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THE AGROECOSYSTEMS OF BUHI: PROBLEMS AND OPPORTUNITIES

Report of a Workshop held at
Naga City, Bicol, Nov. 14-18, 1985

Edited by
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PREFACE

Development, like a coin, has two sides. One side represents its expected positive impacts and the other its negative effects, on the place and on the lives of the people where it is intended. Therefore, there are expected changes and dislocations to the usual life of the area.

But efforts are being exerted to check the inconvenience resulting from development undertakings.

One of these cases is the Rinconada Buhi-Lalo Integrated Area Development Project where certain beneficiaries claim that problems have occured as the project nears completion. Certain area resources, too, are in a threatened condition of being exploited to a maximum level that will affect ecological balances.

The Buhi Agroecosystem Analysis Workshop, therefore, has been a most fitting response to the problems felt by the beneficiaries of the irrigation component of the Rinconada Buhi-Lalo Project and the people engaged in fishing who also are dependant on Lake Buhi for their livelihood. The National Power Corporation's use of the lake's water has triggered a resource allocation problem - the lake water is now being used for irrigation, fishing and power supply. Will Lake Buhi be able to sustain such demands in equal terms without threatening its own existence? The critical assessment of the lake which was undertaken in the workshop provided a clear picture of what could be undertaken to overcome the inconsistencies and development problems in the project area.

This publication is a document of the proceedings of the workshop whose participants came from all sectors involved in the project. The different study groups came up with key questions for both research and development, as well as solutions and recommendations to meet the major challenges in rural development. They specifically to create an environment have sought that will be supportive to the overall goal of uplifting the quality of life of the Buhinon. At the same time this publication crystallizes our experiences and attempts to develop the project area, and what we intend to accomplish by way of solutions to the pressing problems.

Carmelo R. Villacorta
Director
Bicol River Basin Development Program

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We also wish to thank the Mayor of Buhi, Crispin Mercurio, and the inhabitants of Buhi for their hospitality to the field study team prior to the workshop and for their contributions of useful insights during the workshop.

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We would like finally to express our special thanks to both UPLB-PESAM and BRBDPO staff who provided invaluable support for the conduct of the workshop; Marilyn Casinas, Vicky Ortega-Espaldon, Adel Bautista, Vicente Gapas, Emma Lameyra, Rica Florece, Nilo de los Santos, Nards Florece, Nathan Santos and Teresita Zapata

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EXECUTIVE SUMMARY

In 1979 an agreement was made between the Republic of the Philippines and the US Agency for International Development (USAID) to implement "The Bicol Integrated Area Development III (Rinconada/Buhi-Lalo) Project. The project forms part of a larger strategy of developing the resources of the Bicol River Basin which has the general goal of "improving the socio-economic situations and quality of life of the rural poor" in the area. Specific goals are to increase agricultural productivity and employment opportunities, increase farmer participation in development activities that affect them and to reverse the deterioration of the upland watershed areas. Major components of the project are a Hydraulic Control Structure at the outlet of Lake Buhi, channelisation of the Tabao River outlet, together with various irrigation works and the development of Irrigators Association's in the service area, and, in the watershed, a variety of soil conservation measures based on agroforestry practices.

The lead implementing agencies for these projects are the National Irrigation Administration (NIA) and the Bureau of Forest Development (BFD). But overall responsibility for coordinating development in the Bicol River Basin lies with the Bicol River Basin Development Program (BRBDP) which is charged with reconciling conflicts and implementing an Integrated Area Development Program.

In 1985 these projects wee nearing completion and the effects of the Hydraulic Control Structure were becoming apparent. Some of these effects were seen as detrimental to the lakeshore inhabitants, adversely affecting fishing and agricultural activities, and to the people of the municipality, interfering with transportation and domestic water supplies in particular. In addition the Lake has been experiencing a number of long term declines in productivity and stability, particularly of the fishery. These problems may be summarised as follows:

I. Temporary Problems associated with the Construction Phase

A. Unespected rises in lake water level
   1. Flooding of rice fields

B. Unexpected falls in lake water level
   2. Drying out of fish cages

II. Permanent Problems associated with Control Structure Operations

A. Use of full water level capacity of lake (83.5m)
   1. Periodic flooding of dwellings
   2. Periodic flooding of cropped land

B. Use of low water level capacities of lake (below 81.4m)

3. Periodic drying out of fish cages
4. Drying up of shallow groundwater wells in Buhi municipality
5. Drying up of dock at Poblacion
6. Loss of lake transport capacity
7. Drying up of Buhi Freshwater Demonstration Fish Farm
8. Drying out of spawning grounds at Barangay Sta. Cruz and around lake generally
9. Health problems from domestic refuse exposed in drawdown

