapia mossambicus	156.8	50.1	35- 100	475	550
Tawas	Puntius gonionotus	123.0	39.3	25- 165	450	500
Nila	Tilapia niloticus	18.8	6.0	100- 250	475	550
Karper	Cyprinus carpio	10.6	3.4	400-6,000	1,100	1,250
Wader	Trichogaster pectoralis	0.6	0.2	20- 25	400	450
Gabus	Ohpiocephalus striatus	0.6	0.2	500-1,500	650	750
Belut	Fluta alba	0.6	0.2	ca.50	1,000	1,500
Lele	Clarias batrachus	0.3	0.1	100- 200	1,800	2,500
Betok	Anabas tastudineus	0.3	0.1	ca.50	300	350
Kerang*	Anadonta woodiana	0.3	0.1	50- 200	--	400
Others		0.6	0.2	15- 20	450	450

* Kerang is a mussel introduced originally from China to Java.
Source: Department of Fisheries, Praya.

The Department of Fisheries has recently introduced a fish farming demonstration and training program. Karper are stocked in floating fish nets or cages and raised to 0.5 kg size in four months with prepared feeds. It is too early in the program to assess its technical and economic feasibility.

Although not surveyed for fish populations, it can be assumed that most species present in the reservoir are also found in the rivers below. The Technical Assistance Survey Team observed fisherman catching tawas and mujair in the Penujak River.

Socioeconomic and Cultural Resources

Population Profile

Project Beneficiaries.[1] Direct benefits will accrue to owner cultivators and sharecropper households tilling land in the service area. These beneficiaries are estimated to constitute between 15 to 20 percent of the five village study area population. Some of these beneficiaries live in other parts of the villages outside the boundaries of the service area, while a few live farther away, such as in the town of Praya, or in the Batujai Kanan service area.

As is true of virtually all the SSIMP sites, landholding is not consolidated, and due to the inheritance (and some purchases) of small parcels of land, most farmers raise their crops in fields scattered across village sub-areas (dusun) and in neighboring villages. Thus, the population living in village sub-areas receiving irrigation is not necessarily the same as the population of direct project beneficiaries, although it is likely that the majority of residents of a particular sub-area will own and/or sharecrop nearby land.

Direct beneficiaries are the target population and access to irrigation is expected to result in them experiencing substantial gains in net income and in standard of living. Farmers benefitting from the project may be expected to hire out many of the tasks, as they have in the past, providing employment for the many landless agricultural laborers living in the area. Thus, the economic benefits will be indirectly distributed beyond the target population.

The indirect beneficiary population of the study area are those village residents who do not receive direct benefits from the project in the form of irrigation water on land that they either own or sharecrop. As mentioned above, they include the agricultural laborers, as well as other households where the primary source of support is from occupations in the community not directly involving growing paddy or secondary food crops in the project service area. Increased prosperity of the target population should benefit these people economically by increased demand for goods and services.

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[1] The discussion in this section is limited to the population who will primarily benefit from the project. The discussion regarding those who may be negatively affected by the project is found in Chapter V.

Population Density. The Batujai Kiri Irrigation Project is located in Subdistrict Praya Barat, District Lombok Selatan, NTB Province. In fiscal year 1989-90, Subdistrict Praya Barat had a population of slightly more than 87,000, living in 12 villages, with an overall population density of 297 persons per square kilometer. This is double the overall population density for NTB Province, which was about 150 persons/km^2 in 1988 (most recent figure available).

The five project villages have an overall population density of 343 persons/km^2 (see Table IV-10). For comparative purposes, this is about 20 times the population density of the Gapet Irrigation Project area (another SSIMP site, located in Sumbawa, NTB Province).

Densities of the five villages are not uniform and vary according to land use and farming systems. For instance, Mangkung Village, located at the south end of the Batujai Kiri service area, extends to the south coast. The village includes coastal fishing hamlets, large pasture areas where farmers primarily raise livestock rather than crops, many hectares of upland tree crops (about 900 ha), upland gardens (300 ha), and only a few places that are really suitable for padd. production. The overall population density of Mangkung Village is relatively low (193 persons/km^2). At the other end of the range, Bondir Village, located in the middle reach of the service area, is almost totally converted to paddy fields. This village already supports a high population density of more than 700 persons/km^2, although it has no technical irrigation. Probably because Bondir Village land is almost completely converted to agricultural production, its total population density is apprximates the overall population density for the productive agricultural land in the five villages, which is about 850 persons per km^2 (column 6 of Table IV-10).

Population Growth. Population data on the five villages, available from the Department of Statistics in Praya, indicate the population increased by about 28 percent in the 14 year period between 1975 and 1989, with an annual growth rate of about 1.8 percent.

Caution should be taken in applying this growth rate straightforwardly to any population projections for the area. There are many reasons for such caution. Introduction of technical irrigation is expected to produce significant changes in social and economic conditions, resulting in changes in migration patterns. Observation of other areas in Indonesia experiencing technical irrigation development indicates that initially, there will probably be an upward surge in the population over the first five to ten years of the project. Later,

in-migration will probably decrease and out-migration may eventually even increase as the population density levels out at a higher plateau than existed before the introduction of technical irrigation. The birth rate is expected to continue to decline due to the influence of the national family planning program, but the population is expected to continue to grow as a result of natural increase in the immediate future.

Table IV-10

Population Densities in the Five Project Villages, 1989-90

Village	Total Area (ha)	Paddy Fields (ha)	Population	Overall Density (per km^2)	Density of Population per km^2 of Paddy Fields
Penujak	1,750	1,027	8,351	477	813
Bondir	640	605	4,506	704	745
Mangkung	5,497	691	10,611	193	1,536
Setanggor	958	906	4,138	432	457
Kabol	1,430	1,143	7,677	537	672
Tot./Avg.	10,275	4,372	35,283	469	847

Note: Areal size of villages and number of hectares of paddy fields based on estimates provided by Bangdes; the areas have not been surveyed.

Source: Mantri Statistik, Kecamatan Praya Barat, "Kecamatan Praya Barat Dalam Angka, 1986," and, Bangdes "Laporan Klasifikasi Tingkat Perkembangan Desa, Kabupatan Dati II, Lombok Tengah, 1989-90."

Age Structure and Sex Ratios. Acceptance of family planning has greatly reduced the number of children that would probably have been born had the program not been available. Today, only about 25 percent of the total population is aged less than 15 years (Table IV-11). The 15 to 54 year age group, considered the working age cohort, contains 72 percent of the population; those persons aged 55 years and older constitute only about 3 percent of the population.

The sex ratios are fairly regular between age groups, except in the age group 35 to 39 years, where there are substantially more females than males. Even allowing for some age misreporting, which may distort the sex ratios between adjacent

age groups, it seems likely that some of these men have out-migrated from the area in search of employment, while more women than men have remained in the village.

Table IV-11

Population by Age Group and Sex, and Sex Ratios, Project Area Villages, 1989

Age Group	Males	Females	Sex Ratio
0 - 4	1,210	1,258	96
5 - 9	1,437	1,564	92
10 - 14	1,707	1,770	96
15 - 19	1,635	1,887	87
20 - 24	1,705	1,805	94
25 - 29	1,900	2,057	92
30 - 34	1,644	1,606	102
35 - 39	1,748	2,301	76
40 - 44	1,390	1,453	96
45 - 49	1,241	1,331	93
50 - 54	830	927	90
55+	551	533	103
TOTAL:	17,063	18,498	92

Source: "Daftar Isian Potensi Desa dan Kelurahan," for the five villages, 1989-90.

Household Size. Village statistics indicate that average household size is only about 4 persons. Visual inspection of the area lays some doubt on this figure's accuracy. The Batujai Kiri Household Survey (1988), found that households averaged closer to 6 persons. Of those households in the sample, 50 percent had 5 or fewer persons, 38 percent had 6 to 7 persons, and 22 percent had 8 or more members.

Status and Social Structure

Ethnicity and Religion. The majority of the population in the five project villages are ethnic Sasak, who are Muslim. There are also Protestants (probably fewer than ten), and some Hindus (mostly Balinese school teachers, probably numbering fewer than 50 persons).

Islam dominates the lifestyle of the area. The majority of the population still believe in the old Sasak belief system known as "Waktu Telu". As in other parts of Indonesia, farmers

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share a common, general consensus about agricultural practices. The population continues to hold various pre- and post-harvest ceremonies and ritual meals related to the rains and paddy production, held at special sites.

Social Classes. The Sasak of South Lombok are quite traditional and maintain a social stratification system divided along both hereditary lines and the roles people assume in daily life. They roughly distinguish between those of royal descent, public speakers and advisors to the traditional aristocrats, religious figures, customary experts, modern official administrators, and the majority of people, who are commoners. A very rough estimate puts those with some claim to royal descent at between 15 to 25 percent of the population in the study area villages.

Increasingly, educational attainment and income have become more important in changing traditional status and role relationships. However, many of the traditional elites continue to maintain their dominance, in part by owning fairly large amounts of land that provide them with the economic advantage to enable their children to complete higher levels of education and a competitive advantage to acquiring jobs. Often their land is sharecropped out to the same families over several generations, and the same families continue to work as agricultural laborers, so that the same relationships are maintained.

Archeology

The project villages have a number of Muslim graveyards located in the area, most located on hillocks, and some individual grave sites located near houses.

The general area has known paleolithic and neolithic sites, as well as sites where various bronze and ceramic artifacts of unknown age have been found, but which are believed to be quite old. Most archeological searches have been directed at the area surrounding the Pengga dam site and reservoir area, downstream of the Batujai project area. Two surveys (1982/83 and 1989/90) have been conducted for the Pengga Project, and findings are summarized in Sir M. MacDonald & Partners Asia's "Environmental Evaluation Study Final Report - Main Volume" (March, 1990). This study reportedly covered most, if not all the Batujai Kiri area, in addition to the Pengga area. According to their summary table of significant cultural (i.e., archeological) resources within their study area, there are no such sites of interest located in the Batujai Kiri project villages.

Education and Literacy

There has clearly been progress in education. There are now a total of 39 primary schools, with about 6400 pupils and 280 teachers. These villages also have a total of 7 intermediate level schools and 3 senior level schools. In earlier years the area had virtually no schools and the majority of children never attended school or dropped out before completing primary school.

Despite improvements to educational attainment, attendance is likely to remain rather uneven, as there are still many very small hamlets located some distance from primary schools. In this situation, some children may start school at age 8 or 9 years, frequently miss class due to illness, lack of motivation, or because they must work, and they frequently drop out before completing primary school, usually because of the necessity to work, or even marry.

Among students in schools located in the five villages (some may attend school in Praya, Mataram, or elsewhere), only 1 percent are attending upper secondary level (high school) and 13 percent are attending intermediate level (junior high school); the majority (86 percent) are primary school students. Looking at the population as a whole, it is likely that some graduates of intermediate level schools (and higher) leave the area, since overall, only about 8 percent of the population have higher than a primary school level of educational attainment.

Much of the adult population remains illiterate or near illiterate, although a few who never attended formal public or religious school have attended some adult literacy courses ("Paket A") and may have achieved literacy. Among the 10 to 55 year old population, however, an estimated 35 to 45 percent are still functionally illiterate.

Public Health

Domestic Water Supply. As in other relatively dry areas of Eastern Indonesia, domestic water supplies in the five villages become increasingly less abundant as the dry season progresses.

The Rural Water Supply and Sanitation Project in South Lombok has produced a data base including information on hamlets located within the Batujai Kiri irrigation area. These data indicate that about 59 percent of the wells, pools, and springs in the area are permanent, about 10 percent are low yield, and about 31 percent usually dry up as the dry season advances. There is one bore, powered by solar power that supplies much of the domestic water to the main hamlet in Mangkung

Village at the south end of the service area. The rest of the population living within the service area seek domestic water supplies from various rivers.

Water-Related Diseases and Health Conditions. The incidence of water-related disease is difficult to assess, given the lack of adequate sources of data. Certainly poor hygiene practices are evident throughout the area. Visual inspection of the local population indicates many small children suffer from skin diseases that include scabies and skin infections. These skin diseases, particularly evident among small children, are an indicator that there is an inadequate supply of bathing and laundry water, or that the available water is located too far from hamlets, so that the very young are unable to wash daily.

According to health officials in the clinic located in Penujak Village, the main diseases treated are mostly related to poor quality or inadequate supplies of water, as well as poor hygiene, inadequate nutrition, and inadequate control of disease vectors. The main diseases in the area include: conjunctivitis, skin infections, scabies, gastroenteritis, dysentery, worm infections, eye infections, ear infections, malaria, head/throat/respiratory infections, and influenza. Other serious problems throughout the area are hepatitis, tuberculosis, and malnutrition. Despite the presence of many other debilitating diseases, the area is still free of dengue fever.

Reportedly, the incidence of malaria, gastroenteritis, and diarrhea is worse in the wet season. According to health officials, efforts to get the population to drink only boiled water have been widely ignored in daily practice, and the people commonly drink water taken straight from their paddy fields.

Housing and Sanitation. Housing styles in the area reflect a combination of several influences, including general poverty, limited availability of raw materials, lack of an adequate service infrastructure, and, of course, cultural preference, or taste. Sasak housing generally consists of a slightly raised packed earth platform (true for about 70 percent of all houses in the area, according to recent village statistics), upon which is built a small, simple, wood and bamboo-walled, thatched roof structure. Better houses may be slightly larger, have a cement base, brick walls, glass windows, and tile roofs.

Often there are several structures used for different purposes in one compound, including a small house for sleeping, an open thatched platform on which to work or nap, storage sheds, cattle shelters and a granary. Several nuclear families of extended kin may build their own sleeping quarters in one large yard and share a closely packed communal living area.

House compounds may or may not be separated from other house compounds by mud walls or bushes.

The more traditional style houses frequently have very small windows or even no windows (fewer than 30 percent of houses have any windows built with glass and frames according to Bangdes data), and have low doors and ceilings. People commonly use sleeping mats on the floor and their furniture is sparse and simple.

Toilet facilities are almost unknown to the area. According to village statistics for 1989-90 (data taken from the "Buku Potensi Desa"), less than 2 percent of the houses in these five villages had built any toilet facility.

Health Care Facilities and Services. Subdistrict West Praya is serviced by two doctors and two main health clinics. Most of the Batujai Kiri irrigation area has its main clinic in Penujak Village, except the southern end, which is served by another clinic (with doctor), located in Mangkung Village.

These villages participate in standard health care training programs conducted by the Department of Health. Most village sub-areas have several "traditional" midwifes, equipped with basic health kits. In the six village area serviced by the main clinic in Penujak, there are 76 such midwives, or roughly 12 per village. There are also 5 to 10 volunteers (Kader Kesehatan) per village who have participated in some health training courses, who assist the subdistrict health officials when clinics are held, and who have some rudimentary knowledge of health care.

Each village has a health clinic (Posyandu). These clinics are open generally 4 to 5 times a month when a 3 to 4 person travelling health care team (PUSKESMAS Keliling) visits the clinic, assisted by the village volunteers (kader). Usually the travelling team consists of the doctor, a nurse, and a trained midwife. The main health care program emphasizes immunization of infants and young children, general health problems to people of all ages, family planning services, and nutrition.

The area also has an active Family Planning program. Initially begun on a very limited level in the early 1970's, the program has steadily expanded. Despite the general poverty of the area and poor educational attainment, there seems to be little difficulty in gaining acceptors to the program. Overall, according to village statistics (as found in the "Buku Potensi Desa"), about 78 percent of couples "at risk" are currently actively participating in the program, ranging from a low of 69 percent in Penujak Village, to a high of 89 percent

in Setanggor Village. While these figures must be taken at face value cautiously, the following population pyramid, based on recent population data for the five villages (Figure IV-4), indicates fairly significant declines in the number of births over the previous 10 to 15 years.

Figure IV-4

Population by Age Group and Sex,
Batujai Kiri Project Villages, 1989-90

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 Age            Males                          Females
Group

 55+                      XXXXXX!XXXXX
50-54                    XXXXXXXX!XXXXXXXXX
45-49                XXXXXXXXXXXX!XXXXXXXXXXXX
40-44               XXXXXXXXXXXXX!XXXXXXXXXXXXXX
35-39            XXXXXXXXXXXXXXXX!XXXXXXXXXXXXXXXXXXXXXX
30-34             XXXXXXXXXXXXXXX!XXXXXXXXXXXXXXXX
25-29          XXXXXXXXXXXXXXXXXXX!XXXXXXXXXXXXXXXXXXXXX
20-24            XXXXXXXXXXXXXXXXX!XXXXXXXXXXXXXXXXXX
15-19             XXXXXXXXXXXXXXXX!XXXXXXXXXXXXXXXXXXX
10-14            XXXXXXXXXXXXXXXXX!XXXXXXXXXXXXXXXXXX
 5- 9               XXXXXXXXXXXXXX!XXXXXXXXXXXXXXXX
 0- 4                 XXXXXXXXXXXX!XXXXXXXXXXXXX
-------------------------------------------------------------
            !    !    !    !    !    !    !    !    !    !
         2000 1500 1000  500   0   500 1000 1500 2000 2500
                         X = 100 Persons
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Source: "Daftar Isian Potensi Desa dan Kelurahan," for the five villages, 1989-90, as found in Table IV-11 of this report.

Labor Force

Occupations. The work force in the five project villages is predominantly engaged in agricultural production (87 percent of reported primary occupations), although only 57 percent of this same work force is principally engaged in paddy production. Other members of the (officially reported) agricultural work force are principally engaged in raising crops in dry fields and upland gardens, in tree crops, and in livestock production. Overall, only about 3 percent of the total work force are principally engaged in petty trade, about 2.5 percent are government workers, and the rest are engaged in a variety of trades

including day labor, tailoring, transport, home industry/ handicraft, wood gathering, carpentry, masonry, and other semi-skilled trades and services. During off-peak seasons, however, many who are principally engaged in agricultural production may engage in other trade and service-oriented occupations.

Agricultural Labor. Despite a high population density, results of the project Household Survey highlighted some peak labor demand period that occur during the land preparation, transplanting, and harvest. At these times, farmers hire outside laborers for wages, production shares or on a contractual basis. Wage payments predominate for most non-harvest tasks and crop shares are common for harvest activities. The value of these wages generally falls within the range of Rp 1,500 to Rp 2,000 per day. The exception to the general use of wage payments for compensating outside laborers is the case of land preparation for paddy GORA. Much of the very labor-intensive soil opening is done on a contract basis by groups of 10 to 15 laborers working under the direction of a supervisor (mandor). During non-peak activity periods, many of the tasks are accomplished with household or exchange labor.

While use of hired labor in the area is noted, farmers do not report being constrained in production by labor shortages at this time. Approaches to increased efficiency in labor, such as extensive use of tractors, herbicides, and contract labor, are not yet evident in the project area, and can not be expected to develop without the provision of irrigation. Given the fairly high proportion of landless agricultural laborers, it is unlikely the current situation will change until such time as the cost of labor begins to exceed the cost of renting/ owning tractors and other technical equipment.

Landless agricultural laborers are most prevalent in the villages of Setanggor, Bondir and Penujak (Table IV-14). The duty of the mandor is to travel around and make work agreements among farmers in need of labor. The work crews live in their home village and travel around within a short distance, returning each night to their homes.

Project Economics

Prices and Marketing of Agricultural Production. The most valued agricultural output in the area is paddy. According to the Batujai-Surabaya Household Survey results (1988), crop use is allocated among consumption (46 percent), marketing (32 percent), harvest wage payments (12 percent), and seed stock and other uses (10 percent). Prices for dried husked paddy at Rp 150/kg are ten percent lower than prices received in the neighboring areas where irrigation already exists. This price gap may be due to both qualitative differences and cost

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of collection. Buyers arrive at harvest from the Praya and West Lombok urban centers, and in sufficient numbers to provide a competitive buying market to farmers. In addition to sales to the buying agents, farm households also sell limited quantities of milled paddy throughout the year to meet other household expenses.