C. Deepening of Tabao River

10. Loss of fish cages in Tabao River and East Channel
11. Loss of Tabao River transportation

D. Construction of Control Structure

12. Growth of water hyacinths in lake

III. <u>Long Standing Problems</u>

1. Loss of migratory fish
2. Decline of traditional fishery
3. Low productivity of fish cages
4. Declining water quality
5. Sulphur upwellings
6. Decline to near extinction of Sinarapan
7. Typhoon damage
8. Erosion and sedimentation
9. Declining yields on Mt. Asug and spread of cogon grass

In response to complaints from the inhabitants of the municipality the concerned agencies have begun to address these problems. One response was the holding of a multidisciplinary and multisectoral workshop to discuss the problems and to identify a program of research and development which would lead to satisfactory solutions. The workshop was held under the aegis of the BRBDP with funding from USAID. Responsibility for the workshop was subcontracted through the International Institute for Environment and Development (IIED) to the Program on Environmental Science and Development (PESAM) of the University of the Philippines, Los Banos and to Professor Gordon Conway of the Centre for Environmental Technology, Imperial College, London. PESAM, under the leadership of Dr. Percy Sajise, conducted field studies to gather appropriate data for the workshop. was responsible for the running of the workshop and with Professor This was held from 14-18 November in Naga City. Over 60 participants were present, drawn from a wide range of Philippine government agencies, from USAID and the Asian Development Bank, from the Buhi Municipality together with representatives of farmers and fishermen of the area. This report describes the analyses conducted by the workshop and the recommended research and development priorities.

The participants divided into five case study teams who analysed the Buhi Watershed, Lake Buhi, the Tabao River, the Lower Lalo Service area and the Buhi System as a whole. Each study team began by defining the boundaries and hierarchic structure of their system and then conducted a pattern analysis of the system in terms of the patterns of space, time, flows and decision making. This was followed by an analysis of system properties and the identification of key questions for research and development. Each question was accompanied by a statement of the relevant hypotheses and guidelines and identification of the actions required. Finally the whole workshop participated in an assessment of the potential effects, costs and time to benefits of the innovations contained in the proposed key questions.

The resulting list of priority key questions for research and development is as follows:

<u>The Buhi System</u>

1. How can a satisfactory minimum lake level (81.7m) be maintained throughout the year, or at least be guaranteed up to the end of May?

<u>Buhi Watershed</u>

1. What is the maximum sustainable productivity of the watershed area?

2. What will be the overall consequences for the productivity, stability, sustainability and equitability of building an access road around the lake?

3. What government policy should be adopted to settle tenurial conflicts and human settlement problems in the Buhi watershed?

<u>Lake Buhi</u>

1. What are the socio-economnic costs and benefits that would accrue to the lakeside inhabitants at the minimum and maximum elevations of the lake water (79.65, 83.5 and 85 m.a.s.l.)?

2. What is the maximum sustained yield of fisheries and subsequent fishing efforts that can be carried by the lake?

3. How can Lake Buhi be managed effectively as a multipurpose resource?

4. What is the possible future water supply for people whose groundwater sources have dried up?

5. How can help be provided to fishermen whose fish cages have been affected by the drawdown?

Tabao River

1. How effective is the earth fill dam at the old Tabao River for water impoundment and as a means of transport?

2. Will filling-up of the old Tabao River be beneficial to the people of Buhi?

3. Will traditional fishing and fish caging be viable in the Tabao Channel with the operation of the Buhi: Lalo Project?

4. How is access for people across the west side of the Tabao to be improved?

5. What government policy should be adopted to settle tenurial conflicts and human settlement problems in the Tabao Channel system?

6. How can Sinarapan be maintained in the lakelets in the upland of the Tabao River system?

Lower Lalo

1. What improvements in crop management can increase the productivity and sustainability of irrigated rice farms?

PART ONE

INTRODUCTION

1.1 OBJECTIVES OF THE WORKSHOP

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It is often said that left alone, nature can take care of itself; that the need for environmental management arises because of conflicts in the perception of priorities in the use of these resources by various sectors of society. This is the primary reason for convening this multi-sectoral, interagency, and multidisciplinary group for the conduct of the Buhi Agroecosystem Workshop. For the next five days, we will try to gain a common level of understanding of the Buhi Watershed Systems: the upper catchment/watershed, the lake, the Tabao area, the Buhi-Lalo Service area and the human components of these various areas and their interactions and relationships. This common level of understanding resulting from our own interactions will enable us to generate a commonly agreed set of key questions for research and development, on a short, medium and long term perspective.