Nationally, the price of paddy is stabilized by the central government procurement agency through BULOG-directed purchases and sales. The 1987-88 floor price for milled paddy was Rp 307/kg and the ceiling price (for Class IV paddy - current production) was Rp 430/kg. When market prices for paddy drop below the floor price, BULOG initiates purchases of paddy on the market, and when paddy prices rise above the ceiling price, BULOG orders market operations to sell paddy stocks.

SubDOLOG, Lombok Tengah, has warehouse facilities to store more than 26,000 metric tons of paddy (Table IV-12), while NTB provincial capacity is at 118,000 metric tons. The stock position varies considerably throughout the year depending on the prevalent harvest periods. According to discussions with procurement agency officials, the price offered in private markets has been sufficiently strong in recent years to bid stocks away from the government procurement agency which is guided by fixed support prices. DOLOG estimates put the amount of paddy acquired by the procurement agency at 5 to 10 percent of total production. In any case, should government stocks approach capacity, the procurement agency transfers supplies to other branches. NTB is a surplus producer of paddy and ships supplies to other paddy-deficit regions in Indonesia (the Eastern Islands being the most proximate markets).

Table IV-12

SubDOLOG Warehouse Capacity,
District Lombok Tengah

Storage Center/ Location	Type	Capacity (tons)
Ubung I	permanent	7,000
Praya	permanent	4,000
Sengkol	semi-permanent	14,000
Ubung II	open-walled	1,000
TOTAL		26,000

Source: DOLOG, NTB, 1990.

The government has recently exhibited its willingness to continue to support paddy prices. In January 1989, government-announced price increases took effect raising the BULOG floor purchase price for paddy to Rp 250/kg, and in October of 1989, the government announced a further increase in the price of paddy to Rp 270/kg to take effect 1 January 1990. The one year 8 percent price rise should be sufficient to maintain real prices received by farmers (nominal prices minus inflation).

Secondary food crop production is almost exclusively for market in the cases of soybean and mungbean, less so for the small amounts of other traditional crops grown in the area. In the project area, soybean provides the bulk of the secondary food crop production, and flows to market at rates of 80 to 90 percent of production. It is sold at an average farmgate price of Rp 540/kg.

While floor prices have been set for some secondary food crops by BULOG; in fact, they have been set low relative to actual market prices, and BULOG has not been active in price stabilization for these crops. The implication here is that farmers are subject to more price uncertainty with secondary food crops than with paddy. Surplus secondary food crop production from NTB flows to Surabaya, East Java.

Costs and Returns of Agricultural Production. Information on costs and returns of agricultural production is derived from the Household Survey and discussions with local agricultural officials. Crop production costs include expenditures on seed, fertilizer, agrochemicals, labor and miscellaneous expenses (farm investments such as tools, fences, land taxes, interest payments, etc.). The present crop production costs are placed

at approximately Rp 340,000 per ha for wet season rainfed paddy, and Rp 78,000 per ha for soybean cultivation (Table IV-13). Gross revenues are based on farm crop production (whether consumed or sold) and prevailing farmgate prices at harvest. The average net returns per hectare are Rp 45,000 for wet season rainfed paddy and Rp 130,000 for soybean cultivation. The low returns to paddy cultivation are due in large part to the low yields and high labor inputs and costs. Paddy GORA, as indicated earlier in this section, utilizes up to 100 labor days in land preparation activities alone.

Table IV-13

Typical Financial Costs and Returns per Hectare Under Existing Rainfed Cultivation Practices

	Paddy (Rp)	Soybean (Rp)
Total Expenses	340,000	78,000
Material Inputs	65,000	35,000
Labor and Draft Inputs	270,000	40,000
Miscellaneous	5,000	3,000
Gross Crop Returns	385,000	208,000
Net Crop Returns	45,000	130,000

Source: Household Survey 1988; Field Surveys, 1987-90.

Current net value of field crop production in the Batujai Kiri area in financial prices is placed at Rp 95,000,000 per annum.

Model Farm Budgets under Existing Situation. Per capita farm income for project area households is low, as would be expected in dry, rainfed farming areas, averaging under Rp 300,000 per year. An average farm size in the Batujai Kiri area is 2.1 ha of which 1.9 ha is lowland (sawah), and 0.2 ha is orchard or home garden.

Gross annual farm income for project families (average family size of six) is estimated at Rp 1,030,000. Farm and related production expenses total approximately Rp 740,000. This leaves a net farm income of about Rp 290,000, which for an average family would not in itself be sufficient to minimally

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cover living expenses (fuel, clothing, medical needs, off-farm food purchases, household improvements, etc.). Under such circumstances, the annual net family income would have to be supplemented by a value of approximately Rp 500,000 from off- and other-farm earnings. It is very unlikely that any reserve could be generated by the average farm (the minimum rural income standard proxy from DPU is: 240 kg paddy per capita per annum X 6 persons per household X Rp 474/kg for paddy = Rp 798,000).

When looking at median (the central observation in the distribution of farm sizes) and small farms, the income situation is significantly worse. The median farm in the project area is 1.1 ha and the small farm is 0.5 ha. Of the Household Survey sample, 11 percent of the sample cultivated lowland in the range of 0.1 to 0.5 ha only. Like the owners of an average sized farm, but to a much greater extent, these households would have to generate substantial earnings from off- and other-farm income activities in order to meet minimum consumption standards.

Other income sources include such activities as other-farm wage labor, transport, petty trade, wood gathering, livestock management, and home industry/handicraft -- but it should be noted that the extent and availability of these other employment opportunities in the project area are limited.

Input Supply: Credit. 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. This agricultural credit program finished in the early 1980's.

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 (KUD's) which have been approved as reliable by Bank Rakyat Indonesia (BRI). Interest payments on loans are 1 percent per month for members and 1.5 percent for non-members. The local cooperative, Tunggal Karya, located in Penujak, distributes limited quantities of inputs under the KUT credit program including fertilizer, agrochemicals, and seed.

KUPEDES (Kredit Umum Pedesaan, general rural credit program) is a cash credit program administered by BRI (Bank Rakyat Indonesia) Unit Desa (village bank units). It can be

utilized by farmers if a reliable KUD (and KUT credit) is not available. There is a BRI Unit Desa in Penujak. Money extended from the BRI to creditors under this program though is usually for the sectors of trade and commerce, with little flowing to the undependable rainfed agriculture sector. Officials generally state that agriculture is an historically bad loan performer, especially if the agriculture is rainfall dependent.

Private Credit. With the limited success and amount of institutional credit available to the agricultural sector, the most prevalent credit arrangements are among 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 25-50 percent over a season. A typical loan would be in the input form of fertilizer to be paid back at harvest in a greater weight of paddy.

Material Inputs. Throughout NTB Province, the production and marketing of certified seed to farmers occurs through PT Pertani, the KUD's, and also on a commission basis through extension officers, local kiosks and farmers groups. So while farmers have the opportunity to acquire certified seed from a number of outlets, in the project area the use of certified seed is, in fact, not yet an accepted practice. Most seed is acquired from previous harvests or from other farmers' supplies. Certified seed costs 50-100 percent more than non-certified seed and the expense comes at a time (the beginning of the planting season) when most farmers don't have excess cash available.

In Indonesia, PT Pusri is the government enterprise charged with distribution of fertilizer throughout the provinces. Within the district, several other players take over distribution at the lower levels. The district cooperatives office (PUSKUD) acquires fertilizer from PT Pusri and distributes to village cooperatives (KUD) which in turn serve the farmers. Several other companies with varying degrees of government involvement (PT Pertani, etc.) have also been active in acquiring fertilizer from PT Pusri and distributing to kiosks and private merchants for ultimate delivery to farmers.

For agrochemicals, PT Pertani is active in distribution at the provincial and district levels. Much of its supplies are then distributed to farmers through kiosks and cooperatives, rather than through private merchants. Payments are generally made in cash, not through a system of barter credit as is often the case with fertilizer. Agrochemical distribution to the provinces is also handled by the manufacturers who

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channel supplies to agents in the provinces who then in turn sell through town stores and market stalls.

Although government subsidies remain intact for inputs, they are being reduced gradually. Subsidy reductions were announced for fertilizers in October 1989 along with an 8 percent increase in the government support price of unhusked paddy (from Rp 250/kg to Rp 270/kg) to take place as of 1 January 1990.

Settlements and Administration

Settlement Pattern. Villages range in areal size from about 1100 ha to about 4400 ha. The village land areas are divided into administrative sub-areas (dusun), each with several hundred hectares and populations ranging between 500 to 1000 persons. Setanggor Village has the fewest sub-areas (5), while Mangkung and Penujak have the most (12 and 13 respectively).

Unlike many other parts of Indonesia, there are still many small unconsolidated hamlets scattered across the villages. The very small neighboring hamlets are sometimes grouped together, and the larger hamlets are subdivided into units known as "Rukun Tetangga", or "RT", usually consisting of 25 to 50 households. Bondir Village has the fewest "RT" (33), and Penujak Village with a total of 54 "RT", has the most.

Administrative System. The villages are administered under the modern Indonesian system of village government. Village heads (kepala desa) are appointed by the subdistrict government. Village administrative officers, including secretary and other 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 semigovernmental organizations like the rural women's group (Program Kesejahteraan Keluarga, or "PKK"), key or contact farmers (kontak tani), the leaders of water users' associations (P3A), and village unit cooperatives (KUD). Proposals are made by the village advisory body, known as the "LMD" (Lembaga Masyarakat Desa) who finally make recommendations to the village head.

In practice, the quality of the village administration strongly depends on the personal capabilities of the village leaders rather than the activities of these formal councils or committees. In this area, traditional leaders, particularly religious figures, are held in high esteem and wield much influence, so that the "modern" and "traditional" leaders often share public duties and decision-making.

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Land Ownership and Inheritance

Land Ownership. Virtually all the land in the Batujai Kiri service area that has any agricultural potential is privately claimed and cultivated. As in other SSIMP sites, 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. According to results of the Household Survey, perhaps 88 percent of paddy fields have been acquired through inheritance, this being most common in downstream areas farthest from the Batujai Reservoir. Purchase of paddy fields is quite uncommon in these downstream areas, but has become more common the closer the fields are located to existing irrigation, nearer the town of Praya, and/or nearer to areas that may be irrigated in future.

Some farmers acquire temporary rights (often for 2 to 3 years) to paddy fields through sharecropping/renting/pawning, where land owning farmers pawn out land to other land owners or to landless tenants. Statistics taken from village records (as found in the "Buku Potensi Desa") indicate a high proportion of farmers in these five villages are totally dependent upon such arrangements for access to agricultural land.

Overall, about 45 percent of farmers own at least some of their own paddy fields, although small farmers may not own enough to be self-sufficient. Assuming these statistics have some degree of reliability, then owner-operated farms are most common in the villages of Mangkung and Penujak. In the villages of Kabol and Setanggor, land holdings are consolidated into the hands of relatively few farmers, where about one-third of the farmers are owner-operators and the remainder are either sharecroppers or agricultural laborers (Table IV-15).

Inheritance. Typically, daughters inherit one-third the amount of land inherited by sons. As an example, if two hectares were divided between two sons and two daughters, each son would receive 0.75 ha and the daughters would each receive 0.25 ha. In practice, some siblings receive a cash amount rather than land, and some use this cash amount to purchase other land, to build a house, to invest in education, to estab-lish a business, etc. While the size of farms in the area is small relative to other SSIMP project areas, some families have been successful in preventing the extreme fracturing of land- holdings that have been observed in parts of Java, and continue to control holdings of considerable size.

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Table IV-14

Land Tenure and Agricultural Labor Status
in the Five Project Villages, 1989

Village	Owner Operators		Only Share-cropping		Agricultural Laborers		Totals	
	No.	%	No.	%	No.	%	No.	%
Penujak	1,127	66	231	13	355	21	1,713	100
Bondir	415	43	325	34	219	23	959	100
Mangkung	2,367	68	784	23	330	9	3,481	100
Setanggor	325	29	458	41	330	30	1,113	100
Kabol	1,282	26	3,259	66	407	8	4,948	100
Totals:	5,516	45	5,057	41	1,641	14	12,214	100

Source: Bangdes, "Buku Potensi Desa", for the five project villages.

Regional Infrastructure

Roads. One of the main roads to the south coast beach area passes through the service area. This asphalted road is narrow and generally of poor quality. As the service area is long and relatively narrow, most of the service area east of the Mangkung River is located less than one kilometer from this main road. Off the main road, local roads are much more rudimentary and motorized vehicles may use them only in the dry season. Access is most difficult to the service area located between the Mangkung and Penujak Rivers, but access will be improved with the construction of a service road along the length of canal going into this tail-end area.

Transportation. Public transport in the form of small, local buses is readily available along the main road through the service area. The area is mostly serviced for local travel by horse-drawn carts available for hire. There are at least 9 cars, 2 buses, 12 trucks, 140 motorcycles, more than 100 horse-drawn carts, and about 100 bicycles in the villages.

Communications. There is no telephone service in the area. About 4 percent of the households have a radio, while only 1 percent own a television. There are no local newspapers; the nearest regular point to purchase a paper is in the district town of Praya.

Electricity. Approximately 4 percent of the houses in the five project villages have access to electricity for evening lighting. Most of these houses are located in the main administrative center of Penujak Village. There are also some small generators that can be rented to provide lighting for special events.

Markets and Shops. There are more than 100 very small, minimally stocked shops located along the main road through the service area. There are also a number of small, local markets in the Batujai Kiri area. Thriving markets in Mangkung, Penujak, and Setanggor Villages are each held once or twice a week on a rotation schedule. The largest and nearest commercial center is located in the town of Praya.

Other supporting agricultural infrastructure in the study area include the agricultural extension and support services (Table IV-15), and a total of seven rice mills, three warehouses, fifteen kiosks selling agricultural inputs, and a number of privately owned drying floors (Table IV-16).

Table IV-15

Agricultural Extension and Support Services in the Study Area

Villages	Agrcltr. District WKPP	Ag. Ext. Agent	Farmers Group	Contact Farmers	Advanced Farmers	Ordinary Farmers	Location KUD	Location Bank RI
Bondir	Bondir	1	16	16	160	412	Penujak	Penujak
Mangkung	Mangkung	1	16	16	160	2678	Penujak	Penujak
Penujak	Penujak	1	16	16	160	1673	Penujak	Penujak

Note: The main agricultural office (BPP) is located in Penujak. Data for Kabol and Setanggor Villages are similar to those for the other villages listed above.

Source: Agricultural Office (BPP), Penujak, 1990.

Table IV-16

Paddy Processing Facilities in Project Vicinity

Village	Paddy Mills	Kiosks	Ware-houses	Drying Floors
Bondir	2	2	1	9
Mangkung	1	5	1	11
Penujak	4	8	1	24
Totals for main villages:	7	15	3	44

Sources: Agricultural Office, BPP, Penujak, 1990.

Regional Development

The district planning agency, BAPPEDA, Tk II, has had much contact with foreign donors providing development assistance to south Central Lombok. The agency is familiar with the need for integrated planning in the development of a very poor and densely settled region of the island. The SSIMP Batujai Kiri Irrigation Project has been a part of the regional development plan for a number of years and is eagerly awaited by both beneficiaries and planners alike.

As South Lombok is particularly dry and very poor, with high population densities, many foreign-donor sponsored projects have been devised to improve their living conditions. The area has already benefitted from USAID-funded road improvements to the area. The Batujai Kiri project villages have participated for at least five years in an AIDAB-sponsored Rural Water Supply and Sanitation Project (RWSSP), that has sought to improve the supply of drinking water. It has also benefited from a World Bank/Australian-sponsored project known as the Nusa Tenggara Agricultural Support Project (NTASP). Among its activities have been attempts to improve palawija crops and encourage soil conservation.

A New Zealand-sponsored pottery project has brought new sources of income-earning into the area to some families in the Batujai Kiri service area. This business continues to grow.

GOI-sponsored projects have included many local road improvements, construction of local market places, schools, village offices, new post offices, a small dam for irrigation (outside the Batujai Kiri service area), some O & M improve-

ments to existing irrigation, regreening projects, and rehabilitation of health clinics, and installation of generators. Malaria control programs continue, as do agricultural extension services and farmer training projects. Programs are in place to support livestock development (cattle, goats, etc.).

Attitudes Toward the Project

People in the project area are greatly in favor of the project, representing as it does a major improvement in water availability for agriculture. The Batujai Kiri Project represents the completion of the originally envisioned Batujai Irrigation System. The project does not require any resettlement, and bears none of the controversy surrounding some dam development projects that have forced resettlement of the population. In principle, the population does not oppose the taking of small parts of the land for project structures, which are mostly canals.

Results of initial assessments indicate that the Batujai Kiri irrigation site will be socially suitable for technical irrigation. This site meets the general USAID requirements that farms be principally smallholdings, and that the knowledge and interests of farmers is sufficiently high so that provision of irrigation will result in maximum benefits. Virtually all the area suitable for irrigation has already been converted to terraced fields, so there should be little or no extra labor inputs initially. What extra labor is needed, should be abundantly available within the service area surplus labor pool, represented by the many landless agricultural laborers and sharecroppers seeking such work.

CHAPTER V

POTENTIAL ENVIRONMENTAL IMPACTS

Methodology Used to Identify Project Effects

Identification of the potential impacts of a particular project are usually based on several types of 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 of the Batujai Kiri Irrigation Project.[1]

On 20 December 1989, a scoping meeting was held in Praya, Lombok, with 24 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 the Batujai Kiri Irrigation Project. 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 categories of effects were used in the meeting as in this

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[1] The theory and methodology currently available to analyze 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.

report: water, land, biological, and socioeconomic resources. The general areas of concern that emerged from this meeting and subsequent informal discussions were largely those already identified by specialists at USAID and by the Technical Assistance Team. These may be summarized as follows:

- Availability and quality of river water for downstream users
- Effect of the project on current uses of the Batujai reservoir, including recreation, fisheries, and weed control
- Effect of maintaining reservoir height (necessary to store adequate water) on Praya Town and farm land adjacent to the reservoir

Pre-construction Phase

Work during the pre-construction phase such as site surveys produced generally positive social impacts among the local beneficiary 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 relatively small (only 12.5 ha), and the local population is enthusiastic about the project, the impact should be small. It is important that negotiations for compensation to the villagers for their land be conducted in an expedient and fair manner. Otherwise, significant delays in the project and ill-will amongst the populace could result.

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 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. Contractors using local roads as access to any construction area should attempt to minimize disruption of village life. 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 laborers 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.

During the construction phase, a certain amount of resettlement of people living too close or within the reservoir area will be necessary. Land will have to be purchased from farmers who are currently farming land that will be inundated, and housing/land compensation will be required for those forced to move.

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 nas 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 sequence as earlier chapters: water, land, biological, and socioeconomic resources. They are summarized in Table V-6, "Summary of Environmental Impacts," found at the end of this chapter.

Water Resources

Major Surface Water Bodies: Reservoir. The Batujai reservoir receives its water from a number of different rivers. As would be expected, these rivers contribute sediment and nutrients to the reservoir. Both of these factors over time could affect the quantity and quality of the reservoir water and consequently irrigation supply to downstream users. The effect of the Batujai Kiri Irrigation Project on the reservoir operation should be minimal. The reservoir levels are maintained between 87 and 92.5 m (1.3 and 24.8 MCM, respectively), but usually has not been raised to the maximum height. At the higher level, water overflows the dam spillway gates, and the lower level is the bottom elevation of the irrigation intake. At the higher level, reportedly some flooding occurs in the town of Praya, as well as in agricultural land immediately adjacent to the reservoir.

Sedimentation of the reservoir is a primary concern since it decreases the reservoir's water storage volume. The Batujai reservoir was designed with an allowance for sedimentation due to erosion over a 50 year period by including a dead storage of 3.6 MCM. Field surveys measuring the sedimentation rate since

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the Batujai dam was completed have yielded inconclusive results. The water budget simulation for the Batujai Kiri Irrigation Project is based on a loss of 10 percent of the active storage volume of the reservoir (i.e., the maximum operating volume of 22.3 MCM), in addition to that already planned as part of the dead storage volume. This would appear to be a reasonable safety margin to allow for unplanned or erroneous projections of reservoir sedimentation rate.

Of course poor watershed management upstream of the reservoir, due to urbanization, deforestation, overgrazing, and unsuitable agricultural and irrigation techniques could significantly contribute to future erosion, and eventually render even these allowances insufficient. The watershed is made up of a series of overlapping diversion and irrigation schemes, as well as forested areas. The size and complexity of the watershed is beyond the scope of this environmental study to assess its future impacts on the project. Further study is necessary before recommendations can be made.

Batujai Kanan Irrigation. Batujai Kanan currently diverts most, if not all, of the water which can be regulated from the reservoir. As a result, the cropping intensity is higher than was originally planned, and a cropping pattern of paddy/paddy/palawija is obtained over much of the area, with an intensity of about 290 %. Reservoir simulations studies show that this is not sustainable over the long term using a 1 in 5 year criteria. Reallocation of water to Batujai Kiri would force Batujai Kanan to adopt a less intense cropping pattern or to plant palawija instead of paddy in the second season. It is difficult to predict at this time how much land will be affected but it may be up to 250 ha or 10 percent of the second season paddy crop. There are measures that may lessen this impact of water reallocation. Currently, the Batujai Kanan supply canals are being upgraded to improve efficiency which will result in a savings of water. It is suspected that there is also water wasted in the form of high irrigation return flows. Visual observation of the fields and their drainage to the river indicate that irrigation water could be applied more efficiently to the paddy in Batujai Kanan. The Pengga Reservoir to the south, when filled, will inundate 200 ha of the present 3500 ha Batujai Kanan service area.

Streamflow. Streamflow in the Penujak River is determined by a number of different factors whose relative importance is determined by the time of year and location on the river. During the rainy season reservoir spill, tributary inflow and runoff are the most important contributions. During the dry season irrigation return flows and ground water (springs) become important. The Batujai Kiri Irrigation Project will tend to increase subterranean and irrigation return flows.

The amount of water spilled to the Penujak River during the wet season should not significantly change. In most years

there will be little or no water released to the river from April through November (Table V-1). Some water that is currently used by Batujai Kanan will be reallocated to Batujai Kiri with little influence on reservoir spill to the river. Irrigation return flows will be from a larger area, but water quality should not decline as a result since most second and third season crops will be palawija instead of the more heavily fertilized paddy now seen in Batujai Kanan alone. Flow will increase in the Mangkung River and water quality decrease slightly due to the irrigation return flows from the paddy in its lower reaches.

Water Supply

Ground Water. The irrigation water supplied to Batujai Kiri should help recharge the ground water in the area especially during the dry season. Not enough is known about the ground water dynamics of the area to qualitatively predict the quantities involved, but it should be significant.

Domestic Water Supply. Batujai Kiri already takes most of its household water from wells. This trend will increase as some wells that are normally dry later in the year are recharged by irrigation water. Where convenient, villagers will use the irrigation canal for washing, and bathing steps will be supplied for this purpose. Water will be available in the irrigation canals for all but 2 or 3 months in most years (Table V-2).

Livestock Water Supply. Presently, the Penujak and Mangkung rivers are the only permanent source of water for livestock. This presents some difficulty during the dry season when the rivers are reduced to standing pools. The irrigation canal will become a ready source of water for livestock, and washing sites and watering troughs will be constructed along the primary canal for this purpose.

Water Quality

Reservoir. The reservoir catchment includes large areas of irrigated land as well as towns with high urban density. Their potential contribution of pollutants in the form of agricultural runoff and domestic sewage is enormous. Indications of pollution are already visually evident in the reservoir by virtue of its high turbidity and aquatic weed density. Water quality measurement of the Leneng River as it flows into the reservoir, while acceptable for most parameters, did show elevated levels of nitrate and phosphate. The consequences of sedimentation have been discussed above. Of course, some inflow of nutrients is advantageous for the fisheries, but the management of the reservoir is complicated as the concentrations increase. Pesticides and pathogens may tend to collect in the reservoir; their tendency to be broken down in the reservoir, or to be passed downstream will be determined by

pollutant type and the ecology of the reservoir. Sewage and pathogens in the reservoir may produce a number of serious health hazards, particularly by contaminating the shellfish that are currently harvested, by concentrating hepatitis, salmonella, and heavy metals.

The uncontrolled growth of algae stimulated by pollution (eutrophication), followed by a rapid maturation, die off, and decomposition of organic matter can have serious consequences for reservoir water quality. A high biological oxygen demand (BOD) can rob the water of its oxygen such that it will no longer support fish and other aquatic organism. In its advanced stages the reservoir could become anaerobic (decomposition without oxygen) thus producing hydrogen sulfide and a rotten egg smell. The water quality for irrigation and other downstream uses would consequently suffer. This scenario, while unlikely, could occur when the reservoir volume is low, nutrients, temperature and sunlight are high, and when there is no wind for a prolonged period of time.

Irrigation Area. Water entering the irrigation system will be as good a quality as it is at the reservoir under pre-project conditions. How long that quality will be maintained will depend on whether waste discharges into the canals are curtailed and on what non-irrigation use is made of the water. The canal water, at its worst, will be of better quality than the surface water available to people of this area under present conditions. In general, the Penujak River probably will contain the best water during the middle part of the wet season, when the dam is spilling, but the canal system probably will be better during the rest of the year.

Downstream. Water quality in the river all the way downstream is likely to be degraded somewhat, especially during the dry season when irrigation return flows, bearing some fertilizers, pesticides and considerable human and animal waste, will be the main source of flows. The assimilative capacity of the river will be low, so the use of water in the main stem of the river for any purpose other than livestock watering would pose a risk to human health. Excess nutrients will encourage the growth of water plants in the river and farther downstream in the planned Pengga Reservoir. For the farmers growing water spinach (kangkung) in the river, this may be welcomed as long as other weeds or filamentous algae do not crowd it out.

Ground Water. Contamination of the ground water by fertilizer and pesticides is a potential hazard of increased irrigation flow. Not only is agrochemical use higher, but more contaminated water is flowing into the shallow wells and springs. In one spring outlet on the riverbank, water quality analysis indicated dangerous concentrations of nitrate (16 mg/l). At this level the water presents a health hazard if used for drinking or cooking. The extent and source of the nitrate is unknown at present, but fertilizer contamination is suspected.

Contamination by pesticides is also likely, not only 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.

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Table V-1

Simulated Batujai Reservoir Spill to the Penujak River (MCM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1950	61.83	46.70	1.35	0.00	0.00	2.29	0.00	0.00	0.00	7.58	11.37	8.22	139.3
1951	17.37	39.35	9.06	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	66.6
1952	17.20	16.19	18.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.71	1.51	65.4
1953	14.62	7.46	9.35	2.66	3.21	0.00	0.00	0.00	0.00	0.00	0.00	23.51	60.8
1954	20.75	0.88	3.15	34.11	20.77	0.00	0.00	0.00	0.00	0.00	1.94	34.12	115.7
1955	35.42	29.22	4.06	6.73	8.32	13.77	15.72	1.95	0.00	2.49	12.23	12.56	142.5
1956	38.43	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.75	50.1
1957	37.90	44.01	14.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.62	100.8
1958	0.00	14.87	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.05	32.0
1959	17.88	3.21	17.01	0.00	7.97	1.31	0.00	0.00	0.00	0.00	0.00	21.75	69.1
1960	16.30	17.03	10.88	2.74	16.86	0.00	0.00	0.00	0.00	0.00	2.34	0.00	66.2
1961	5.01	13.35	0.00	2.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.1
1962	3.04	29.88	0.00	11.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.23	50.0
1963	45.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.2
1964	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.30	30.81	0.00	59.1
1965	32.98	2.24	7.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.6
1966	0.00	3.64	21.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51	28.7
1967	29.32	0.00	15.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.87	52.4
1968	37.34	21.45	3.07	9.14	30.40	13.14	14.42	0.00	0.00	0.00	0.00	2.63	131.6
1969	0.00	0.00	32.25	0.67	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.4
1970	35.12	23.53	10.50	0.00	8.50	0.00	0.00	0.00	0.00	0.00	0.00	5.49	83.1
1971	36.72	25.07	16.36	0.00	14.70	0.00	0.00	0.00	0.00	0.00	1.83	11.96	106.6
1972	15.19	5.27	13.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.1
1973	22.73	9.65	7.13	35.63	20.08	0.00	0.00	10.70	11.13	0.90	27.26	63.03	208.2
1974	26.12	16.80	4.81	10.09	7.16	0.00	0.00	0.00	0.00	8.44	34.30	4.17	111.9
1975	14.93	23.74	33.98	17.33	22.62	0.00	0.00	0.00	11.95	23.29	23.45	3.22	174.5
1976	15.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.8
1977	4.32	58.06	18.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	80.4
1978	30.98	12.44	32.50	0.00	26.38	45.05	9.42	12.38	1.67	0.00	21.42	13.52	205.8
1979	5.80	28.87	11.53	5.52	16.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68.2
1980	5.16	11.79	0.00	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.44	23.0
1981	34.45	14.70	0.00	0.00	8.61	0.00	4.99	0.00	0.35	0.28	44.99	26.73	135.1
1982	35.05	15.39	0.00	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.3
1983	7.16	18.53	2.19	10.59	9.73	0.00	0.00	0.00	0.00	0.00	0.00	3.77	52.0
1984	42.81	8.09	30.60	12.78	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	94.5
1985	0.00	33.13	34.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.05	0.00	81.9
Mean	21.19	16.57	10.90	4.67	6.18	2.12	1.24	0.70	0.70	1.98	6.60	7.74	80.6

Note: Simulation based on a cropping pattern of 4272 paddy/4272 soybean/500 mungbean.

Source: Harza report, by R. Elmore, 1989; updated by J. Frey, 1990.

Table V-2

Simulated Irrigation Releases to Combined Service Areas of Batujai Kiri and Kanan (MCM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1950	0.00	1.45	6.10	2.79	3.78	0.00	4.61	0.41	0.55	0.00	5.48	10.39	35.56
1951	0.00	0.00	6.55	2.37	4.52	0.31	5.82	1.25	0.60	1.24	5.77	13.88	42.81
1952	1.30	1.50	2.33	4.46	2.87	7.58	5.82	1.25	0.60	0.98	5.48	13.17	47.34
1953	1.50	2.37	2.20	3.06	1.35	7.58	4.93	1.25	0.60	1.24	5.48	7.40	38.96
1954	0.00	7.76	5.48	0.00	0.83	7.38	5.82	0.50	0.60	0.71	5.59	8.94	43.61
1955	0.00	0.00	1.84	1.22	0.00	0.00	0.00	0.92	0.56	0.21	5.48	10.16	20.39
1956	0.00	2.61	7.35	3.30	0.00	0.00	1.14	0.59	0.50	0.82	5.63	10.16	32.10
1957	0.00	0.00	0.00	4.46	1.78	7.45	0.98	1.17	0.60	1.24	5.78	12.00	35.46
1958	7.27	0.00	6.28	3.62	3.22	3.32	3.35	1.08	0.60	0.96	5.97	7.55	43.22
1959	0.00	2.08	0.00	3.47	0.47	3.91	5.82	1.25	0.54	1.24	5.52	7.20	31.50
1960	0.00	4.02	2.51	1.25	0.00	7.58	1.46	1.25	0.59	0.65	5.48	14.79	39.58
1961	0.00	0.00	5.88	1.20	4.49	7.51	5.77	1.24	0.60	0.81	5.51	16.89	49.90
1962	0.00	0.00	7.66	0.00	4.42	7.31	4.72	1.25	0.60	0.87	5.90	8.56	41.29
1963	0.00	7.76	1.49	3.84	4.52	6.59	5.82	1.25	0.60	1.19	6.05	12.97	52.08
1964	5.70	6.98	4.73	3.28	4.24	7.58	5.82	1.25	0.46	0.00	5.48	13.75	59.27
1965	0.00	5.28	4.42	3.03	4.35	7.58	5.82	1.25	0.60	1.24	5.58	12.28	51.43
1966	4.54	1.55	2.73	3.26	0.58	6.53	5.82	1.25	0.60	0.91	5.52	7.98	41.27
1967	0.00	9.17	2.55	4.26	4.52	7.58	5.82	1.25	0.60	0.99	0.94	8.87	46.55
1968	0.00	0.00	4.60	1.94	0.00	0.00	0.00	0.72	0.60	1.12	5.63	5.00	19.61
1969	8.18	6.30	0.00	1.60	0.00	7.58	5.82	1.25	0.59	1.15	6.06	13.37	51.90
1970	0.00	1.21	3.97	2.93	0.00	6.73	5.82	1.25	0.22	0.96	5.48	10.32	39.49
1971	0.00	0.00	5.57	3.35	0.00	7.25	5.82	1.25	0.53	0.06	5.84	11.85	41.52
1972	1.70	2.47	0.00	2.20	0.00	7.58	5.82	1.25	0.60	1.24	5.48	9.98	38.32
1973	0.00	2.76	0.00	1.63	0.00	7.58	4.25	0.90	0.19	0.81	5.98	7.37	31.47
1974	0.00	0.00	4.68	4.46	0.00	6.33	3.77	1.02	0.22	0.00	5.48	12.74	38.70
1975	4.69	1.21	0.64	2.64	0.00	6.99	4.67	1.21	0.30	0.00	5.48	13.95	41.78
1976	5.25	7.95	7.39	4.32	4.07	7.38	5.82	1.12	0.60	1.12	5.90	15.80	66.72
1977	0.00	0.00	3.35	3.66	4.52	7.58	5.82	1.25	0.60	1.24	6.04	13.98	48.04
1978	0.00	0.00	0.00	3.35	0.00	0.00	0.00	0.13	0.52	0.62	5.48	4.82	14.92
1979	2.16	0.00	3.49	3.18	0.00	5.02	5.82	1.15	0.60	1.24	5.49	12.97	41.12
1980	0.00	1.93	4.95	1.19	3.47	7.58	3.35	0.97	0.60	1.18	5.48	8.03	38.73
1981	0.00	0.00	8.99	2.33	0.00	5.28	0.00	1.16	0.41	0.91	5.48	9.98	34.54
1982	0.00	3.54	4.15	1.89	4.52	7.58	5.82	1.25	0.60	1.15	6.03	8.44	44.97
1983	0.00	0.00	7.35	3.06	0.00	7.38	5.82	1.25	0.60	0.45	5.48	14.71	46.10
1984	0.00	1.59	0.00	0.81	0.00	7.58	5.82	1.25	0.00	0.68	5.48	12.16	35.37
1985	8.59	0.00	0.00	2.74	3.15	0.44	3.04	1.25	0.60	1.24	5.50	14.71	41.26
Mean	1.41	2.26	3.59	2.68	1.82	5.60	4.35	1.09	0.52	0.85	5.51	11.05	40.75

Note: Simulation based on a cropping pattern of 4272 paddy/4272 soybean/500 mungbean.

Source: Harza report by R. Elmore, 1989; updated by J. Frey, 1990.

Land Resources

Land Use

Most of the land to be irrigated under this project is already dedicated to agriculture, and nearly all of it produces only wet season crops. Land use in the project area is not expected to change considerably upon provision of irrigation as much of the area is currently cultivated as bunded lowland.

With the development of a technical irrigation system, some areas of the project area will be devoted to new canals, drainage, and inspection road development. Engineer estimates place this amount of land at 1.3 percent (12.5 ha) of the service area. The secondary supply canal for the project will total about 14.2 km in length and about 4 to 6 m in total width (including the service road), thus consuming approximately 6.0 ha of land, much of it now in agriculture or along the field fringes. The tertiary and quaternary system will also take strips of land (approximately 5.0 ha) from the edges of fields. The project drainage system will require some land (approximately 1.5 ha) now in agriculture, but will attempt to utilize existing drainage routes whenever possible. The exact amount required has not been calculated but certainly the distribution of land taking will be very broad. The land lost to canals will more than be made up for by the increased production brought about by the irrigation scheme.

Soils and Erosion

Soil Chemistry. No significant changes in soil chemistry are expected to occur within the project. Increased soil moisture is the general objective of the project, of course, to be accomplished in a controlled manner. Waterlogging and the attendant salinity problems are not common in Indonesian irrigation projects, due partly to the requirements of rice soils, partly to high pH, and partly to the use of effective drainage systems.

Erosion. Erosion is not expected to become a serious problem in the Batujai Kiri irrigation area. Almost all the land has long been cleared and converted to agriculture, so soil loss should not occur as it would in newly cleared forest land. Any additional bunding of land for paddy will serve to conserve soil.

A serious source of canal bank erosion is the use of the channels for laundry, personal bathing and watering livestock. Additional availability of water in the dry season is likely to lead to an increase in this activity, to the detriment of the canals.

Agricultural Practices

Cropping Patterns. Emergent cropping patterns are dependent on several factors:

- dependable water supply for crop requirements
- land and soil suitabilities
- crop marketing and profit potential
- labor, livestock and input sufficiency
- social acceptance and traditions, and
- government policy

Farmers in Indonesia (as in most parts of Asia), when provided with plentiful irrigation supplies, typically show an initial preference for paddy production. This crop choice is based on several factors: farmer experience in paddy culture; paddy being seen as an essential to family food security; historically widespread demand for this food staple; and in the past several decades, government support in promoting cultivation and guaranteed markets. Irrigated paddy cultivation also tends to generate higher and more stable returns per area cultivated than most crop alternatives under presently employed technologies.

The envisaged Batujai Kiri Project will divert water which can be distributed on a supplemental basis in the wet season, and further provide water for an irrigated crop in the dry season. Because of farmer cultivation preferences and the relatively abundant supply of rainfall from December through February, paddy is the crop of choice for the wet season. Beyond the wet season, the choice of crop mixes and extent is highly sensitive to the availability of water. Early hydrology analysis indicates that there is insufficient water to reliably serve all of the Batujai Kanan and Kiri areas for irrigated paddy in the second season. The major secondary crop already cultivated in the second dry season in the irrigated Batujai Kanan is soybean. According to agricultural officials, the soils existing in the project area are suitable for cultivation of soybean, and the marketing channels are already well developed for this crop. Another secondary crop quite suitable for cultivation in the area is mungbean.

A number of cropping patterns have been analyzed hydrologically to ensure reliable irrigation supplies are sufficient to meet full crop water requirements four years out of five. They provide several alternatives for planners. From a purely economic point of view, the crop patterns with second season

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paddy achieve a higher value for the entire irrigable area. However, only the cropping pattern with second season, palawija cropping, attains a fully irrigated area during the second season, and a cropping pattern surpassing 200 percent for both the Batujai Kanan and Kiri commands (Table V-3). So while the value of the Paddy/Palawija/Palawija cropping pattern may be slightly less than patterns with second season paddy, there are strong arguments for introducing a Paddy/ Palawija/Palawija pattern from an operational and equity basis.

Table V-3

Irrigable Areas and Cropping Intensities

Cropping Pattern	Area (ha) by Season I	II	III	Cropping Intensity
Paddy/Paddy/Palawija	4,272	2,500	400	168%
Paddy/Paddy-Palawija/Palawija	4,272	3,000	500	182%
Paddy/Palawija/Palawija	4,272	4,272	500	212%

Note: Calculations based on full crop water requirement being met in four out of five years.
Source: Elmore, "Study of Results of Water Availability for Batujai - Surabaya Subproject", November 1989, Harza Engineering Company, p.15.

Agricultural Practices and Yield Levels. Recommended agronomic practices for cultivation of the proposed irrigated crops will require intensified efforts by farmers both in application of inputs and labor.

Average farm input requirements per ha with project are depicted in Table V-4. The use of inputs in crop cultivation is seen as increasing considerably with the provision of stable water supplies. Application of fertilizer under current rainfed conditions can be risky and counterproductive. Fertilizer use without timely application of controlled water can result in damage to developing plants. Timely application of water supplies eliminates the risk associated with uncertain rainfall and thus provides greater security and returns for farmer investment in agricultural inputs. Increased use of agrochemicals is also foreseen with the provision of irrigation. Quantities used will roughly double over current usage rates and the extents covered will be larger due to the increased cultivable areas achievable with irrigation.