This workshop has been made possible because of the desire of BRBDP under Director Villacorta's leadership to help alleviate some of the adverse effects of development activities in the Buhi watershed. BRBDPO desires to find new ways of effectively discharging their functions and in particular, coping with some vital emerging phenomena in Integrated Area Development Programmes: conflicts which arise from the management of interacting agroecosystems. The workshop has also been made possible because of a heightened and motivated leadership awareness for total development needs on the part of the local government of Buhi, headed by Mayor Crispin Mercurio.

Agroecosystem Analysis

UPLB-PESAM in cooperation with BRBDP through a grant from the International Institute for Environment and Development (IIED) funded by USAID is tasked with the guidance, organization and logistic support for the conduct of this Agroecosystem Analysis Workshop. The workshop also constitutes the Lake Buhi Ex-post Environmental Assessment - specifically with reference to the Hydraulic Control Structure and related projects. The output of this workshop will constitute the basis for the rationale, method, level of efforts of the monitoring and data requirements for research, mitigation measures, and for the development program in the area.

What is the Agroecosystem Analysis method? We will be guided in the use of this procedure by Dr. Gordon Conway of the Impérial College Center for Environmental Technology who is the original proponent of this method and who has used it successfully on many occasions during the past seven years. It consists of a structured but flexible workshop procedure of ecosystem analysis, based heavily on a multidisciplinary analysis to generate key questions and guidelines for research and development (See Part Three).

Timetable

The timetable for the workshop consists more or less of the following:

1st Day

Presentation of background papers dealing with the policy and institutional context of Buhi agroecosystem development and management, including that of farmers, fishermen, and other interest groups in the Buhi ecosystem.

2nd Day

Multidisciplinary analysis of the Buhi ecosystem using the procedure of Agroecosystem Analysis. Five multidisciplinary and interagency, intersectoral groups will be formed to analyze the following:

- Buhi Watershed
- Lake Buhi
- Tabao Area
- Buhi/Lalo Service Area
- Integrated Buhi Watershed System

3rd Day

Generation of key questions for research and development and identification of guidelines, hypotheses, and actions required.

4th and 5th Day

Presentation of the findings of each group in a plenary session of the whole workshop to determine the program of priorities for action.

As I have described it, the task before us is very important in that the quality of our output depends very much on how well we work together. Most importantly, it depends on how well we incorporate and harmonize the needs of the local communities (upland and lowland farmers, fishermen, and other sectors) into our programs.

1.2 HISTORY OF BICOL RIVER BASIN DEVELOPMENT PROGRAM AND THE INTEGRATED AREA DEVELOPMENT BUHI/LALO PROJECT

WILFREDO G. OLANO
Bicol River Basin Develoment Program

The early concept of River Basin Development evolved from singular projects for water management such as the Suez Canal of Egypt or the Tiza Flood Control Project in Hungary. By the end of the first decade of this century, interest had developed in multi-purpose projects or entire river basin management. Miami Beach, the Aswan Dam and the Indus Barrage are examples of efficient application of engineering techniques to water management. In 1930, the Tennesse Valley Authority (TVA) made the first attempt to adopt an integrated basin development. In the Philippines, the BRBDP was the first attempt of the Philippine Government and USAID to improve rural areas through the integrated development approach.

What is the environmental condition or setting of the Basin Area prior to BRBDP? We have mass poverty, a high rate of unemployment, inequitable distribution of income, malnutrition, a low rate of savings, restricted growth due to inadequate irrigation and drainage systems, periodic flooding, poor transport and marketing facilities and an unstable agrarian structure. Compared to other regions of the country, Bicol has remained among the most economically depressed areas. So that, in 1969, a United Nations Survey categorized Bicol as in a downward transitional trend and, unless a dramatic developmment innovation was resorted to, the Bicol Region would be left behind among the other regions in the country which are bound for development. Yet, in spite of these conditions, the Basin Area of about 312,000 hectares shows a high potential for growth, especially in agriculture, agribusiness, rural manufacturing, and industry. Thus, the need was felt for a dramatic and innovative approach to reverse this downward transitional trend of the Basin Area. In May 17, 1973, Executive Order 412 creating the BRBDP was signed by the President of the Philippines. This order started the first integrated development of a river basin in the Philippines. Basically, the objective of BRBDP is to improve the quality of life of its program beneficiaries through increased agricultural activity, increased employment opportunities, more equitable distribution of wealth and promotion of agribusiness industry.