For most cases, increases in labor and draft requirements are also foreseen in cultivation under technical irrigation. The exception to the preceding statement is in the case of paddy GORA cultivation. Due to dropping the intensive nature of land preparation by hand in paddy GORA, total labor requirements for paddy cultivation are seen as actually declining with the provision of irrigation and the return to traditional transplanted paddy. At the same time, the demand for draft animals is expected to increase.

The with-project input packages are derived from discussions with local agricultural specialists from government and university, and from recommendations made in agronomic reports for the area.

Table V-4

Batujai Kiri Farm Input With Irrigation

Farm Input	Unit	Paddy	Mungbean	Soybean
Seed	kg/ha	30	25	40
Fertilizer				
Urea	kg/ha	300	75	75
TSP	kg/ha	100	100	100
KCl	kg/ha	100	50	50
Insecticide	lt/ha	2	2	2
Rat Poison	kg/ha	2	1	1
Labor	work days	200	80	90
Draft	team days	16	8	8

Source: Agricultural Extension Center (WKBPP), Penunjuk, 1990.

Yield levels with the project are expected to rise with: (1) stabilized water supply; (2) use of high-yielding varieties of quality seed; (3) increased application of water-complementary cultivation inputs; and (4) improved cultural practices (Table V-5).

Table V-5

Forecast Crop Yields With Irrigation In Batujai Kiri

Crop	Yield with-Project (tons/ha)
Paddy	4.5
Soybean	1.1
Mungbean	1.0

These crop yields are conservative in comparison to Department of Agriculture standards of production. Paddy yields attained at various demonstration plots in the area reportedly average between 6 to 8 tons per ha according to statistics provided by agricultural officials at the Penujak Agricultural Office (BPP). Average NTB yields for all soybean and mungbean production, rainfed and irrigated, are at 1.0 and 0.7 tons respectively. Both NTB and University of Mataram agricultural officials claimed that yields under irrigated conditions as high as 1.4 and 1.2 tons per ha for soybean and mungbean, respectively, were not unrealistic.

Under a cropping intensity of 200 percent Paddy/Palawija/Palawija, it is estimated that the Batujai Kiri area would produce 4,400 tons of paddy and 1,100 tons of soybean annually.

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 from fertilizers demonstrably improved returns with chemical use. The types of fertilizer 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 though 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. Pesticides in rural areas often are not sufficiently protected from accidental ruptures of bags or wetting

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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 pesticides use, other than from a major spill or other accident, seems unlikely, 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, however their use is strictly controlled by the governmental law (INPRES III/1989).

Grazing and Fodder. Livestock density in the area is relatively low. For those livestock that are free-ranging, primarily water buffalo and goats, there should continue to be sufficient feed even with the loss of some grazing land to second and third season crops. The people in the area are accustomed to the cut-and-carry method of supplying fodder to their livestock. As a consequence they plant trees (pohon turi) on the paddy bunds that can be cropped for food, fodder and firewood. The prolonged planting season will also make available more grasses that also grow on the paddy bunds and can be harvested for livestock feed. The loss of open grazing land will force livestock owners to keep water buffalo tethered close to houses or in feed lots, as is done presently during the wet season paddy crop. The tendency toward corralling livestock, which is already seen for horses and cattle, will be reinforced.

The addition of irrigation may also change the demand for draft livestock. Presently, the ground is too hard to plow just prior to the wet season, and many times the farmer breaks it up with hand tools and spreads the seed on the field (GORA method). The fact that some fields will be moist for much of the year may make it possible to plow before the onset of the rainy season. Demand for draft livestock would then increase providing that sufficient year-round fodder is available. It is unlikely that mechanization of field preparation will occur any time soon. The reasons for this include a current high labor supply, high capital costs, operation and maintenance problems, and land topography.

Irrigated Crop Production versus Improved Pasture. 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)[2] on livestock development

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

for Sumbawa may also be applied to Lombok. 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 usable dry fodder for livestock per ha per year. This fodder can consist of paddy straw, soybean and mungbean hay, 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 bonus 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, 2 adult animals per year can be sustained. Assuming a high herd growth rate of 20 percent per year, that would provide 0.4 animals for sale 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.

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).

Biological Resources

Terrestrial Habitat and Wildlife

The introduction of irrigation will result in little change of present land use. Most of the project area is already devoted to agricultural fields and the remainder has been converted to gardens. None of the area remains in a natural state. Commercially important species are primarily those that are grown or tended by the people of the area. It is unlikely under these circumstances that rare or endangered species are present. The presence of water on the fields for much of the year will invite new species into the area or prolong the stay of those that already visit. Since the forest has long ago been cleared, no additional destruction of woodlands will occur, except for perhaps some conversion of garden tree areas to paddy fields. Villagers will continue to take firewood from their usual sources (eg., trees planted along paddy field bunds and along the riverbanks).

Pests

Any intensification of cropping is likely to result in higher and more persistent populations of crop pests. These may be categorized by animal group.

Insects. Back-to-back paddy cropping would be likely to allow insects to maintain their populations from one crop season to another, necessitating higher insecticide use. The proposed paddy/palawija cropping will be less of a problem, since different pests affect the two types of crops.

Birds. No bird species have been identified as special pests of paddy in the Batujai area, but munias and Java sparrows cause considerable damage in other areas where paddy is multiple cropped. Repetitive cropping of paddy, followed by soybeans, allows these grain-eating birds to attain higher populations then they can sustain when forced to seek alternative dry season food.

Mammals. Rodents are the main pests of paddy in the area, taking grain both in the field and in storage. The species involved are different, but the problem parallels that of birds.

The Rice Field Rat (Rattus argentiventer) is the most serious rat pest of paddy in Lombok. It feeds on paddy plants at all stages of development and on the grain heads, causing considerable damage to fields where it is abundant. These rodents have extremely high reproductive potential, rendering them capable of rapid population explosions under [illegible]ble ecological conditions such as those presented by multiple cropping of paddy. The situation may become particularly worse when there is great variation in planting times within one

field complex. In this situation the rats forage quite well, moving from field to field, continuously eating ripening grain.

The Polynesian (or Little) Rat (R. exulans), and the House (or Black) Rat (R. rattus), also are agricultural pests. Although they are more prone to taking stored grain and other foodstuffs, these two species enter paddy fields when other food is scarce and may do considerable damage. They live in or near villages and farmsteads, causing damage to many different types of foodstuff. The Rice Field Rat, on the other hand, lives in burrow systems in the paddy field dikes, which may be damaged, to the extent of being washed out, by water passing through the burrows. Rice Field Rats can be more easily killed by communal hunts for them over the whole field complex.

Disease Vectors. The principal disease vector that benefits from year-round irrigation is the mosquito, which tends to breed in stagnant drains and field edges. The incidence of malaria in Lombok is already fairly high. Some increase in the vectors of malaria may occur with more widespread surface water availability. There is reportedly no dengue fever in the area.

Aquatic Habitat

Reservoir. Since the reservoir's completion, aquatic weeds have proliferated to the point that they now cover a significant portion of the reservoir (6 percent). To some extent they do provide benefits in the form of a habitat for fish and other wildlife, as well as a nutrient sink for the sewerage and fertilizer that flow into the reservoir. The disadvantages of water weed overgrowth include interference with fishing and boat traffic. With regard to reservoir operation, they increase siltation by trapping suspended solids, and can more than double the normal evaporation rate. Both of these factors decrease the amount of water available for irrigation.

Fisheries. The reservoir promotes a varied and productive fisheries. The downstream irrigation affects the fishery in as much as it draws down the reservoir volume from a maximum of 24.8 MCM (890 ha) to a minimum of 1.3 MCM (100 ha) in dry years. The Department of Fisheries (personal communication) estimates that 250 ha (4.5 MCM) is the minimum area necessary to maintain the present fisheries. During the past seven years records show that the reservoir areas has dropped below 250 ha only three times, and only for a couple of weeks at each time.

The addition of the Batujai Kiri Irrigation Project will not tend to increase the likelihood and duration of suboptimal reservoir volume for the fishery. However, a 36-year simulation of both the Batujai Kiri and Kanan irrigation demands (Elmore, 1989) indicates that the reservoir area will drop below 250 ha a total of 70 months in 15 years occurring during dry years. In fact, for 50 months in 11 years the reservoir is at its minimum operating level of 100 ha (1.3 MCM).

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This drawdown will most likely put a strain on the fisheries and decrease production. Unfortunately, little is known about the reservoir fishery other than annual catch levels, and it is therefore difficult to give quantitative estimates of potential loss. Lake Tempe in South Sulawesi varies in area by as much as 35,000 and 1,000 ha between wet and dry seasons, and yet supports an annual average production of 600 kg/ha (Whitten, et al., 1988), as compared to Batujai reservoir at about 425 kg/ha/yr. Tilapia species such as Oreochromis mossambicus and O. niloticus are especially hearty and would probably surpass other species under stressful conditions. Under circumstances of reduced volume, overfishing and concentration of pollution would probably deplete population as much as the loss of habitat. Obviously, more needs to be known about the fishery population, recruitment and production before the potential impacts of reservoir drawdown can be definitively assessed.

Canals. 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 the irrigation 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 types of waste nourishes plant life. Pest plants are of several varieties: 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. The increase in canal area will almost certainly produce more potential mosquito breeding sites.

Socioeconomic and Cultural Resources

The primary objective of this project is an increase in the living standard among local farmers through the provision of water for multiple-crop agriculture. The economic benefits of improved agricultural production will be unequally distributed among members of the population, some of whom will receive direct benefits and others of whom will receive secondary benefits or even adverse effects. For the purpose of considering these secondary effects, which are generally considered "environmental", due to their not being the main objectives of the project, the local population may be considered in several categories (USAID, 1980):

1. Target Population. These are the group to whom the projects benefits are directed, in this case, farming households that will receive additional irrigation water.

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 effects, such as loss of resource, deprivation of an amenity, or even some minor inconvenience.

3. Migrant Population. This category includes both immigrants to the area, 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.

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2. Opportunities to enhance the use of a resource through secondary applications of 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 workforce 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 maintenance, or misuse by the local population.

This section on socioeconomic effects deals with both the effects 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 may have effects on the health or economic status of the local people.

At-Risk Population

Farmers and others who do not receive the direct benefits of the project will, nevertheless, obtain some secondary benefits. Their labor probably will bring more income if they hire out--many farmers in this category do not have sufficient land for complete subsistence--and the natural products with which they augment their income, such as thatch, woven mats, and firewood, will see increased demand as the target farmers find themselves with less time for off-farm activities.

Also included in the at-risk population are those who may be negatively affected by the project. In the case of the Batujai Kanan Irrigation Project, this group is significant. They include the farming population of Batujai Kanan, who will have to change their cropping pattern from the current paddy/paddy/palawija, to paddy/palawija/palawija. The at-risk population also includes those residents of Praya Town and adjoining areas to the reservoir, who may have to move to avoid being flooded when the reservoir is raised to its maximum height.

Target Population

Settlement Patterns and Movements

One positive factor of the project is that there is no major relocation of any people necessary for the purposes of project construction. At most, a few houses may have to be moved over a few meters to be out of the way of the canals as they pass near the edges of hamlets.

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The presence of irrigation, on land now farmed on a rain-fed basis, may lead farmers from other areas, especially those nearby, to attempt to buy into the Batujai Kiri area. This would elevate land values and lease rates but mainly only for lands in the project service area. It is unlikely that owners of the improved lands would sell, since the increase in production would be greater than what they could make on a one-time sale of land.

Sharecropping farmers probably will find that part of the gain that they acquire through irrigation will be shared with the landowners. Nevertheless, the tenant will see substantial benefit.

Increased agricultural activity in the area is likely to provide work to the agricultural laborers who now live in the area, and be a stabilizing force to the area. Given the current high labor demands under the GORA system, there is already a large labor supply in the area; in fact, the area is overpopulated. It is unlikely that with irrigation there could be a much more increased demand for labor than what already exists; rather, a reallocation of the timing of peak labor demands will change with the introduction of technical irrigation.

Increased agricultural production and cash flow may lead some entrepreneurs to relocate permanently in the area. Initially, these are likely to be vendors who sell food, clothing and other items at the weekly market in Praya, but others may follow.

Public Health

Vector-borne Diseases. With the possible increase in mosquitoes will come an increase in the risk of malaria and other vector-borne diseases. The risk tends to be lower when water is used conservatively, which it is when scarce, and there is a higher risk when water is allowed to stand in drains or fields. The area is reportedly still free of dengue fever, but this may spread rapidly if ever introduced to the area.

Other Water-related Diseases. The risk of increase in water-related diseases will depend in large measure on the reaction of a population accustomed to dry season water (limited to pools in the river bed), to a greater availability of purer water in the canal system. It seems likely that intestinal and parasitic diseases, poliomyelitis, and typhoid will decrease as people utilize the purer water source.

Reportedly many of the local population are still lax about boiling drinking water and continue to doubt its efficacy in disease prevention. Until this simple procedure becomes widespread, it seems likely the population will continue to suffer from many preventable water-related diseases.

Regional Economics

Target Population. Farmers in the Batujai Kiri service area, experiencing increased disposable income, will spend much of it locally, on food, clothing, and home improvements. Some of the disposable cash will be spent on agricultural improvements, such as mechanized implements.

Greater affluence in a population generally results in non-economic improvements: better nutrition, increased awareness of health risks, with more demand for health services and pharmaceuticals, and more attention to education.

Land Ownership. Given that the population should experience significant increases to their income, it is expected that the farmers will prefer to have their more valuable land surveyed and registered under modern terms of land tenure. It is expected that there will be a cadastral survey (ideally based on aerial photographs) and a land registration program (PRONAS) in the near future. Conversion to a modern system of land tenure should also be followed by adjustments to the current system of land taxation and result in significant increases in the district's source of tax revenue.

Services, Infrastructure and Social Organization

Improved living standards and more economic opportunity in the target population probably will result in some of the younger farmers remaining in the area rather than out-migrating. Other farmers will move into the area because of irrigation development, although, given current high population densities, this is likely to be limited. Traders and middlemen will establish more shops and services as trade increases.

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

Resource Use

Water: Quantity. The seasonal lack of water in the Penujak River is now a considerable source of hardship for some of the people of the area. Conditions with the project should be no worse, and probably even improved throughout the year. There will also be increased availability of water in the canals and drainage system. Water uses now accomplished in the river, such as personal bathing, laundry, and the all important watering of livestock, will shift to the main and secondary canals. This shift, especially the watering of buffalo, will severely degrade the canal banks unless preventive steps are taken. Use of planned personal washing points in the canals and turnout washing points for water buffalo must be enforced.

Farther downstream, within the service area, the project will increase dry season flows through the discharge of irrigation return flows. This water, although of poor quality, may augment the meager pools that are now used for dry season bathing, laundry, and livestock watering.

Quality. The water available to most of the population in the canal system will be of superior quality to that obtained from river pools during the dry season, but probably inferior to the well water used during the wet season.

Other Resources. The improved levels of disposable income and standard of living in the project area may lead to home expansions or improvements that would place a demand on timber and other local forest resources. The number of such improvements is not likely to be great enough to severely stress local forest resources, however.

Effects of Project Alternatives

No Action Alternative

The pressure of a continually increasing population in an area that is already densely settled, dependent on a land resource with limited irrigation and an unreliable water supply, would lead to greater poverty and lower living standards in an area where the people are already very poor. These pressures would induce the younger members of the communities to continue to emigrate in search of wage labor or better farming conditions. Given the limited resources of the Province, and particularly the south part of Lombok island, it is difficult to envision where these people might easily relocate or find work. Most are acutely ill-prepared to find work in an urban environment on an another island.

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

Alternative Technologies

Water Sources. One alternative water source in the region--ground water--is not sufficient to meet irrigation needs, so that pumping ground water is not viable. Another option--pumping water from the reservoir--would only be able to service some limited areas adjacent to the reservoir. Any pumping directly from the river would be limited to a few places as well.

Water Management. Effective management of existing surface water resources could not, of itself, improve the agricultural situation, since the river is too seasonal and its year-to-year fluctuation too great for reliable irrigation.

Design Alternatives

Location. There being no downstream dam sites in the basin that offer the possibilities of the selected one, no environmental effects will be postulated for such alternatives. The siting of the access road is fairly well fixed, but the environmental effects of the alternate routes would not be greatly different from those of the current plan.

Selection of the service area on other than topographic, soils, and geographic bases really is not possible if the project is to function. The environmental effects of alternative command area selections would be about the same as those of the proposed area.

Scheduling Alternatives

The effects of scheduling the project so as to stretch it out over a longer period would resemble those of the no action alternative, i.e., continued poverty for the part of the target population not receiving water and, possibly, shifts of people within the area to take advantage of irrigation water.

Alternative Uses of the Reservoir Water

South Lombok has been defined as a tourism development area. Future construction of large hotels may require that some reservoir water be piped to the south coast. This subject is still under discussion and there are no known firm plans.

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TABLE V-6
SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS
BATUJAI IRRIGATION PROJECT

ENVIRONMENT COMPONENT	DESCRIPTION OF IMPACT	SOURCES OF IMPACT		IMPACT LOCATION			TIMING OF IMPACT			EXTENT OF IMPACT			REMARKS
		PRIMARY	ASSOCIATED	CATCHMENT AREA	IRRIGATION AREA	DOWNSTREAM AREA	PRE-CONST.	CONST.	OPER.	UPON?	DURATION	INTENSITY	
WATER AND ATMOSPHERIC RESOURCES													
Water Quantity	Loss of reservoir storage	Sedimentation of reservoir	Deforestation, Urbanization, Overgrazing, Unsuitable Irrigation Techniques	X			X	X	X	Beneficiary farmers	Long-term	Minor to severe	Water shortages could destroy P/L benefits
	Water diversions to other systems	Competing demand for water	Water shortage	X	X	X	X	X	X	Beneficiary farmers	Long-term	Minor to severe	Competition for water needs to be settled equitably
	Reduced availability in river below dam	Water diverted from river to canal			X		X	X	X	People along river	Long-term	Minor	Irrigation return flow provides water to river
	Increased recharge of ground water	Percolation of irrigation water	Runoff and drainage		X	X			X	Groundwater and springs	Long-term	Minor to moderate	Project will improve recharge in dry season
Water Quality	Reservoir water pollution	Agricultural runoff	Domestic sewage	X	X	X	X	X	X	Downstream water users	Long-term	Moderate to severe	Pollution already a problem, not due to project
	Irrigation water pollution	Reservoir water pollution	Chemical and waste discharge into canals		X	X			X	Project beneficiaries and downstream population	Long-term	Moderate to severe	Water in system only as good as its source
	Downstream pollution	Quality of river water	Chemical and waste discharge			X			X	Downstream population	Long-term	Moderate to severe	Assimilative capacity of river is low
	Ground water contamination	Chemical and waste discharge	Percolation of irrigation water		X	X			X	Irrigation area and downstream	Long-term	Unknown	Likely to affect domestic water supplies
Air Quality	Increased dust	Construction activity			X			X		Irrigation area	Long-term	Moderate	Mitigation involves contractor dust control (road watering)
	Increased smoke	Burning slash and litter			X				X	Irrigation area	Long-term	Minor to moderate	Slash burned when intensive cropping leaves no time
LAND RESOURCES													
Land Use and Capability	Loss of farm land	Construction of canals, roads			X			X	X	A few landowners	Long-term	Minor	Unavoidable. Small part of total area
	Less grazing land	Multiple cropping			X			X	X	Livestock in irrigation area	Long-term	Minor to moderate	Area lost partially made up for by improved fodder quality on irrigation area water ground
Agriculture	Increased production	Multiple cropping	Dependable water supply		X				X	Irrigation area and Batujai Kanan irrigation area	Long-term	Moderate to major	Water to Batujai Kiri will require running back water to Batujai Kanan
BIOLOGICAL RESOURCES													
Aquatic Habitat	Proliferation of Aquatic weeds in canals	Increased nutrients	Inadequate maintenance		X				X	Irrigation area	Long-term	Minor to severe	Depends on maintenance
	Increased numbers of mosquitoes	Increased breeding sites with irrigation			X				X	Resident Population	Long-term	Minor to moderate	Malaria and dengue fever may increase
SOCIOECONOMIC RESOURCES													
Settlement Patterns and Movements	Increased population and immigration	Economic opportunity	Overpopulation in Lombok		X			X	X	Resident Population and migrants	Long-term	Moderate	Unavoidable
Community stability	Disruptions of social patterns	Influx of temporary construction workers			X			X		Resident population	Short-term	Moderate to serious	Mitigation requires contractor cooperation, local involvement
Services and infrastructure	Increased demand for svcs. and infrastructure	Improved economy	Increased population		X			X		Resident population	Long-term	Moderate	Unavoidable
Land ownership	Cadastral survey and modern land titles	Intensification of farming	Improved value of land		X			X	X	Beneficiary farmers	Long-term	Major	Project will result in new land values; improved tax base
Public health	Increased disease vectors	More mosquitoes	Lack of vector prevention		X				X	Resident population	Long-term	Moderate	Control required
Farm Support Organizations	Increased demand for farmer organizations	Need to operate systems			X			X	X	Project beneficiaries	Long-term	Intensive	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.

Pre-construction

The irrigation and drainage canals will take approximately 12.5 ha of predominantly agricultural land or 1.3 percent of the total service area. Of this area, 6.0 ha will be secondary canal and service road, for which some type of compensation will have to be given to the owners. As for the

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remainder of the land, the villagers are expected to donate it at their own expense. Negotiations for the land must be conducted in a fair and expedient manner, otherwise the project could be delayed and ill-feelings will be generated among the project area population.

Construction

There will be some disruption of agricultural activities along the canal route as construction proceeds. The local population will also have to temporarily cope with some noise and congestion. The contractor must provide his laborers with those commodities that are scarce locally, such as housing, water, and firewood. The local population may realize some economic benefits from the sale of services and commodities.

During the construction phase a certain amount of resettlement of people living too close or within the reservoir area will be necessary. Housing and land compensation will be required for those forced to move--if the land is still privately owned.

Water Resources

Reservoir. The Batujai Reservoir, which will supply the Batujai Kiri irrigation water, is the depository for some of the sediment washed from its catchment area. Allowances have been made for siltation in the construction of the reservoir and simulations of irrigation water supply. However, if upstream erosion increases more than anticipated; then, the reservoir's future capacity will be decreased causing a short-fall in irrigation supply. Past measurements of Batujai Reservoir sedimentation rates have yielded conflicting and inconclusive results.

Batujai Kanan Irrigation. The Batujai Kanan irrigation area currently uses most, if not all the reservoir's available capacity. A significant quantity of this water is wasted due to substandard operation and maintenance of the supply canals. A World Bank-funded project is currently underway to correct these deficiencies. Some water will have to be reallocated from Batujai Kanan to Batujai Kiri. In some areas of Batujai Kanan it will therefore be necessary to adapt a lower cropping intensity. Over the total Batujai areas though, the economy and living standards will improve. Probably, these changes are justifiable on the basis of equity.

Water Supply. The water supply will improve for both domestic and livestock needs. The irrigation canal, which will have a flow most of the time, will be a ready supply of water for bathing and livestock watering. Structures will be built in

the canals to accommodate these activities (see Table MA-1). The irrigation water should also recharge some wells that currently go dry in the later part of the year.

Water Quality. Pollution in the form of sewerage and agricultural runoff could have grave consequences for the water quality of the reservoir. Excess nutrients will stimulate the growth of water weeds which will clog the reservoir and lessen its capacity. Concentration of pesticides and pathogens in the water could become a public health concern.

As the use of fertilizers and pesticides increase with the introduction of irrigation water, possible contamination of the ground water and wells has to be considered. Overall, however, water quality from the canals should normally be of better quality than the river.

Land Resources

Agriculture. Agricultural intensity will increase from the present 140 percent to over 210 percent, with the introduction of irrigation. Cropping patterns in Batujai Kiri will expand to include a second crop of palawija over the total 972 ha in addition to the first paddy crop. Crop yields are forecasted to increase 80 percent and 190 percent for paddy and soybean, respectively, due to irrigation water and improved cultural practices. Inputs of seed, fertilizer, pesticides and labor will likewise increase.

Draft Animals. The current supply of draft animals is estimated at about 0.5 animals owned per household, but perhaps 75 percent of all households, in fact, own no draft animals. Demand for draft animals is expected to dramatically increase as farmers switch from the GORA land preparation system, to plowing. It is expected that with intensification of farming, most farming households will eventually acquire their own animals.

Livestock Grazing and Fodder. The areas available in Batujai Kiri for livestock grazing will decrease somewhat as fields that are now fallow in the dry season are converted to irrigated agriculture. The practice of bringing fodder to water buffalo, cattle and horses kept in pens, already seen to some extent in the area, will be intensified. Cropping of grasses and leguminous trees on the paddy bunds will continue to be the predominant source of fodder, and this supply should increase with irrigation water. Demand for water buffalo may even increase as the fields become easier to plow due to a higher year-round moisture content.

Biological Resources

Pests. There is the risk that crop pests such as insects, birds and rodents will increase as a result of the increased intensity of agricultural production. Disease vectors such as mosquitoes that benefit from the presence of stagnant water are likely to increase in population size, followed by a likewise increase in mosquito-borne diseases such as malaria and dengue fever.

Aquatic Weeds. The continued proliferation of aquatic weeds on the reservoir's surface could eventually decrease its efficiency and the volume of water available for irrigation. Siltation and evaporation will both increase in the reservoir as a result of the weeds. Aquatic weeds in the canals will decrease flows and provide additional breeding sites for mosquitoes.

Fisheries. The reservoir's surface area and volume will fluctuate considerably from wet season to dry season and from year to year in response to rainfall and irrigation demand. In some years the reservoir will drop to 6 percent of its maximum operating volume and 12 percent of its maximum operating area. This is likely to have an impact on the reservoir's fisheries so as to decrease potential production. More must be known about the fishery before the magnitude of any loss can be predicted.

Socioeconomic and Cultural Resources

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

Settlement Patterns and Movements. The high demand for labor with technical irrigation should not be much different from the current high labor demands, although the timing of work and some of the tasks will change. It is expected that the current oversupply of labor available in the area would be utilized rather than bringing more people into the area, although a few may come seeking work.

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

Regional Economics. Income and living standards should improve with the project. There will probably be an increased demand for a cadastral survey and land registration under the modern

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system. Land values will increase, as well as the potential tax base for the area.

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).

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 area.

Domestic fuel use will increase, and at least at first, the demand for fuel wood will increase. As there are very few fuel wood resources left in the area, the population will either end up further depleting current resources or resort to purchasing fuel wood from other areas.

In summary, construction of the Batujai Kiri system would complete the left bank of a system whose right bank has been in operation for more than eight years. Completion of the left bank would bring more balance to the living standards of the area, where left bank farmers have watched as the living standards of their neighbors on the right bank have improved, while they have stagnated.

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CHAPTER VII

CONCLUSIONS

The Batujai Kiri Irrigation Project will construct a series of canals from the existing Batujai reservoir (established in 1982), and Batujai Kanan main canal to supply water to a service area of 972 ha. The project will boost the service area's cropping intensity which is currently at 140 percent to approximately 210 percent.

Much of irrigation water supply of the reservoir is currently being diverted to the Batujai Kanan irrigation scheme. Some of this water will be reallocated to Batujai Kiri. Although part of this reallocated water can be made up by improving the efficiency of the Batujai Kanan canal operation, the cropping intensity in Batujai Kanan will decrease due to water being diverted to Batujai Kiri, and the cropping pattern will become paddy/palawija/palawija.

Other potential environmental impacts of the project include additional recharge of the ground water aquifers, generally improved water availability and access to water, a small portion of agricultural land being used for the project canals, perhaps a few houses in the service area moved a few meters where canals run close to hamlets, some disruption during construction, decreased dry season grazing areas for livestock, possible contamination of river and ground water supplies, increased crop pests and mosquitoes, and most importantly, substantially improved economic conditions for the local population. A major negative effect will result from filling the reservoir since some houses will have to be relocated and some farm land inundated. Construction of some dikes might mitigate the effect of flash flood and the higher operating level of the reservoir.

Most impacts of the environment on the project concern the operation of the reservoir. Sedimentation, pollution and proliferation of aquatic weeds can all affect (over time) the reservoir's ability to supply irrigation water to the project. Canal banks can be eroded by human and livestock traffic if protective measures are not taken.

Alternatives to the proposed project are limited. If no action is taken, it is doubtful that village-level irrigation schemes could ever provide sufficient water storage on the scale required for effective utilization of the catchment's

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surface water resources. A few hectares might be irrigated from small-scale pumping schemes. There are no other viable technical solutions to the need for more water in this area. There are no downstream dam sites in the basin that are really suitable where the water could reach this service area, and the service area is defined and limited by topography, soils and geography. Lowering the reservoir elevation would reduce project benefits, and raising the elevation would not be technically or economically advantageous. Delaying the schedule would only continue poverty in the area.

Based on these studies, the conclusion of this Environmental Assessment is that there are no major detrimental environmental 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 largely positive environmental benefits for the local population. The few potentially negative environmental impacts are more fully addressed in the Environmental Management Plan.

APPENDIX A

LIST OF PREPARERS

No.	Name	Specialization
1.	Mr. Jeffery P. Frey	Chief-of-Party
2.	Mr. W.P. Schoenleber	Team Leader
3.	Dr. Peter L. Ames	Environmental Scientist
4.	Mr. Douglas C. Kneale	Environmental Scientist
5.	Mr. Robin B. Erickson	Agricultural Economist
6.	Dr. Carol B. Hetler	Social Scientist
7.	Ir. Pamudji Raharjo	Hydraulic Structures
8.	Ir. Terry Haryanto	Irrigation Engineer
9.	Ir. Soekardi P.	Hydrogeologist
10.	Untung Subagio	Geologist
11.	Drs. Richardson Rendak	Socioeconomist
12.	Ir. Agus P. Hendrarahardja	Civil Engineer
13.	Nengah Sukartha, BE	Civil Engineer
14.	Abas	Hydrologist
15.	Ismail Amin	Draftsman

Note: Preparers 1 through 10 are members of the SSIMP Technical Assistance Team; preparers 11 through 15 are PU staff assigned to the project.

APPENDIX B

BIBLIOGRAPHY

Acciaioli, G. n.d. "What's in a Name? Appropriating Idioms in the Implementation of the Rice Intensification Program in South Sulawesi, Indonesia." Unpublished paper delivered at the fourth annual California Universities Conference on Southeast Asian Studies, entitled "Rethinking Development in Southeast Asia," 14 - 15 March 1987, Berkeley.

Blaike, P. and H. Brookfield. 1987. Land Degradation and Society. London and New York: Methuen.

Canter, W. Larry. 1977. Environmental Impact Assessment. McGraw Hill Book Co., New York.

Conway, G.R. 1986. Agroecosystem Analysis for Research and Development. Bangkok: Winrock International Institute for Agriculturel Development.

Crippen International Ltd. 1975. "Lombok Island Water Resources Development, Phase 1," including: Vol.2 "Climate", Vol. 4 "Groundwater", Vol. 6 "Soils" and "Geology."

Davidson, J. 1987. "Strategies for Implementing Social Forestry in West Nusa Tenggara: A Case Study in Southern Lombok." GOI/UNDP/IBRD - Project INS/83/013, PPIPD (Regional Planning Investment Preparation and Experimental Area Development Project for Nusa Tenggara, South East Sulawesi and Irian Jaya).

Duewel, J.W. 1989. "Household Survey (HHS) Report on the Proposed Batujai Kiri/Surabaya Commands."

Elmore, G.R. 1989. "Study Results of Water Availability for Batujai - Surabaya Subproject." SSIMP.

Food and Agriculture Organization (FAO). 1984. "Crop Water Requirements." FAO Irrigation and Drainage Paper No. 24. Rome.

Food and Agriculture Organization (FAO). n.d. "Response to Water." FAO Irrigation and Drainage Paper No. 33. Rome.

Geertz, H. 1967. "Indonesian Cultures and Communities." In: Indonesia. R.T. McVey, ed. New Haven: Yale University Press.

Harvey, M. n.d. "Manual for Implementation of the ANDAL Process." Draft Report. Kantor Menteri Negara KLH, Jakarta.

Hidayat, A. 1978. Methods of Soil Chemical Analysis. Central Research Institute for Agriculture, Bogor.

Hugo, G.T.; T.H. Hull; V.J. Hull, and G.W. Jones. 1987. The Demographic Dimension in Indonesian Development. East Asian Social Science Monographs. Singapore: Oxford University Press, Pte. Ltd.

ILACO B.V. 1985. Agricultural Compendium for Rural Development in the Tropics and Subtropics. Amsterdam: Elsevier.

Indonesia, Government of. Ministry of Transmigration, Directorate General of Settlement Preparation. 1988. Review of Phase 1 Results, Nusa Tenggara. Regional Physical Planning Programme for Transmigration (RePPProt).

Kantor Menteri KLH (Sekretariat Menteri Negara). 1988. Keputusan Menteri Negara Kependudukan dan Lingkungan Hidup Nomor: KEP 02/MENKLH/I/1988 tentang Pedoman Penetapan Baku Mutu Lingkungan. Jakarta.

Kantor Menteri KLH. 1987. Keputusan Menteri Negara KLH No.: KEP 50/MENKLH/6/1987 tentang Pedoman Penyusunan Analisa Mengenai Dampak Lingkungan. Jakarta.

Kantor Menteri KLH. 1987. "Mitigation of Pollution and Damage of the Environment", unofficial translation by the Environmental Management Development in Indonesia (EMDI).

Kantor Menteri KLH. 1986. Peraturan Pemerintah RI No. 29 Tahun 1986 tentang Analisa Mengenai Dampak Lingkungan. Also, in English: "Analysis of Impacts Upon the Environment", unofficial translation by the Environmental Management Development in Indonesia (EMDI/CIDA).

Kantor Menteri KLH. 1982. Undang-Undang Republik Indonesia Nomor 4 Tahun 1982 tentang Ketentuan-Ketentuan Pokok Pengelolaan Lingkungan Hidup. Jakarta.

Kantor Menteri KLH. 1980. Pedoman Pembuatan Analisis Dampak Lingkungan. Jakarta.

Kantor Statistik, Kabupaten Lombok Tengah. n.d. Kecamatan Praya Barat Dalam Angka 1986.

KEPAS (Kelompok Penelitian Agro-ekosistem), Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian. 1986. "Agro-ekosistem Daerah Kering di Nusa Tenggara Timur: Studi kasus enam desa pengembangan pertanian."

King, Ben; Woodcock, Martin; Dickinson, E.C. 1975. A Field Guide to the Birds of South-East Asia.

Mackinnon, John. 1980. Birds of Indonesia. FAO, Bogor.

Merck, Damstadt. 1974. The Testing of Water. 9th Edition. West Germany.

Messi, M.N.; I. Saad; and G. Acciaioli. 1986. "Implementation of the Rice Intensification Program in South Sulawesi: The Case of SidRap." Center for Policy and Implementation Studies (CPIS), Jakarta.

Metzner, J.K. 1982. Agriculture and Population Pressure in Sikka, Isle of Flores: A contribution to the study of the stability of agricultural systems in the wet and dry tropics. Development Studies Centre Monograph No. 28. Canberra: The Australian National University.

National Academy of Sciences. 1976. Making Aquatic Weeds Useful: Some Perspectives for Developing Countries. Report of an Ad Hoc Panel of the Advisory Committee on Technology Innovation, Board on Science and Technology for International Development, Commission on International Relations. Washington, D.C.

Neame, P.A. 1988. "Hydrochemistry of the Lower Solo River, Indonesia." Verh. Internat. Verein. Limnol. 23: 1372-1379.

Needham, J.G. and P.R. Needham. 1963. A Guide to the Study of Freshwater Biology. San Francisco: Holden-Day, Inc.

Oudshoorn, W. 1975. "Lombok Island Water Resources Development Forestry." Technical Report No. 8.

Peace Corps. 1982. "Grazing and Rangeland Development for Livestock Production: A Handbook for Volunteers." Appropriate Technologies for Development, Reprint R-47. Washington, D.C.: Peace Corps.

Pekerjaan Umum, Sub-Dinas Pengairan NTB, Proyek Irigasi Lombok Selatan, Team Site Profile Survey Proyek Proyek Pengairan, NTB. 1987. "RRIA Pada Daerah Irigasi Batujai Kiri dan Saluran Surabaya di P. Lombok." Also in English.

Scott and Furphy. 1985. "Survey on Groundwater in Central Lombok." Rural Water Supply and Sanitation Project. Praya.

Shaner, W.W.; P.F. Philipp; and, W.R. Schmehl. 1982. "Farming Systems Research and Development: Guidelines for Developing Countries." Westview Special Studies in Agriculture / Aquaculture Science and Policy. Boulder, Colorado: Westview Press.

Sir M. MacDonald & Partners Asia; et al. 1990. "Nusa Tenggara Agricultural Development Project; Irrigation Component for West Nusa Tenggara Province: Environmental Evaluation Study Final Report - Main Volume. Mataram.

Sir M. MacDonald & Partners Asia. 1986. "West Nusa Tenggara Irrigation Study: South Lombok Water Balance Final Report," "Hydrometeorological Data Book," "Hydrometerology," and "Irrigation."

Soedjiran Resosudarmo, Kuswata Kartawinata, and Aprilani Sugiarto. 1984. Pengantar Ekologi.

Steenis, CGGJ Van. 1981. Flora. Pradnya Paramita. Jakarta.

Sudarsono. 1983. Kelas-Kelas Tanah Menurut FAO-UNESCO, Jurusan Ilmu-Ilmu Tanah. Bogor: Fakultas Pertanian, Institut Pertanian.

Sudarsono, S., and K. Takeda. 1978. Hidrologi untuk Pengairan. Pradnya Paramita. Jakarta.

Sudjadi, M., Widjik, and M. Saleh. n.d. Penuntun Analisa Tanah. Bagian Kesuburan Tanah. Lembaga Penelitian Bogor.

United States Man and the Biosphere Program; United States Agency for International Development; and R.E. Tillman. 1981. Environmental Guidelines for Irrigation.

United States Agency for International Development. 1980. Environmental Design Considerations for Rural Development Projects. Washington, D.C.

Universitas Mataram, Fakultas Pertanian. 1986. "Action Research: Petak Tersier Pencontohan Gaya Baru D.I. Batujai, 1 Unit 125 Ha." Mataram.

Van der Poel, H.P., and R.F. Schinkel. 1985. "An Appraisal of Farming Systems in 6 Villages on Lombok and Sumbawa." FONC (Forestry/Nature Conservation Project) Project Communication 1985-8. Yogyakarta: Fakultas Kehutanan, Universitas Gadjah Mada.

White, C.M.N., and M.D. Bruce. 1986. The Birds of Wallacea. British Ornithologists' Union Checklist No. 7. London: Zoological Society.

Whitten, A.J.; M. Mustafa, and G.S. Henderson. 1988. The Ecology of Sulawesi. Yogyakarta: Gadjah Mada University Press.

Young, A. 1976. Tropical Soils and Soil Survey. Cambridge: Cambridge University Press.

APPENDIX C

RECORD OF SSIMP ENVIRONMENTAL SCOPING SESSION HELD IN PRAYA, LOMBOK IN DECEMBER 1989

Note: This record was prepared by SSIMP/Mataram shortly after the December 1989 Scoping Session. Some rearrangement of responses to questions has been done in order to bring similar topics together. In addition, the Harza editors have added a few comments on some of the statements made by the meeting participants.

Introduction

In general, the purpose of an environmental scoping session is to inform the project participants of environmental concerns and to identify potential environmental problems that should be studied in greater depth. The results of the scoping sessions and the follow-up studies are then used throughout the project cycle for planning and management purposes, particularly, with regard to efforts to ensure project sustainability.

On 20 December 1989, SSIMP/Mataram held its a joint USAID /GOI Environmental Scoping Sessions for SSIMP site, Batujai Kiri, in NTB Province.