Why was there a need for this approach? The regular government mechanism pursues planning and development efforts through the sectoral approach. In an economically depressed area like the rural area, sectoral approaches to improvement schemes do not respond completely to the interlocking and complex needs of the people. For example, when irrigation, roads, and flood control projects are pursued separately and uncoordinated, aside from realizing its objectives, the action breeds unwanted environmental, social or secondary and tertiary problems and impacts which are not expected. Singular projects on irrigation systems sometimes become a flood risk or sometimes elevated roadways promote flooding of ricefields. Other input/outputs to various infrastructure facilities do not complement each other or do not respond to the various complementary needs of the projects, thus negating the very benefits the projects have been designed for. For example, a good flood control facility will lose its effectiveness if no corresponding program on watershed conservation is adopted. Similarly, irrigation facilities without complementary post harvest facilities, good extension programs, and supply/demand management support will not be very effective. With the integrated approach, the various socio-economic and environmental variables are viewed and treated as components of a system. Each variable is assessed not only on its individual productivity output but viewed on its interdependent relationship to every other variable and its contribution towa-. its ultimate goal, that is, the improvement of the quality of life of the people. A good example is when people clamour for improvement of roadways, we look into the problem on a wider scale. We think of improving the productivity of the influence area by giving them irrigation, extension programs, livelihood alternatives and the improvement of their social services which may be overcrowded as a result of the improvement of their standard of living. We think of the supportive capacity of their environment, and that it does not degrade in an accelerating manner. These are assessed into a package of a total development or project mix which we give to the people.

This conceptual approach gained Integrated Area Development recognition and acceptance by national government so that, President Marcos on April 28, 1976, issued Presidential Decree 926 expanding the area to include the whole land area of Camarines Sur and Albay and vesting the agency with broad powers and responsibilities. The organization machinery was given enough flexibility to build its own planning management capabilities and be responsive to its complex requirements. Confidence in this pilot program (Integrated Area Development Concept) does not end there. Presedential 1553 issued June 11, 1978 expanded the Program area to include the whole province of Sorsogon. At this point, the entire Program area was sub-divided into 13 IDA`s (Integrated Development Areas).

In each IDA, an Area Development Team (ADT) is constituted with the Mayors, representatives of various line agencies, and other interest groups in the area acting as the project area level mechanism to generate and institutionalize local people's participation in both project planning and implementation. So during the preparation of the Rinconada-Buhi/Lalo Project a series of consultations with the ADT and the local officialdom of Buhi were undertaken, especially during the social soundness analysis of the project package. The BRBDP as a planning and coordinating body is also vested with adequate authority to secure funding for projects it initiates in order to be able to realize its goal.

Rinconada Buhi-Lalo BIAD III Project

One of the early BRBDP Projects was the Rinconada Buhi-Lalo BIAD III Project. The project is partly financed by USAID with a total cost of 87.88 million pesos and has two major components:

a) Watershed Development, and b) Irrigation Development. The feasibility study was prepared in January 1979 and presented to local officials and people for their comment and support, and in the same year start-up activities were also commenced.

Watershed Development: The watershed development was designed to reforest/agroforest denuded areas of about 536 hectares involving 245 has.in Barangay Ipil, Sta. Cruz, and Iraya, Buhi, Camarines Sur. Included in this component are training programs, institution building, research and management studies, erosion control, graded trail development, a backyard livestock program, nursery development and reforestation and agro-forestation activities. As a pilot project gaining experience, project management encompasses several agencies (Ministry of Local Government and Community Development, BRBDP and Bureau of Forest Development) each gaining insights and experience in piloting this component. Ministry of Local Government and Community Development, whose training and exposure are people-oriented, finds the need for adequate technical and management training in order to run the project successfully. BRBDP on the other hand, although successful in management, finds itself functioning in an area outside its mandate and therefore has to divest itself from implementing activities. BFD also has to survive the various technical, managerial, and bureaucracy problems it meets during the project implementation. The project was 93.9 percent accomplished as of December 1984.

Irrigation Development: In 1979, the pre-construction activities were started with the core group from the Libmanan-Cabusao IDA. Initial activities were the rehabilitation of the 1,000 hectare Upper Lalo Irrigation system. This component upgraded the existing irrigation facilities by constructing service roads, farm dikes, intake structures, increased storage facilities and organized Irrigator's Associations or IA`s. From the previous production of 60-70 cavans/hectare/crop, the production increase to 80-90 cavans/hectare/crop. The next activity included the construction of irrigation facilities for the 2,000 hectare Lower Lalo irrigation system and the formation of 8 Irrigators Associations (IA`s). The project beneficiaries were enthusiastic about the project. Organization of the IA`s were very much facilitated. The IA`s entered into a construction contract with NIA and thereafter were able to have a capital build-up for their associations.