The Batujai Kiri Project session was attended by representatives from several provincial, district, and subdistrict level Indonesian agencies, including PU, BAPPEDA Tk. II, Agricultural Services, Land Affairs (formerly Agraria), Forestry, Fisheries, Transmigration, Health, Village Development, and Animal Husbandry. Representatives from the national level PU, Jakarta, also attended.

Record of the Meeting

The official session began on Wednesday, 20 December 1989, with Mr. Ircham, Bupati of Central Lombok, opening the meeting. Ir. Masnun, Head of the Provincial Water Resources Division, explained current SSIMP-NTB program activities. Ir. Pudji Hastowo, Pimbagpro of Lombok Selatan, briefly described the key features of the project, such as the total area to be irrigated, the size of the affected population, etc. Following this, Dr. Peter Ames, Harza Environmental Scientist, explained

the rationale, goals, and procedures for the environmental scoping session. He was followed by Drs. Ch. Nasir from PU, Jakarta, who explained the new GOI regulations (AMDAL), a policy change that requires project analysis of environmental, as well as technical, economic, and management issues.

Ir. Wahju Djoko, M.Sc., SSIMP-NTB Coordinator, led the discussion, which is summarized below.

I. Water Resources

A. Water Quality Testing
B. Dry Season Planting
C. Water Hyacinth as Animal Feed

Questions/Statements and Answers:

1. Statement: Water sampling will be done in seven (7) locations (upstream and downstream) by the end of this month (Ir. Wahju Djoko, MSc).

2. Statement: The water quality (based on the sampling done in this study) was considered adequate for the purposes intended, but this did not include the standards necessary for fisheries.

3. BAPPEDA TK. II: There is not enough water during the dry season, so could the farmers use the drawdown area in the reservoir for planting?

   Response: They may use the drawdown area for planting as long as they take care of the surroundings (Ir. Pudji Hastowo).

4. Animal Husbandry: Don't you think that water hyacinth can be given to animals?

   Response: That needs to be assessed. We don't know if livestock will find any feed produced acceptable (i.e., taste), or what nutritional standard it might meet (Dr. Peter Ames).

II. Land Resources

A. Farmer Organizing
B. Land Acquisition

Questions/Statements and Answers:

1. BAPPEDA TK. II: Don't you think that new farming systems and a new irrigation system will increase the farmers

income? How can they do this while they don't have any information/knowledge about it?

Response: Certainly, they will earn more and we plan to place WUAOs in this area in order to help the farmers (Ir. Gunawan).

2. Agraria: We have some problems with land acquisition because private land and ownership data are not available.

Response: A schedule for land acquisition should be made, Dispenda had to work together with Land Affairs and use the same data source.

III. Biological Resources

A. Types of Environmental Studies
B. Fisheries

1. BAPPEDA: What about the environmental study for the Pengga Dam Project? Are there any differences? The locations are close to each other.

Response: The environmental studies are different because Pengga Dam is funded by ADB while Batujai Kiri is funded by USAID. The study probably is the same in content but the guidelines are different (Ir. H. Masnun).

2. Fisheries: Stock assessment for fisheries in Batujai Kiri has never been done before.

Response: This would require a special study, with the support of the project and the Fisheries Office (Ir. Pudji Hastowo).

IV. Environmental and Public Health

A. Bathing and Laundry Washing Steps in Canals
B. Agro-chemicals and Water Weeds

1. BAPPEDA: Please do not forget to build bathing steps in the canals.

Response: The project will contact the village head in order to get the right location, and we hope that the people will take care of it in the future (Ir. Pudjihastowo).

2. Animal Husbandry: What is the negative impact of using agro-chemicals and its relation with water weeds? What is the priority scale?

Response: We need input from all of you, regarding your problem, so we can solve them together. That is why we are holding the scoping session here. If you want to know more about water-weeds please contact BIOTROP-BOGOR. You can obtain free books from them (Drs. Nasri).

V. Socioeconomic

A. Local Taxes

1. BAPPEDA: Is it possible to build a restaurant or water sport in Batujai Reservoir?. Local Government planned to do it in order to get income from taxes.

Response: The water surface height of Batujai Reservoir is not constant so it is difficult to build a restaurant, but for recreation it is OK, for instance, fishing, (Ir. H. Masnun).

BATUJAI KIRI ENVIRONMENTAL SCOPING SESSION

LIST OF PARTICIPANTS

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a. Directorate Irrigation I, Jakarta - Drs. Nasri

b. USAID, Jakarta - Ir. Gunawan Wijaya

c. Provincial Water Resources Division, West Nusa Tenggara Public Works:

1. Head, Water Resources Division - Ir. H. Masnun
2. Pimbagpro Lombok-Sumbawa Project - Ir. Pudji Hastowo
3. SSIMP-NTB Coordinator - Ir. Wahju Djoko
4. PILSS Technical Staff - Ir. Surana

d. Technical Assistance (TA) Consultants:

1. Acting Team Leader - W. J. Schoenleher
2. Agro-Economist - R. B. Erickson
3. Environmental Scientist - Dr. Peter Ames

e. Local Government:

1. Head, BAPPEDA Tk. II Loteng - L. Puri
2. Agriculture - Subhan
3. Forestry - Pri Pughu Santoso
4. Fisheries - Sunardi
5. Department of Health - S. Parinda
6. Land Affairs - Nyoman Suartha
7. Horticulture - L. Sukardha
8. Animal Husbandry - Shahabuddin Sadar
9. Village Development (Bangdes) - L. Tayang
10. Regional Government - I Made Praya
11. Regional Development Division - Suparlan
12. Regional Income (Dispenda) - I Putu Tusta
13. Public Works - Anas Mal
14. PU Kabupaten - H. Ramli
15. Head, West Praya Subdistrict - H. L. Mathur
16. Head, Praya Subdistrict - L. Bukran

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PROGRAM OF THE BATUJAI KIRI ENVIRONMENTAL SCOPING SESSION

1.	08:30 - 08:45	: Team visited Mr. Ircham, Head (BUPATI) District of Central Lombok
2.	09:05 - 09:15	: Mr. Ircham opened the discussion of the Batujai Kiri/Surabaya Scoping Session
3.	09:30 - 09:35	: A brief Introduction of the Small-Scale Irrigation Management Project (SSIMP) activities by Ir. H. Masnun
4.	09:30 - 09:35	: Introduction of USAID activities and program, by Ir. Gunawan Wijaya
5.	09:35 - 10:00	: Description of Batujai Kiri-Surabaya by Pimbagpro South Lombok, by Ir. Pudji Hastowo
6.	10:00 - 10:10	: Explanation of Environmental Scoping Session by Dr. Peter Ames, Harza Environmental Specialist
7.	10:10 - 10:15	: Information concerning AMDAL and PIL by Drs. Ch. Nasri, staff of DGWRD, Jakarta
8.	10:15 - 10:30	: Explanation of Environmental Scoping Session by Ir. Gunawan Wijaya from USAID
9.	10:30 - 13:10	: Questions/Statements and Answers of the Environmental Scoping Session led by Ir. Wahju Djoko, MSc.; SSIMP-NTB Coordinator
10.	13:15	: Batujai Kiri Scoping Session closed by Mr. Ircham, Bupati of Central Lombok

APPENDIX D

GLOSSARY AND ACRONYMS

AID	Agency for International Development
AIDAB	Australian International Development Assistance Bureau
AMDAL-Analisa Mengenai Dampak Lingkungan	Environmental Impact Assessment
Amythas, PT	Indonesian Environmental/Engineering Investigations Company
ANDAL-Analisa Dampak Lingkungan	Environmental Impact Study
APBD-Anggaran Pendapatan Belanja Daerah	Regional source for GOI operating budgets
APBN-Anggaran Pendapatan Belanja Nasional	National source for GOI operating budgets
AU	Animal Units
BAKOSURTENAL	GOI national mapping agency
BANGDES-Pembangunan Desa	Directorate of Village Development, under the Department of Home Affairs
BAPPEDA-Badan Perencanaan 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
Cabang Dinas	Branch office

Cipta Karya	Public Works; in charge of urban and some village water supply projects
Cita Prisma, PT	Indonesian Engineering Company
Crippen	Canadian Engineering Company
Desa	A village
DGWRD	Directorate General of Water Resources Development
DIP-Dafta Isian Proyek	Operating budget for a project
DOLOG/SUB DOLOG-Depot Logistik	Provincial food logistics body
DPUP-Dinas Pekerjaan Umum Propinsi	Provincial Public Works Services
Dusun	A village administrative sub-area
EA	Environmental Assessment
EIS	Environmental Impact Study
EMP	Environmental Management Plan or Environmental Monitoring Plan
FS	Farm Survey
GOI	Government of Indonesia
GORA-Gogo Rancah	A direct-seeded approach to planting paddy
Harza	American Engineering Company
HHS	Household Survey
INMAS-Intensifikasi Massal	Massive Intensification, a farm input program
INPRES-Instruksi Presiden	Governmental law
INSUS-Intensifikasi Khusus	Special Intensification, a farm input credit program for groups of farmers with improved infrastructure facilities
IPEDA/PBB	Agrarian taxes

ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature and Natural Resources
Kabupaten	District
Kebun	A garden, usually with some tree crops
Kecamatan	Subdistrict
Kepala Desa	Head of a village
KUD-Koperasi Unit Desa	A village cooperative
KUPEDES-Kredit Umum Pedesaan	General rural credit program
KUT-Kredit Usaha Tani	Farmer credit scheme
Lavalin International Inc.	Canadian Engineering Company
LKMD-Lembaga Ketahanan Masyarakat Desa	Organization for Self-Reliance of the village community (Village community development committee)
LMD-Lembaga Masyarakat Desa	Village Development Council
LP3ES-Lembaga Penelitian Pendidikan dan Penerangan Ekonomi dan Sosial	Indonesian non-governmental organization with expertise in organizing water users' associations
MENKLH-Menteri Kependudukan dan Lingkungan Hidup	Minister of the Office of Population and the Environment
NEPA	(US) National Environmental Policy Act
NTASP	Nusa Tenggara Agricultural Support Project (World Bank/Australia)
NTB-Nusa Tenggara Barat	West Nusa Tenggara
O & M	Operation and Maintenance
Paddy	Rice

Palawija	Non-rice food crops, secondary crop, such as soybeans, mungbean, maize
PB 36, PB 42	Paddy seed varieties
PELITA V	Indonesia's fifth Five-Year Development Plan
PEMDA-Pemerintah Daerah	Regional Government (District, Subdistrict)
Pengairan	Irrigation; generally used in reference to the irrigation division of DGWRD-Directorate General Water Resources Development
Pertanahan	Directorate General of Land Affairs
Pertanian	Ministry of Agriculture
Pertanian Tanaman Pangan	Food crops services
PPL-Penyuluh Pertanian Lapangan	Field extension agent
Peternakan	Livestock Services
PIL	Preliminary Environmental Information Report
Pohon Turi	Trees planted on paddy bunds, cropped for food, fodder, and fuel wood
POM-Penylidikan Obat dan Makanan	Department of Health's testing laboratory
P3A-Perkumpulan Petani Pemakai Air	Water Users' Association
P3SA-Proyek Perencanaan Pengembangan Sumber-Sumber Air	Public Work's project for planning the development of water resources
PKK-Program Kesejahteraan Keluarga	Usually referred to as a village-level women's group
PUSKESMAS-Pusat Kesehatan Masyarakat	Rural public health service
PUSKUD-Pusat KUD	District cooperative office
Ranting, Sub-Ranting Dinas	Sub-branch, "sub"-sub-branch

RePPProt	Regional Physical Planning Programme for Transmigration
Rinjani	Highest mountain of Lombok Is.
RKL	Environmental Management Plan
Rp	Rupiah
RPL	Environmental Monitoring Plan
RRIA	Rapid Rural Irrigation Appraisal
RT-Rukun Tetangga	Neighborhood units of 25-50 households
RWSSP	Rural Water Supply and Sanitation Project (Australian)
Sawah	Lowland, usually planted in paddy
Sir M. MacDonald & Partners, Asia	British Engineering Company
SSIMP	Small-Scale Irrigation Management Project
Tambak	Brackish water fish pond
TK I-Tingkat I	First level of provincial government
TK-II-Tingkat II	Second level of government at district level
USAID	United States Agency for International Development
Waktu Telu	Traditional religion of the Sasak
WHO	World Health Organization
WUA	Water Users' Association
WUAO	Water Users' Association Organizer

Small-Scale Irrigation Management Project (SSIMP)

FINAL REPORT
BATUJAI KIRI IRRIGATION PROJECT
ENVIRONMENTAL ASSESSMENT

VOLUME II

EXECUTIVE SUMMARY
ENVIRONMENTAL MANAGEMENT
AND MONITORING PLANS

December 1990

Prepared by

HARZA ENGINEERING COMPANY

in association with

Development Alternatives, Inc. Global Exchange, Inc.

PT. Wiratman & Ass.

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PART I

EXECUTIVE SUMMARY

Introduction

The Batujai Kiri Irrigation Project will provide reliable irrigation to 972 hectares (ha) in Central Lombok District, NTB Province, by constructing a canal system, using water from the existing Batujai Reservoir, located on the Penujak River. Experts from Indonesia and the United States have reviewed the project plans and concluded that it will accomplish its primary objectives, but that it will have some environmental impacts. 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 project is located within the villages of Penujak, Bondir, Setanggor, Kabol, and Mangkung in West Praya Subdistrict of Central Lombok District, NTB Province, Indonesia. The reservoir catchment lies on the southern slopes of Mt. Rinjani, and the headwaters are at an elevation of approximately 1000 m asl. The service area of 972 ha occupies the area within the valley formed by the Penujak and Mangkung rivers, and is bordered by a road to the north and east, the Penujak River to the west, and by foothills to the south (Figure ES-1).

Limits of the Study Area

The study area for this environmental assessment consists of the Batujai Reservoir and its immediate environs, including the southern end of the town of Praya, the irrigation areas of the Batujai Kanan and Batujai Kiri irrigation systems, and the downstream (proposed) Pengga Dam. The reservoir catchment and its environs was considered to estimate reservoir inflow and the effects of filling the reservoir to capacity. The study area also includes the land and population located within the administrative boundaries of the five villages mentioned above.

Pre-Construction Period

The Batujai Kiri Irrigation Project is an extension of two earlier irrigation projects that left unirrigated some 972 ha of potentially irrigable land, using water from the Batujai Reservoir. The Batujai Kanan Project, to the west of the Project area, was initiated with the completion of the Batujai Dam in 1982. The Surabaya Irrigation Project, to the east of the Project area, receives its water from a weir constructed in about 1938 on the Lekong River about 500 m from that river's entry into Batujai Reservoir. The downstream Pengga Dam is being proposed for construction, relying in part on the spill from the Batujai Dam to fill its reservoir.

Construction Period

Major Structures. The project already has a functioning diversion structure in place in the form of Batujai Dam and primary canal. The Batujai Kiri (i.e., left bank) main canal (classified as a secondary canal) requires only a control structure to divert water from the Batujai Kanan (i.e., right bank) main canal (also a secondary canal) in the vicinity of Penujak Village.

The Left Bank Canal will cross the Penujak River with an aqueduct/siphon upstream of the present ford, then turn south along the existing road from Penujak to Mangkung villages. After crossing the Mangkung River with another aqueduct/siphon, it will extend one km south, then bend sharply to the northwest, ending approximately 2 km west of the confluence of the Mangkung and Penujak Rivers. Water from the main canal will be distributed through a network of tertiary and quaternary canals to a service area lying between the main canal and the Penujak River.

The project may also build some flood control dikes near the town of Praya, to prevent flooding of some areas where there are houses close to the reservoir, and even within the reservoir area (if it were filled to capacity). A final decision on this matter requires further study, which will be included in the Final Design Contract.

The existing main canal may be too small to convey water to both Batujai Kanan and Kiri simultaneously at the optimal rate. This issue will be addressed in the design review. It may be that a prolonged period for land preparation will be necessary to get sufficient water through a narrow outlet to irrigate all the areas to be served.

Work Force and Schedule. Estimates on the size of the total work force required are incomplete, but are likely to be similar to those for other projects of approximately this size, figured at about 300 or more laborers. Similarly, no schedule has been completed yet since the contract for the final design has not been awarded, but it is likely to take less than 12 months to complete.

Operation Period

Irrigation: Method of Operation. Water will be provided to the service area on an as needed basis, which is determined partly by rainfall.

Equipment Use. Little special equipment will be required, other than that installed at the dam, at the diversion structure, and in the canals to control flow. Some tools will be required for maintenance.

Resource Use. The only resources used by this project during operation will be water and hand labor. Virtually no mechanical energy resources will be required, since the system will be manually operated.

On-farm Management. The functioning of local water users' associations (P3A) will be examined and, where necessary, streng-

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thened. The relative roles of the locally elected pekasih (village water master) and the PU Operations and Maintenance (O & M) staff will be examined in terms of the effectiveness and reliability of the water distribution system.

Public Bathing and Livestock Watering. Public Works will install structures. Once built, there will be some monitoring of the structures to see that they remain in good condition. Community education and, eventually, community-led enforcement programs will be required to effectively protect canals and other structures from damage.

Waste Treatment. The only significant waste created by the project will be water in the form of irrigation drainage. Those flows will contain some fertilizer and pesticide residues from the fields, plus human and animal waste from villages. The flows will be returned to the rivers without treatment.

Operation and Maintenance. Operating and maintenance costs for the canals and irrigation system are estimated based on other studies and experience in the region. If the control of aquatic weeds in the reservoir area is included in the regular maintenance costs of this project, it is likely that maintenance costs will be higher than the normal rate.

Alternatives to the Proposed Project

No Action Alternative

If this project is not implemented, the present uncertainties of agricultural production will continue, with the local people remaining at basically a subsistence level. Continued emigration of younger farmers will occur, due to the attraction of better conditions elsewhere, and the inability of the land to support any more people than it currently does.

Alternative Technologies

Water Sources. One alternative water source in the region, ground water, is not sufficient to meet irrigation needs. Another option--pumping from the reservoir--would only be able to service some limited areas adjacent to the reservoir. Any pumping directly from the river would be limited to a few places as well.

Water Management. Effective management of existing surface water resources could not, of itself, improve the agricultural situation, since the river is too seasonal and its year-to-year fluctuation too great for reliable irrigation.

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Siting Alternatives

The placement of the various access roads, the canals, and the service area was dictated by topography, and the presence of other irrigation systems in the area.

Alternative Uses of the Reservoir Water

South Lombok has been defined as a tourism development area. Future construction of large hotels may require that some reservoir water be piped to the south coast. This subject is still under discussion and there are no known firm plans.

Existing Environmental Conditions

Climate

The project is located in an area of tropical moist climate, characterized by average monthly rainfall of 16 to 281 mm, and a yearly average of about 1454 mm, nearly all of it falling within a seven-month period. The average daily minimum temperature ranges from 19.7 degrees Centigrade in August, to 23.7 degrees Centigrade in April. Average maximum temperatures range between 27.6 to 31.7 degrees Centigrade.

Topography and Geology

The project irrigation area is contained within the valley formed by the Penujak and Mangkung rivers. A string of knolls runs along the northeast road. The terrain undulates from north to south, but is gently sloping from the borders of the irrigation area to the riverbeds. The underlying bedrock is mostly volcanic breccia, overlain with an expansive (Tanah Malit) clay.

Water Resources

The project lies within the valley of the Penujak and Mangkung rivers. Upstream of the Batujai Reservoir, the main rivers are the Leneng, the Surabaya, the Semayang, and the Lajut. The Batujai Reservoir has a surface area of approximately 890 ha at its maximum elevation of 92.5 m asl. The live storage volume, ignoring sedimentation, is approximately 24.8 MCM. At its minimum operating elevation of 87.0 m asl, the reservoir is reduced to 100 ha and 1.3 MCM.

Water quality analyses made during the period December 1989 to January 1990, show that for the parameters measured, all samples taken from locations in the rivers were within acceptable levels for livestock, fisheries and agriculture. The

levels of nitrate (NO_3) were high at all sites, probably because of excessive runoff of fertilizers from the land at the time of sampling.