This component is expected to be completed in December, 1985. Half of the area was already irrigated by March, 1984. Rice production has increased from a previous 45 cavans/ha./year to 170 cavans/ha./year. Where rights of way has been NIA's usual problem on construction, this problem was very much minimized in this area due to the active participation of the IA's. Similarly, because the IA's are involved in planning and construction. The implementation, transfer of technology, institution building, and spread of project benefits are facilitated.

Progress

In 1982, the intake structures at the National Power Corporation (NPC) forebay and the bifurcation structure were completed. These provide facilities for the conduct of the water to the Lower Lalo irrigation system. The construction was also started of the control structure at the lake. In early 1983, we began the operation of the intake structure at Sta, Justina which can irrigate 200 hectares in that area. By the same year, also, improvement and dredging of the Tabao River was started. The river discharge was improved from 12 cubic meter/second (cms) to 28 cubic meter/second. 12 cms is for NPC and 16 cms for irrigation needs. This improvement of discharge enables NPC to generate 10 million kwh/year, from a previous capacity of 7.5 kwh/year. As part of the dredging, a natural obstruction of the river was removed and thereafter the flow was facilitated. However, the rapid lowering of the groundwater resulted subsequently in drying of water wells around the area.

Along with this is the lowering of the lake water level during summer. This generates additional negative impact, such as drying and stranding of the fish cages, disruption of boat transportation and destruction of spawning grounds. These negative impacts have caused much concern to the people of Buhi and to the Municipal Mayor.

About March of 1984, the wooden bridge at the outlet no. 1 was removed and subsequently closed and filled as part of the design. This resulted in the fouling of the water at Tabao River and corresponding fish kills. Again, complaints from the different fish-cage owners were received by various government line agencies. The Municipal Government proposes to fill this area for civic projects while the fish-cage owners request the construction of a culvert to facilitate drainage. As a result of cost reduction schemes, NIA was able to tackle the problem by constructing a temporary 2 rows of 18"diameter reinforced concrete pipe, with recommendations for the installation of a permanent culvert and the reduction of backfill.

In 1984, we continued the irrigation of Sta. Justina and the 1,000 hectares of Lower Lalo. Simultaneous with this was the continued dredging of Tabao River and construction of irrigation facilities. At the end of 1984, we started to impound water at the lake to a maximum level. However, this resulted in the flooding of 50-60 hectares of riceland ad complaints from the farmers were received. Water was released from the lake. Because of unrestrained and unscheduled releases of water during summer, the lake water level lowers below the previous natural level, causing more complaints from fish cages due to drying of their fish cages, disruption of boat transportation and drying of some 290 pump wells. Thus, the unexpected fish water requirements together with irrigation and power water requirements have become a water resource allocation problem.

In response to this problem and the Mayor's concern for his constituents and the people's complaints BRBDP organized a task force to look deeper into the problem. The task force was able to come up with a package of project proposals to mitigate these negative impacts. This project proposal was subsequently transmitted to lending institutions for funding consideration. The NIA, on its own, created its own task force to solve the problem and submitted its recommendations to the Mayor of Buhi and BRBDP. Cognizant of the problem, the USAID, together with

PESAM, BRBDP and other institutions both from national and international scene, have organized this workshop as an initial response to the situation.

As of now, NIA is conducting a bathymetric survey at the Lake to provide baseline data for future researchers and studies. The Buhi-Lalo Project today is about 90 percent accomplished and is due for completion in December, 1986.

PART TWO

GOALS AND POLICIES

2.1 BICOL RIVER BASIN DEVELOPMENT PROGRAM: POLICY AND GOALS FOR THE LAKE BUHI WATERSHED

CARMELO R. VILLACORTA
Bicol River Basin Development Program

BRBDP has consistently pursued a goal for the past twelve years of uplifting the quality of life of the Bicolanos in the Program area and the Bicol Region as a whole. This primary mandate of the BRBDP is to be attained through a four-pronged multi-sectoral approach, by increasing agricultural productivity, increasing employment opportunities, promoting equitable distribution of wealth and promoting agro-industrial growth. Numerous projects are being implemented to achieve this goal. The Libmanan-Cabusao IDA, the Pili-Bula Land Consolidation Project, the Secondary and Feeder Road Project Package I, the Bicol Integrated Health, Nutrition and Population Project, and the Bicol River Basin Irrigation Development Project are some of these projects.