Most households in the service area draw their domestic water from wells or from the river. During the dry season many wells go dry, while other wells continue to supply water at a reduced rate. Springs and pools in the river help augment the well supplies during the dry season.

Land Resources

Land Use. The prevailing use of land within the Penujak basin is agriculture. Some parts of the upper watershed contain substantial patches of secondary forest, but most of the truly primary forest on Mt. Rinjani lies above the limits of the Penujak watershed.

Within the project irrigation area, the basic uses of land are agriculture, pasture (including the fallow paddy and palawija fields), gardens, brick and p ttery making sites, hamlets and infrastructure (mostly roads). Only a minute fraction comprises natural habitat.

Agricultural Practices. Paddy is the most extensively planted crop in the project area, being cultivated only in the wet season in the rainfed Batujai Kiri area. Over the period of November up until January, almost all the proposed service area is planted to paddy. Harvest of the wet season crop follows in March to April. In addition to paddy, a second season crop of soybean is cultivated in less than half the project area in the dry season, from April up until July. Cropping intensity is presently estimated at 140 percent.

Results of several SSIMP field studies indicates that average paddy yields are 2.5 t/ha, and soybean yields average 375 kg/ha. These low yields are attributable to the dry conditions in the area, the low levels of input use, and limited crop management practices.

Biological Resources

Terrestrial Habitat. The predominant terrestrial habitat types in the project service area are various forms of agricultural land, principally rainfed paddy and pasture. Because of the intensive use to which such lands are put, the habitat varies seasonally and from year to year. Most of the woodlands are small isolated groups of trees close to rivers and houses, and are usually managed as gardens. As a habitat for animals, both the agricultural land and woodlands are fair to poor, and are too

small to be attractive to many of the larger mammals. The levels of succession and diversity are also low.

Fresh Water Biology and Fisheries. The Batujai reservoir supports a dense growth of water plants along most of its perimeter. The high suspended solids content of the reservoir waters limits phytoplankton and zooplankton densities and therefore fisheries productivity. The rivers were not surveyed in detail for aquatic vegetation. A variety of micro- and macrobenthic organisms are in the river, as well as attached algae of various species. Although not surveyed for fish populations, it can be assumed that most species present in the reservoir are also found in the rivers below.

Socioeconomic Resources

Population. Population density in the project area is very high for an area of limited resources, averaging 343 persons/ km^2, ranging from a low of 193 in Mangkung Village, to a high of 704 in Bonder Village. The total population of the five villages is more than 35,000, having increased at an average of 1.8 percent over the past 14 years. The population is mostly within the working age group of 15 to 54 years (more than 70 percent).

Ethnicity and Religion. The majority of the population in the project villages are ethnic Sasak, who are Moslem. The population continues to uphold various agricultural beliefs and holds pre- and post-harvest ceremonies and ritual meals related to the rains and paddy production.

Social Classes. The Sasak of South Lombok are quite traditional and maintain a social stratification system that combines the traditional differences based on birth and marriage, with more modern differences based on educational attainment, income, and leadership/administrative skills. Much of the adult population remains illiterate or near-illiterate, and their opportunities for improving their economic status under present conditions are limited.

Public Health. Little reliable data exists, but information collected in informal discussions and visually assessing the physical condition of people indicates there are many skin and respiratory, gastrointestinal, and diarrheal diseases, some malnutrition, and a certain amount of malaria. These diseases are exacerbated during the dry season when clean water is restricted or unavailable.

Labor Force. Almost 90 percent of the work force is primarily engaged in agricultural production. Peak labor demands for paddy occur during the land preparation, transplanting and harvest

activities in the crop cycle. At these times, farmers hire outside laborers for wages or production shares. About 15 percent of the agricultural work force are landless agricultural laborers, so that overall, there is a labor surplus in the area.

Land Ownership. Virtually all the land in the Batujai Kiri service area that has any agricultural potential is privately claimed and cultivated. Almost 90 percent of the paddy fields have been acquired through inheritance, with purchases of land most common nearest the town of Praya. Overall, about 45 percent of farmers own at least some of their own paddy fields, although small farmers may not own sufficient land to be self-sufficient.

Potential Environmental Impacts

Identification of Project Effects

Identification of project effects is usually based upon a combination of published information, local knowledge and concerns, professional interpretation and analysis of baseline environmental conditions. In December 1989, an environmental scoping meeting was held in Praya to review possible project impacts and to respond to local concerns about the project, which were principally oriented to aspects of the socioeconomic environment and the planning process. The environmental review has incorporated these concerns into the assessment of project impacts.

As might be expected, most of the perceptible side effects of this project will be related to changes in water use and availability that will occur in the post-construction phase of the project. These effects were sometimes alluded to by agency representatives at the 1989 meeting.

Water Resources

Water Quantity. The major objective of this project is the geographic and temporal redistribution of water. The effect of the Batujai Kiri Irrigation Project on the Batujai reservoir operation should be minimal. The reservoir levels are maintained between 87 and 92.5 m (1.3 and 24.8 MCM, respectively), although, reportedly, it has rarely been filled to the 92.5 m level. At the higher level, water overflows the dam spillway gates, and the lower level is the bottom elevation of the irrigation intake.

At the 92.5 m level, there are reportedly "flood" conditions in some fields adjacent to the reservoir, and in the lower parts of Praya Town, where some of the population have built housing too close to the reservoir, or even within the reservoir area. This flooding is probably also a result of wet season heavy rains when the reservoir spill rate is inadequate to prevent some temporary upstream flooding.

Although the original intent was to develop both Batujai Kanan and Kiri, only one side, "Kanan", was completed in 1982. Batujai Kanan irrigation system currently diverts most, if not all, of the water which can be regulated from the reservoir. As a result, the cropping intensity is higher than was originally envisioned, and a cropping pattern of paddy/paddy/palawija is obtained over much of the area. Reservoir simulations studies show that this is not sustainable over the long term using a 1 in 5 year criteria. Reallocation of water to Batujai Kiri would force Batujai Kanan to adopt a less intense cropping pattern, or to plant palawija instead of paddy in the second season. Cutting back on the availability of water to Batujai Kanan is expected to cause some social dissent, unless some means is found to increase the efficiency in the use of water that will be available.

Water Quality. The reservoir catchment includes large areas of irrigated land, as well as towns with high urban density. Their potential contribution of pollutants in the form of agricultural runoff and domestic sewage is enormous. The water quality for irrigation and other downstream uses would consequently suffer if the upstream water became further polluted. In general, the Penujak River probably will contain the best water during the middle part of the wet season, when the dam is spilling, but the canal system probably will be better during the rest of the year.

Land Resources

Land Use. Most of the land to be irrigated under this project is already dedicated to agriculture, and nearly all of it produces only wet season crops. Land use in the project area is not expected to change considerably upon provision of irrigation as much of the area is currently cultivated as bunded lowland.

No significant changes in soil chemistry or waterlogging are anticipated with this project. Likewise, sedimentation should not be a serious problem unless significant land conversion activities were to occur upstream.

Farming Systems. An increased, reliable water supply is expected to have a significant impact on agriculture. Irrigation is expected to result in farmers abandoning the current highly labor intensive field preparation practices under the current

production system (known as "GORA"), that involves hand spading. Farmers are expected to convert to plowing by cattle or water buffalo. This addition of irrigation is likely to result in an increased demand for draft livestock. Greater use of fertilizer and pesticide will result, with their associated environmental and health risks.

Biological Resources

Terrestrial Habitat. The introduction of irrigation will result in little change of present land use. Most of the project area is already devoted to agricultural fields and the remainder has been converted to gardens. The project is not expected to have any significant impact on watershed conditions.

Pests. Any intensification of cropping is likely to result in higher and more persistent populations of crop pests. Higher insecticide use may be required to control insect pests; rodents (mostly rats) may increase and require control measures such as communal hunts. The principal disease vector that benefits from irrigation is the mosquito, which tends to breed in stagnant drains and field edges. The incidence of malaria in Lombok is already fairly high, compared to other Indonesian islands. Some increase in the vectors of malaria may occur with more widespread surface water availability. There is reportedly no dengue fever in the area.

Aquatic Habitat. As aquatic habitat, the canal and irrigation system is not expected to have very high biological productivity.

Species of Special Interest. No species of plants or animals in the project area have been identified as being of special conservation or scientific importance.

Socioeconomic and Cultural Resources

Settlement Pattern. One positive factor of the project is that there is no major relocation of any people necessary within the irrigation area. At most, a few houses may have to be moved over a few meters to be out of the way of the canals as they pass near the edges of hamlets.

Unfortunately, due to the relatively unrestricted growth of Praya Town, caused in part, by the forced resettlement of people when the Batujai Reservoir was created, some low-income families have housing on land that is properly part of the reservoir area. If the reservoir is to be filled to capacity, as is needed, some of these houses should be moved, or a flood control dike should be built to minimize flooding.

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Public Health. The project area may see an increased risk of vector-borne diseases such as malaria and dengue fever (although this disease has reportedly not been found in South Lombok yet). The improvement in quality of dry season water supplies may have the net effect of decreasing many of the current intestinal and skin diseases. Reportedly, many of the local population are still lax about boiling drinking water; until this situation changes, it is likely that the prevalance of diarrheal and gastroenteral diseases will remain high.

Evaluation of Environmental Impacts

Pre-construction

Approximately 12.5 ha of predominantly agricultural will be taken for irrigation and drainage canals. Compensation should be given for about 6.0 ha for main structures, and the rest will be donated by farmers for the smaller canals.

Construction

Some disruption of agricultural activities will occur along the canal route as construction proceeds. Some resettlement of people living too close or within the reservoir area will be necessary.

Water Resources

Reservoir. The Batujai Reservoir is the depository for some of the sediment washed from its catchment area. If upstream erosion increases more than anticipated, then the reservoir's future capacity will be decreased, causing a short-fall in irrigation supply.

Batujai Kanan Irrigation. The Batujai Kanan irrigation area currently uses most, if not all the reservoir's available capacity. A significant quantity of this water is wasted due to substandard operation and maintenance of the supply canals. Batujai Kanan will have to adapt to a lower cropping intensity if Batujai Kiri is to receive water, even if it improves its efficiency. Over the total Batujai areas though, the economy and living standards will improve. Probably, these changes are justifiable on the basis of equity.

Water Supply. The water supply will improve for both domestic and livestock needs. Structures will built along the canals to accommodate these activities. There should be some recharge of existing wells that currently go dry in the later part of the year.

Water Quality. Pollution in the form of sewage and agricultural runoff could have grave consequences for the water quality of the reservoir. As the use of fertilizers and pesticides increase, possible contamination of the ground water and wells has to be considered.

Land Resources

Agriculture. Agricultural intensity will increase from the present 140 percent to over 210 percent in the Batujai Kiri area.

Draft Animals. The current supply of draft animals is estimated at about 0.5 animals owned per households, but perhaps 75 percent of all households, in fact, own no draft animals. Demand for draft animals is expected to dramatically increase as farmers switch from the GORA land preparation systems, to plowing.

Livestock Grazing and Fodder. The areas available in Batujai Kiri for livestock grazing will decrease somewhat as fields that are now fallow in the dry season are converted to irrigated agriculture. The practice of bringing fodder to water buffalo, cattle, and horses, kept in pens, already seen to some extent in the area, will be intensified.

Biological Resources

Pests. There is the risk that crop pests such as insects, birds and rodents will increase as a result of the increased intensity of agricultural production. Disease vectors such as mosquitoes that benefit from the presence of stagnant water are likely to increase, with a possible increase in malaria and dengue fever.

Aquatic Weeds. The continued proliferation of aquatic weeds on the reservoir's surface could eventually decrease the efficiency and the volume of water available for irrigation.

Fisheries. The reservoir's surface area and volume will fluctuate considerably from wet season to dry season and from year to year in response to rainfall and irrigation demand. In some years the reservoir will decrease in size and therefore decrease the potential production area.

Socioeconomic and Cultural Resources

Settlement Patterns and Movements. The high demand for labor with technical irrigation should not be much different from the current high labor demands, although the timing of work and some of the tasks will change. It is expected that the current oversupply of labor available in the area would be utilized rather

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than bringing more people into the area, although a few may come seeking work.

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

Regional Economics. Income and living standards should improve with the project. There will probably be an increased demand for a cadastral survey and land registration under the modern system. Land values will increase, as well as the potential tax base for the area.

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).

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

Domestic fuel use will increase, and at least at first, the demand for fuel wood will increase. As there are very few fuel wood resources left in the area, the population will either end up further depleting current resources or resort to purchasing fuel wood from other areas.

In summary, construction of the Batujai Kiri system would complete the left bank of a system whose right bank has been in operation for more than eight years. Completion of the left bank would bring more balance to the living standards of the area, where left bank farmers have watched as the living stqandards of their neighbors on the right bank have improved, while they have stagnated.

Conclusions

The conclusion of this study is that the Batujai Kiri Irrigation Project has no major detrimental environmental impacts which call into question the viability of this project. The main problems related to implementing this project are not really negative impacts of the project, but are the result of the long delay in building Batujai Kiri and that people have accommodated themselves to the existing situation. The project will result in spatial and temporal changes in water distribution which will

have largely positive environmental benefits for the local population.

Based on the present studies, the conclusion of this Environmental Assessment is that the Batujai Kiri Irrigation Project is environmentally feasible, and that potentially negative environmental impacts have been adequately addressed in the Environmental Management Plan.

Figure ES - 1
PROJECT LOCATION MAP

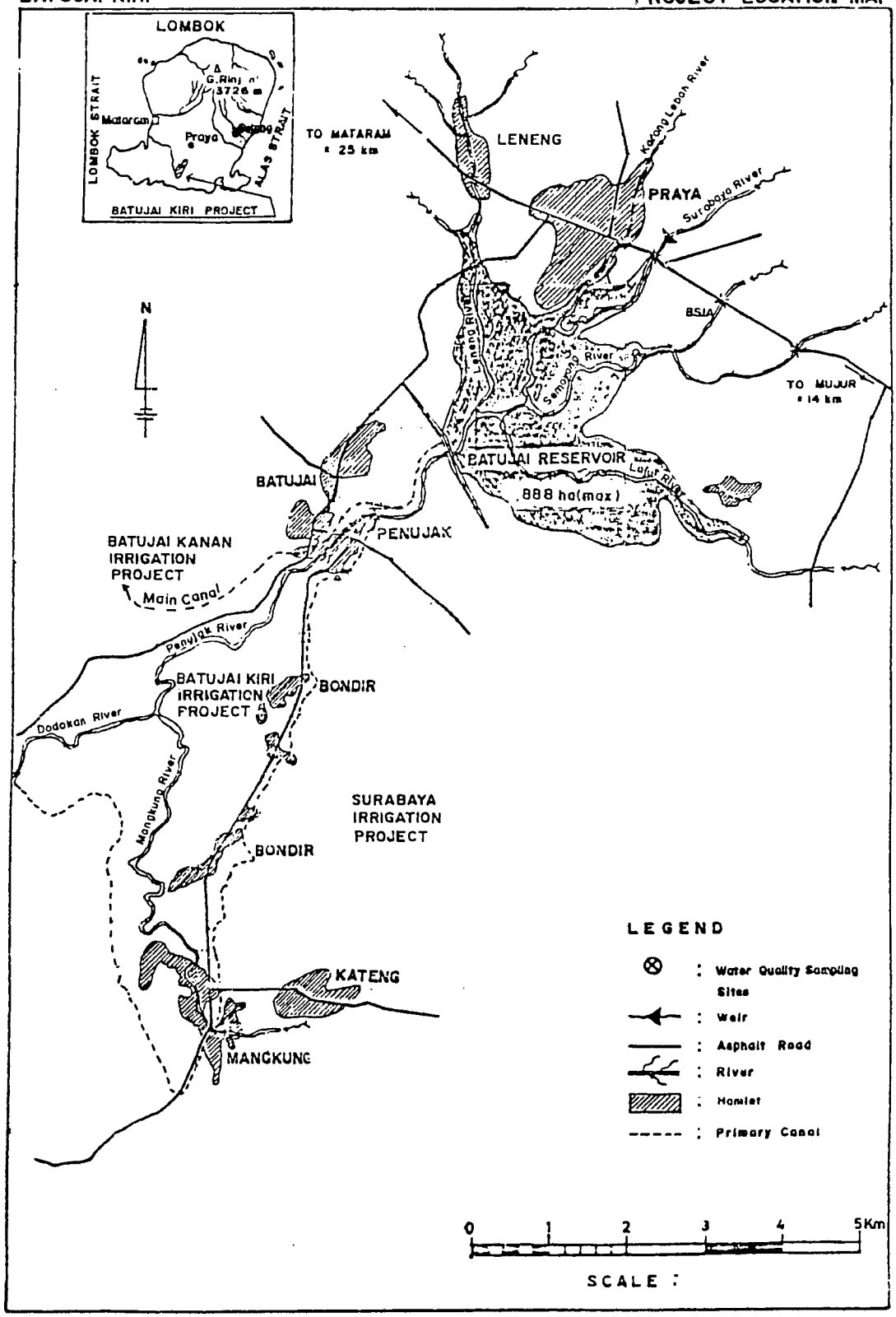

TABLE ES-1
SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS
BATUJAI IRRIGATION PROJECT

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	DOWN-STREAM AREA	PRE-CONST.	CONST.	OPER.	UPON?	DURATION	INTENSITY	
WATER AND ATMOSPHERIC RESOURCES													
Water Quantity	Loss of reservoir storage	Sedimentation of reservoir	Deforestation, Urbanization, Overgrazing, Unsuitable Irrigation Techniques	X			X	X	X	Beneficiary farmers	Long-term	Minor to severe	Water shortages could destroy Pjt. benefits
	Water diversions to other systems	Compelling demand for water	Water shortage	X	X	X	X	X	X	Beneficiary farmers	Long-term	Minor to severe	Competition for water needs to be settled equitably
	Reduced availability in river below dam	Water diverted from river to canal			X		X	X	X	People along river	Long-term	Minor	Irrigation return flow provides water to river
	Increased recharge of ground water	Percolation of irrigation water	Runoff and drainage		X	X			X	Groundwater and springs	Long-term	Minor to moderate	Project will improve recharge in dry season
Water Quality	Reservoir water pollution	Agricultural runoff	Domestic sewage	X	X	X	X	X	X	Downstream water users	Long-term	Moderate to severe	Pollution already a problem not due to project
	Irrigation water pollution	Reservoir water pollution	Chemical and waste discharge into canals		X	X			X	Project beneficiaries and downstream population	Long-term	Moderate to severe	Water in system only as good as its source
	Downstream pollution	Quality of river water	Chemical and waste discharge			X			X	Downstream population	Long-term	Moderate to severe	Assimilative capacity of river is low
	Ground water contamination	Chemical and waste discharge	Percolation of irrigation water		X	X			X	Irrigation area and downstream	Long-term	Unknown	Likely to affect domestic water supplies
Air Quality	Increased dust	Construction activity			X			X		Irrigation area	Long-term	Moderate	Mitigation involves contractor dust control (road watering)
	Increased smoke	Burning surplus straw			X				X	Irrigation area	Long-term	Minor to moderate	Straw burned when intensive cropping leaves no time
LAND RESOURCES													
Land Use and Capability	Loss of farm land	Construction of canals, roads			X			X	X	A few landowners	Long-term	Minor	Unavoidable. Small part of total area
	Less grazing land	Multiple cropping			X			X	X	Livestock in irrigation area	Long-term	Minor to moderate	Area lost partially made up for by improved fodder quality on irrigation area waste ground
Agriculture	Increased production	Multiple cropping	Dependable water supply		X				X	Irrigation area and Batujai Kanan irrigation area	Long-term	Moderate to major	Water to Batujai Kiri will require cutting back water to Batujai Kanan
BIOLOGICAL RESOURCES													
Aquatic Habitat	Proliferation of Aquatic weeds in canals	Increased nutrients	Inadequate maintenance		X				X	Irrigation area	Long-term	Minor to severe	Depends on maintenance
	Increased numbers of molluscs	Increased breeding area with irrigation			X				X	Resident Population	Long-term	Minor to moderate	Malaria and Schisto fever may increase
SOCIOECONOMIC RESOURCES													
Settlement Patterns and Movements	Increased population and immigration	Economic opportunity	Overpopulation in Lombok		X			X	X	Resident Population and migrants	Long-term	Moderate	Unavoidable
Community stability	Disruptions of social patterns	Influx of temporary construction workers			X			X		Resident population	Short-term	Moderate to serious	Mitigation requires contractor cooperation, local involvement
Services and Infrastructure	Increased demand for schools and infrastructure	Improved economy	Increased population		X			X		Resident population	Long-term	Moderate	Unavoidable
Land ownership	Cadastral survey and modern land titles	Intensification of farming	Improved value of land		X			X	X	Beneficiary farmers	Long-term	Major	Project will result in new and valuable improved tax base
Public health	Increased disease vectors	More mosquitoes	Lack of vector prevention		X				X	Resident population	Long-term	Moderate	Control required
Farm Support Organizations	Increased demand for farmer organizations	Need to operate system			X			X	X	Project beneficiaries	Long-term	Intensive	Very positive impact

PART II

BATUJAI KIRI

ENVIRONMENTAL MANAGEMENT PLAN

The objective of an environmental study is to develop the information necessary for assessing project effects and then to develop a plan to minimize the adverse effects and enhance benefits. Environmental impacts can be considered as falling in two general categories:

1. **Unavoidable Adverse Impacts.** These are effects, such as the loss of habitat to reservoir inundation, that are inevitable with project implementation and do not lend themselves to remedial actions without compromising the project.

2. **Manageable Effects.** These are direct or indirect effects, adverse or beneficial, that lend themselves to some sort of actions to improve the situation. Such actions may lessen the severity of adverse impacts or enhance secondary benefits of the project. Sometimes, a potentially adverse situation can be turned into a project benefit through careful planning, intersectoral coordination, and wise use of financial or other resources.

Types 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, construc-

tion 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.

Impacts to be Managed

The most serious potential environmental problems associated with this project involve conflicting demands on the limited water resource, especially during the dry season. The problems are not new to area residents; under present conditions they find it difficult to find water of good quality for domestic purposes and there are inadequate supplies, of course, for irrigation.

Proposed Management Plan

Responsibility. As soon as the construction is completed, the management and monitoring plan will be the responsibility of PRIS and BAPPEDA in each 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 the Management Plan of the project. These agencies include the Extension Services of the Departments of Food Crops and of 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, Camat, and their delegated staffs.

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.

Pre-construction Phase

Some agricultural land (approx 12.5 ha) will be taken for canal construction. In the case of secondary canals and service road (approx 6 ha) compensation will be expected by the owners. Negotiations for the land should be handled in a fair

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and expedient manner. This will avoid delays and create an enthusiastic and cooperative attitude among the local population.

District government should make guidelines against outsider land speculation by limiting land sales to those who will actually live and farm in the area.

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. Efforts should be made to minimize the potentially disruptive effect of the presence of mostly outside laborers in the village over a period of months.

Post-Construction Report. A report should be prepared after completion of Project construction. The report should be a detailed description of the future monitoring and mitigation measures required, estimated costs, the status of what has already been implemented and a designation of the responsible agencies for each task. The report, written in the Indonesian language, should be distributed to the implementing agencies with enough lead time to enable them to submit their annual budgets. The plan should be reviewed after a year or two of operating experience, and revised as necessary.

Water Resources

Reservoir. The current sedimentation rate in the reservoir is unknown. The design of the reservoir allowed some dead storage for sediment accumulation. The irrigation simulation, on which the water budget is based, has allowed for a 10 percent loss of the total active volume of the reservoir as an additional safeguard. If future surveys of sediment deposition show that the reservoir's capacity is seriously threatened then control measures on upstream erosion will have to be instituted. It is recommended in any case that the Departments of Forestry, Agriculture, Livestock and Environment do what they can to promote soil conservation in the catchment area.

Batujai Kanan Irrigation. Water that currently is diverted solely to Batujai Kanan from the reservoir must be shared with Batujai Kiri. As a result some land in Batujai Kanan that now

supports paddy in the second season will have to shift to palawija. The amount of land affected can be decreased in several ways. The Batujai Kanan irrigation canals can be upgraded to convey and distribute water more efficiently. Irrigation water can also be applied to the fields in a manner that will lessen losses to return flows and evaporation. The Department of Public Works under a World Bank funded project, is in the process of implementing a program that should produce these objectives.

Livestock Watering and Canal Bank Protection. Water for livestock bathing and drinking is a critical necessity in rural Indonesia, and the shortage of water in the dry season causes considerable difficulty for the owners of buffalo and cattle in the Batujai area. The reduced river flows during in the dry season makes the situation difficult for those who depend on river pools for livestock watering; those farmers must be expected to turn to the abundant water in the project canals. In the interests of protecting the canal banks from damage by livestock, a three-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, through the water users' associations, with penalties (perhaps in the form of labor or small fines) for violators.

2. Alternative stock bathing 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.

3. Some watering troughs should be built, primarily for the benefit of horses, goats and sheep, who would not normally wallow together with water buffalo.

Water Quality. Some fertilizer and pesticide residues may enter the ground water or rivers from the surrounding fields. Training of the farmers by the Department of Agriculture on the timing and quantities of irrigation water to decrease return flows and percolations can further reduce potential contamination.

Control of pollution entering the reservoir is difficult. There is currently no management of domestic waste water which naturally flow into the reservoir from upstream towns. Primary, secondary and tertiary sewage treatment systems are one means of neutralizing pollution, but they are usually expensive to construct and operate. Maintaining a healthy and diversified ecosystem in the reservoir will assure treatment of cer-

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tain amount waste products. Aquatic weeds, despite their negative impacts, are an excellent medium for removing excess nutrients; and some plants should be allowed to remain in the reservoir. Upstream manufacturing or mining operations that would introduce heavy metals, PCB or hydrocarbon wastes into the reservoir must be prohibited. Fertilizer and pesticide runoff from upstream agriculture can be curtailed to some extent by better management of application quantities and timing, as already discussed above. Periodic sampling should be performed (see Monitoring Plan, Part 4) to ensure that degradation of water sources to unacceptable levels does not occur.

For those 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 dam to flush accumulations of drainage water when it is heavily contaminated with fertilizers, pesticides or animal waste products.

Land Resources

Livestock Grazing and Fodder. The area available for free grazing of livestock will decrease in the dry season while the number of livestock will increase. Owners will resort to corralling in their animals if there is not grazing land conveniently available. Many villagers are already practicing this concept, not only due to wet season planting, but for security. The Department of Livestock should advise on the design and construction of livestock holding pens. The villagers already plant trees (pohon turi) on the paddy bunds for fodder. The villagers should be educated not to take fodder from areas that have recently been treated with pesticides or fertilizers.

Farming Systems. Improvements in irrigation of the Batujai service area will lead to increased demand for agricultural extension services. The Department of Agriculture (Food Crops) will work together with Public Works, PEMDA, LP3ES and local farmers to 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 five-year plan (PELITA V). This whole process is likely to require several decades. During this time, it is likely there will also be increased demand for agricultural cooperatives and extension of credit for technical inputs.

Biological Resources

Aquatic Weeds. The aquatic weeds in the reservoir, if allowed to spread across its surface, could impair the operation of the dam and decrease the water available for irrigation. At the same time, some aquatic plants are needed in the reservoir to remove nutrients contributed by sewage and fertilizer runoff.

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They are also beneficial to the fishery. The weed population should be maintained at a reasonable level. The seasonal drawdown of the reservoir will help to keep the weeds in check. It may be necessary at times to physically remove some weeds if densities get too high.

Aquatic plants that grow in canals and drainage ditches can be controlled in various ways. Weeds can be physically removed, and in some cases, weeds such as Hydrilla verticilata and water hyacinth (Eichhornia crassipes), can be used as feed for cattle, pigs, ducks, and chickens. Water weeds have also been used as a mulch, and to make paper products. Some species of fish, for instance grass carp (Ctenopharyngodom idella), feed on certain aquatic weeds, and therefore might be raised in the canals. Of course, the implications of introducing new fish species into the area must be thoroughly assessed before they are released.

Fisheries. The reservoir's seasonal fluctuation in surface area and volume most likely affects its fishery. The Department of Fisheries has already initiated programs to compensate for this effect. Every year more than one million fish fingerlings are released in order to restock the reservoir. In addition, an aquaculture program is being tested for raising fish in cages placed in the reservoir. The resulting increase in management and feeding rates means that fish can be raised to market size in four months. The economic feasibility of this approach must still be assessed. Some weeds should be maintained in the reservoir as a habitat for the fish and the organisms that they feed on. A study on the present fisheries dynamics would assist in its future management.

Pest Control. 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.

A program of integrated pest management has been successfully implemented elsewhere to control insect populations. Use of biological control and pesticides 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 paddy 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, and coordinated planting regimes restricting the types of food available to the rats at any one time, is also effective.

Mosquitoes will breed in the canals and drainage ditches if there is stagnant water. If the canal's are kept free of

weeds and debris; then, the flow of the water will make it difficult for mosquitoes to reproduce. Insecticides used judiciously for serious outbreak can also be helpful. In some locations mosquito fish (Aplocheilus panchax) can be introduced into the canals as a control measure.

Socioeconomic and Cultural Resources

Public Health. As noted above in the section on Pest Management of Biological Resources, changes in surface water distribution and the attendant possibility of increases in mosquitoes will require a program of malaria and dengue fever prevention on the part of health authorities, if increases in the incidence of the diseases are to be avoided. Any such program should be tied in with a program of public education and local mosquito control. When informed about malaria and dengue fever and given the impetus for action, most rural people respond positively. The additional cash flow in the service area should enhance the ability of people to purchase the inexpensive chemicals needed for mosquito control.

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 should educate mothers, in particular, about the importance of boiling water, basic personal sanitation, and inoculating children against preventable water-borne diseases.

Services and Infrastructure. Improved living standards, more economic opportunity and a larger population will all 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 infra- structure are to keep pace with irrigation components of the project.

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

Land Classification 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. The government should organize a special cadastral survey so that the whole service area will be

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converted to the modern land title system in a systematic and equitable manner.

Land Taxes and Water Users' Fees. The government should expect to receive an increase 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.

Water Users' Organizations. 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 the non-governmental organization (LP3ES) to assist in this process.

Management Plan Components: Timing and Costs

Public Works will construct the "water resources" mitigating factors, provide any possible clearing of vegetation from the reservoir site, and develop water users' associations. Other government agencies, as mentioned above, will be principally responsible for their own extension programs and ongoing activities. In most cases, the commencement of programs and extension services by other sectoral agencies (see Figure MA-1) should occur by the time the irrigation system construction is completed, which is expected to take about 18 months. 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 increases in services and infrastructure (e.g., schools, non-project roads, health clinics) 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. Some land will undoubtedly be sold to "outsiders", but district government should take steps to see this process is not abused.

The organizing of water users' associations and irrigation committees will probably commence in 1991 when the non-governmental organization, LP3ES, begins working with PU staff, local government, and the existing water users' associations.

Table MA-1 summarizes the estimated costs of the mitigating activities. 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. The exceptions to this are: (1) catchment management, where it is anticipated that Rp 1 to 2 million be spent every year monitoring (see Part 4--Monitoring Plan); and, (2) water quality monitoring twice a year which will initially cost about Rp 15 million annually (see Part 4--Monitoring Plan). Also, if the National Board of Lands decides to commence a cadastral survey and land titling program, there will be special costs, only part of which will be borne by the farmers themselves.

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Table MA-1

MANAGEMENT PLAN COMPONENTS
AND ESTIMATED COSTS

Item	Participating Entities	Estimated Cost (Rp)
General Coordination of Sectoral Agencies	BAPPEDA, Tk II, and district government	No Special Cost
Water Resources:		
Bathing and Laundry Steps in Canals Rp 200,000/unit x 50	Public Works, NTB Province	10,000,000 (1)
Foot Bridges over Canals Rp 3,500,000/unit x 12	Public Works, NTB Province	42,000,000 (2)
Livestock Watering Troughs (Rp 200,000/unit x 8)	Public Works, NTB Province	1,600,000 (3)
Livestock Washing Sites in Canals (Rp 2,000,000/unit x 8)	Public Works, NTB Province; Extension Services of Food Crops and Livestock	16,000,000 (4)
Land Resources:		
Farming Systems	Department of Agriculture (Food Crops), with PU assisting	Regular Operating Costs (5)
Land Use: Livestock management for establishing pastures/ fodder sources, and number of cattle	Departments of Livestock and Forestry, assisted by PU and LP3ES	No Special Cost (6)

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Table MA-1 (cont.)

Item	Participating Entities	Estimated Cost (Rp)
Biological Resources:		
Pest Management/ Preventative Training:		
Agricultural	PU, NTB Provinces, and Department of Agriculture/Extension Services	Regular Operating Costs (7)
Mosquitoes	Department of Health	Regular Operating Costs (8)
Socioeconomic and Cultural Resources:		
Public Health	Department of Health	Regular Operating Costs (9)
Services and Infrastructure	BAPPEDA Tk II, and district government	No Immediate Costs (10)
Land Classification, Land Values, and Land Ownership	National Board of Lands (Badan Pertahanan Nasional) and Agrarian Taxation Office (IPEDA/PBB), with district government	Special Costs (11)
Land Taxes and Water Users' Fees	Agrarian Taxation Office, National Board of Lands, district government, and Public Works	No Special Costs (12)
Organizing Water Users' Associations	Public Works, NTB Province, Agricultural Extension Services, and assisted by LP3ES	No Special Costs (13)

Notes to Table MA-1:

(1) Estimated costs are preliminary pending final design of the irrigation system. The number of these structures is based on the length of the canals and the fact that in the Batujai Kanan system, these structures occur every 50 to 100 m along the canals. Cost will be included in the irrigation system contract.

(2) Estimated costs are preliminary pending final design of the irrigation system. Cost will be included in the irrigation system contract.

(3) Estimated costs are preliminary pending final design of the irrigation system. Cost will be included in the irrigation system contract.

(4) Estimated costs are preliminary pending final design of the irrigation system. Cost will be included in the irrigation system contract.

(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 should be included in the annual budget (DIP) of the Department of Agriculture, and amount should be confirmed by BAPPEDA.

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

(7) Unless there is a specific outbreak of an agricultural pest, the Agricultural Extension Services would conduct its normal Training and Visit system, educating farmers in the use of pesticides. If a special problem arose, the Department of Agriculture would have to allocate special funds to meet the problem.

(8) Training in the control of mosquitoes for malaria is a regular part of the Department of Health's public education program. The Department of Health should monitor the situation and make appropriate changes, if necessary, in its public health training. Any particular worsening of the situation in the area may require the initiation of mosquito spraying control measures.

(9) The Department of Health should monitor developments in this area and adjust their programs and services accordingly. Adequacy of funding in annual Health

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Department Budget (DIP) to be confirmed by BAPPEDA, Tk. II.

(10) Regional government would be expected to increase the numbers of schools, health clinics and other services as the population increases. No immediate or special costs are envisaged. BAPPEDA, Tk. II and district government to determine scheduling and funding.

(11) A cadastral survey of the land and the necessary administrative costs of providing certificated title to land would partially be borne by the farmers and partially by the respective agencies involved in this task.

(12) 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.

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

PART III

BATUJAI KIRI 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 during planning, design, and construction, and may be mandated by law (as it is 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 exterior sources, the local government bears 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 inter-agency jurisdictional disputes.

Some of the above factors may be absent in NTB Province and Central Lombok 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, one that will provide data useful for integrated resource management in the project area.

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Proposed Monitoring Plan

Water Quality

Program Objective. The monitoring of water quality will determine the suitability of water in the Batujai 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, rivers and wells. The occurrence of ground water or reservoir pollution can also be established.

Location. Sample sites that should be considered for this program include:

1. From the reservoir 100 m offshore from the dam.
2. From the Penujak river just upstream of the bridge crossing the Penujak.
3. From the Penujak River downstream of the Mangkung River junction.
4. From the Mangkung River just upstream of the bridge of the bridge crossing in Mangkung.
5. From the Batujai Kiri secondary canal where it meets the Batujai Kanan main canal.
6. From other locations on the secondary canal where human use is particularly heavy.
7. From wells and springs in the Batujai Kiri project area where drinking water is taken and contamination from agricultural sources are possible.

If unacceptable water quality is encountered at one of the sampled sites then additional sampling may be necessary to isolate the source of pollution.

Methods and Equipment. A competent water quality laboratory will be needed for analyses. Field meters 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.

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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, phosphate phosphorus, salinity (expressed as chloride ion), alkalinity (expressed as calcium carbonate), and fecal coliform bacteria. Although pesticides are not for seen as a problem, some testing 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 during the wet season and the dry season of every year. 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 sampling although it may wish to contract out the required testing of water samples.

Land Resources

Program Objective. The watershed for the Batujai Reservoir should be monitored for land usage, destruction of forest, expansion of urban areas, agricultural activities, erosion and other factors that may affect operation of the reservoir and all the irrigation systems dependent on the catchment. As part of this program the sedimentation rate of the reservoir should be monitored.

Location. Land used should be monitored periodically throughout the Batujai Reservoir catchment, including all rivers that flow into it.

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. Some ground checking is also 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, erosion, and new land use.

Schedule. This survey of land use changes should be conducted every other year. 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 NTB Province be principally responsible for overall monitoring of watershed protection, but that it work closely with the Department of Forestry, and local government (PEMDA). Since the area involved affects a large; area involving much of the southern slopes of Mt. Rinjani, monitoring funds should be through appropriations made separate from those of Batujai Kiri.

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, or bird pests occurs or there is reason to believe that project activities are affecting biological resources. The objective of such a study program would be to evaluate the problem, identify causes, and develop solutions.

Location. Pest problems may be expected anywhere in the agricultural production system, from planting to storage and marketing.

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.

Implementing Agencies. It is recommended that the Department of Agriculture and the Department of Health share primary responsibility for monitoring the biological resources as

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needed. The Department of Forestry is the logical agency to monitor the condition of an endangered species found in the area.

Socioeconomic and Cultural Resources

Integration of Local and Regional Planning. Any program of environmental monitoring of sociocultural 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 other sectors 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. The Department of Statistics in the District can be expected to provide both BAPPEDA, Tk II, and the sectoral agencies with relevant data, although the sectoral agencies can be expected to collect some of the necessary information through their regular monitoring mechanisms.

Table MO-1

MONITORING PLAN COMPONENTS
AND ESTIMATED COSTS

Item (Rp)	Participating Entities	Estimated Cost
General Coordination of Monitoring Responsibilities	Public Works, NTB Province, and BAPPEDA, TK II	No Special Cost
Water Resources:		
Water Quality Tests (Rp 5,500,000 x 2/yr)	Public Works, NTB Province	15,000,000 (1)
Land Resources:		
Land Use Reconnaissance (satellite imagery)	Public Works (P3SA), with the Bupati, BAPPEDA Tk II, Departments of Forestry, and Agriculture	5,000,000 (2)
Biological Resources:		
Monitoring Pests, Diseases, and Other "Ecological" Problems	NTB Departments of Health and Agriculture	No Immediate or Special Costs (3)
Socioeconomic Resources:		
Medium- and Long-Term Local and Regional Planning	BAPPEDA, TK II, assisted by Dept. of Statistics, and planning sections of Sectoral Agencies	No Special Costs

Notes:

(1) These estimates are provisional and include Rp 4 M for miscellaneous expenses, in addition to the basic costs of testing. Quotes on costs from different laboratories vary widely. We would expect competent laboratories to be relatively close to this estimate. Based on quotations by Mataram University's Analytical Lab (sampling and analytical analysis), and Bogor University's Biotrop Laboratory (pesticide analysis).

(2) Estimated cost of acquiring a satellite image for a 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 administration and report preparation. Rp 5 M should be adequate for one month salary of a watershed management specialist to also visit the upper catchment area, monitor test quadrangles, and prepare a report, along with photocopies of the report.

(3) The Departments of the Agriculture and Health should monitor developments in these areas and adjust their programs and services accordingly.

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