One particular feature of the Program is the Integrated Area Development or IAD scheme, which is the basis for conceptualizing development strategies intended for the coverage of the BRBDP. It is a departure from the old concept of planning projects by a piecemeal approach. The IAD scheme emphasizes the participation of the project users in the identification of problems and probable solutions and in prioritizing the needs of the locality. Through this bottom-to-top method, popular support is encouraged and the ultimate beneficiary finds himself in an active role in the planning, implementation, and maintenance of projects intended to improve his way of life. Furthermore, the participatory approach provides BRBDP management with useful inputs in decision making.

Projects are packaged only after their technical feasibility, economic viability and social desirability have been determined. If negative impacts likely to be generated by the project are identified, measures to mitigate the impact are proposed or are included in the package. This ensures that the total effect of the project will be beneficial, or the overall positive impact of the project package is greater than the negative effect. To accomplish this, consultants are often hired to conduct environmental impact assessment. This method is a routine process in the BRBDP planning approach to development strategies.

Development Strategies

The BRBDP recognizes that when the natural resources which abound in the Program area are effectively tapped, these will satisfy the basic needs of the people. The BRBDP therefore supports other government agencies' efforts to encourage the proper utilization of these resources so that ecological balance is maintained at the same time that development activities are generated.

This concept is attained by the following:

A. Proper use of exhaustible resources. Agribusiness, for example, is prompted to make use of indigenous energy, such as steam energy (geothermal), and identify other energy sources, such as Mini-Hydro and Dendro-Thermal energy.

B. Vigorous development of renewable resources. The BRBDP pilots reforestation and agro-reforestation projects in the area and promotes upland development, not only to protect irrigation facilities but also to develop resources for environmental and economic ends.

C. Overall maintenance of future resource level. The BRBDP maintains the sustainability of resources such as the three lakes in Camarines Sur by joining the Bureau of Fisheries and Aquatic Resources (BFAR) in their fishery programs. The BRBDP also assists in hydrobiological surveys, proposes joint programs on fingerling production for dispersal and projects to increase fish production.

D. Optimizing agricultural productivity and minimizing negative environmental effects due to change of land use. From the very start of the Program, BRBDP has embarked on primary surveys on land utilization and productivity. These are: Land Classification Survey on Lowland Areas and the Land Capability Survey and Evaluation of the Upland Areas. Hydrometeorological stations have been likewise established in major tributaries to continuously monitor runoff, sediments, water quality, etc.

Thus in line with the resource allocation dynamic equilibrium concept, development effort is based on the simple premise of the existence of these resources, instead of the "market opportunity" or the "maximization concept". We do not allocate or exploit resources to the point of environmental degradation or irrationally creating environmental probems. The main goal of the Program is to improve the quality of life of the beneficiaries and concomitant with this is the protection of the environmental resources for the people's benefits.

In the Lake Buhi environment, lake resources are allocated to irrigation, power, and fishing to optimize the benefits that could be derived for the welfare of the people in the area. About 10,000 hectares of ricelands have been targetted for irrigation and support water for the hydroelectric power of the National Power Corporation (NPC) at Barit. Prior to these, the Program piloted the Lake Buhi Watershed for Agroforestation and Reforestation Development in the hope that this will expand in the watershed area of Buhi and eventually throughout the Program area. All of these efforts are geared towards maintaining the environmental balance of Lake Buhi.

Fish cage technology is relatively new in the lake. By the time the construction of the control structure was in full swing, the installation of fish cages at Lake Buhi and Tabao River started to proliferate. This unexpected fishery development poses a conflict over resource allocation. Which should be given the priority in resource use of the lake - irrigation, power or fishery?

In dealing with the problem, BRBDP considers the prioritization of difficulties confronting the beneficiaries by identifying projects that will lessen the negative impact caused by the control structure. Already identified are the construction of domestic water supply, improvement of the fish cages (they will be converted to floating cages), construction of a 10-kilometer circumferential road around Lake Buhi and the extension of the Lake Bato watershed project to Lake Buhi, to an area of 385 hectares. All development activities undertaken in the watershed area, however, must be consistent with Proclamation 573, Parcel No. 10 which declares the whole of the municipality of Buhi as a watershed area.

With the goal of improving the quality of life of the people, the BRBDP aims to optimize the productive capacity of the lake, maintaining the sustainability of this resource, promoting watershed conservation in the environment of the municipality, and by taking special interest in the social concern of the Buhi people. We are going in that direction. With this workshop, it will not be difficult as long as the different government agencies and other institutions render full cooperation to help us realize this goal.

2.2 THE NATIONAL IRRIGATION ADMINISTRATION: ITS GOALS AND POLICIES

FLORENTINO CAMARADOR
National Irrigation Administration

Irrigation is a basic component of any countryside development project aimed to attain balanced regional development in an agricultural country. Among projects where irrigation is a very important feature are rural development projects, irrigated area development projects, river basin projects and land settlement projects.

In all these endeavors, a major thrust is almost always the improvement of the agricultural sector, hence the inevitable inclusion of irrigation. This paper is prepared to discuss briefly the goals and policies affecting the directions of the irrigation program.

Background

The National Irrigation Administration (NIA) evolved originally from the Bureau of Public Work's Irrigation Division which was created on June 13, 1908 in accordance with Act No. 1854. Its main function then was to develop, operate and maintain irrigation systems.

On September 15, 1984, Republic Act No. 3601 dated June 22, 1963 was passed by the, now defunct, congress. This created the National Irrigation Administration which took over the functions of the Irrigation Division and had for its initial personnel complement that division's entire personnel force. The creation of the National Irrigation Administration as a corporate entity has been considered a milestone in national efforts to boost agricultural production.

The need for an expanded irrigation development program during the early 70's prompted the issuance of Presidential Decree, made on R.A. No. 3601. By this decree is granted broader powers and authority to the NIA to undertake program-oriented and comprehensive water resources projects for irrigation purposes, as well as concomitant activities like flood control, drainage, land reclamation, hydraulic power development, domestic water supply, road or highway construction, reforestation and projects to maintain ecological balance in coordination with the agencies concerned. To translate these broadened tasks and goals into reality and to make meaningful its enlarged powers, the same decree increased the NIA's capitalization from 300 million pesos to 2 billion pesos. The amended law also authorized the agency to borrow from foreign sources. All irrigation activities undertaken by the Irrigation Service Unit and Presidential Assistance for Community Development agencies were also taken over by the NIA under a government reorganization that followed shortly.

Presidential Decree No. 1702 dated July 18, 1980, a more recent amendment, set the authorized capital stock of NIA to 10 billion pesos to be subscribed and paid entirely by the Philippine government. All amounts collected by the agency as irrigation fees, administration charges, drainage fees, equipment rentals and materials, and all other income, were also added to its operating capital by virtue of the decree. It further authorized NIA to impose, as administration and engineering overhead charge, five percent of the total cost of projects undertaken by it, which shall likewise form part of its operating capital.

Powers and Objectives

Among the powers of the NIA defined in its charter are the following :

1. To investigate and study all available and possible water resources in the country, primarily for irrigation purposes;

2. To plan, design, construct and/or improve all types of irrigation projects and appurtenant structures;

3. To operate, maintain, and administer all national irrigation systems;

4. To supervise operation, maintenance and repair, or otherwise administer temporarily when necessary, communal and pump irrigation systems constructed, improved and/or repaired wholly or partially with government funds;

5. To delegate partial or full management of national irrigation systems to duly organized cooperatives associations;

6. To charge and collect irrigation fees or administration charges from beneficiaries of systems constructed or administered by NIA;

7. To recover from the beneficiaries of all irrigation systems the full cost of construction or portion thereof within a reasonable time and to the extent consistent with government policy;

8. To construct multipurpose water resource projects that give other benefits aside from irrigation;

9. To establish/create such services and facilities and other means of social economic assistance to the community which might be adversely and directly affected by the construction of NIA projects; and

10. To impose an administration and engineering 5 percent overhead charge of the total cost of projects it undertakes.

As the country's agency charged with irrigation development, NIA's mission is to provide adequate and timely water resources for irrigation and other corollary physical and technical services to the people, in support of the development program of the national government. In support of this mission the general objectives of the agency particulary during this decade of the 80's are as follows:

1. To support the government policy of self-sufficiency in food production;

2. To maintain a satisfactory level of service;

3. To catalyze development in the rural areas; and

4. To operate the agency as a viable corporation and in a cost effective manner, particularly in the implementation of its capital investment construction program, its operation of systems and administration of the agency.

Policies and Strategies

The NIA as a government-owned and controlled corporation faced the challenges posed by the 80's in a manner characteristic of a dynamic and an open organization. The scientific scanning of its internal and external environment resulted in the formulation of a CORPORATE PLAN defining its mission and general objectives. It spelled out among others, the broad directions of the agency, the major operating strategies and the indicative plan on irrigation development for the plan period, all geared towards the attainment of its objectives.

One of the major strategies and policies enunciated in the CORPLAN is Irrigation Development. The agency's development plan has been programmed to support current development thrusts and concurs with national directions for the decade. The current development plans call for the expansion of irrigation development to meet the demand for rice of the growing population, to help correct imbalances in rice supply and demand and increase diversification of irrigated areas to other crops.

It is the policy of the NIA to develop irrigation projects on the basis of a system of priority. Thus preparation and implementation of projects are regionalized to ensure that projects promising the most benefits to farmers and compatible with the NIA's viability thrust are given priority. Emphasis is also on communal irrigation projects which mobilize the productivity of farmers' associations for operation and maintenance while promoting economic progress in the countryside.

Projects which will cause harm to the environment or which will have adverse effects on other development projects will not be prosecuted, unless such harm can be remedied or reduced. Organization of viable and responsible irrigators' associations/cooperatives will be made to share with the capital and assume the maintenance and management of the systems. The completed system shall be turned over to the irrigators' association only after they have been fully trained to manage the systems. NIA shall monitor and evaluate the performance of the irrigation systems to meet certain standards and extend technical assistance as may be needed.

While NIA strongly supports the energy development efforts of the government, particularly hydropower generation, implementation of major multipurpose projects will be sequential, to suit the agency's limited cash resources.

2.3 BUREAU OF FOREST DEVELOPMENT: POLICY AND GOALS

SABADO BATCAGAN
Bureau of Forest Development

Policy

Before the creation of the Wood Industry Development Authority (WIDA), the Bureau of Forest Development (BFD) was responsible for the management of both forest lands and resources. Now, the BFD has to concentrate on forest land management - a function vital to the forest conservation program in the country. However, forest land management, although recognized by law, is not considered much of a priority in forest policy, and therefore, yet to be realized.

The Management of Policy of the BFD is multiple-use and sustained yield (MUSY) of our forest lands. Under MUSY management systems, our forest lands shall be managed to provide commodities and amenities like wood, water, wildlife, forage, recreation, etc. This does not mean, however, that all of these benefits shall be obtained from each hectare of forest lands. A forest land-use plan is therefore necessary to combine (or single out) those benefits under capability and suitability criteria to optimize and best meet the forest resources needs of our people. The main consideration in MUSY management system is that the basic resource, which is the forest land, shall not be impaired in providing the forest resources needs of the people.

Goals

Forest lands, according to functions, may be protection forests, production forests, agroforestry forests or community forests. The forest lands of Buhi Watershed are presently treated by the BFD as both a protection forest for its watershed values and as an agroforestry forest, since we were able to secure clearance from the BFD National Director to allow the awarding of Certificates of Stewardship within the Buhi Watershed.

In the Buhi Watershed, the BFD goals can be specified in terms of the following topics (not necessarily in order listed).

1. <u>Forest Protection</u>: First and foremost action. It is better to prevent than to "cure" forest destruction.

2. <u>Forest Rehabilitation</u>: What nature cannot easily heal or cure, then man helps nature in repairing itself to reach its potentials. Where natural recovery is close to impossible, and if economically feasible, small engineering structures, like check-dams, should be introduced.

3. <u>Water Yield Improvement</u>: Water quality and timing shall be achieved by the foregoing actions 1 and 2 which will reduce sedimentation and improve water water storage.

4. Water Resources Development: This is the final concern of water-using agencies or communities. (The concern of BFD is to deliver water at proper quantity, quality, and timing).

2.4 AGRARIAN REFORM IN THE BUHI WATERSHED

SALVADOR PEJO
Ministry of Agrarian Reform

Background

The Buhi watershed is located in the upland barangays of the Municipality of Buhi, Province of Camarines Sur. The following barangays are within the watershed area:

1. Ipil
2. Iraya
3. Sta. Cruz
4. Antipolo
5. Cabatuan

Within the watershed area are private agricultural lands devoted to rice, corn, coconuts, and other crops. The other areas are within the classified forestland of the public domain.

On October 21, 1972, PD 27 was promulgated transfering to tenant-tillers the ownership of the land they actually till. This is limited to lands devoted to rice and corn. The PD 27 coverage in the Buhi watershed area is as follows:

	Iraya	Sta. Cruz	Antipolo	Cabatuan	Ibayugan
FB	57	42	8	8	6
Hectares	74.67	37.31	7.63	6.38	5.49
Parcels	88	63	10	9	7
Landowners	3	1	5	1	2

Some areas are within the retention privilege of landowners and thus remain under the agricultural leasehold system. These areas are as follows:

	Iraya	Sta Cruz	Antipolo	Cabatuan	Ibayugan	Ipil
FB	32	20	94	5	4	9
Hectares	30.32	12.61	134.15	5.5	2.54	8.62
Parcels	21	35	142	8	14	19
Landowners	30	33	3	4	4	1

The areas devoted to other crops are not covered by Operation Land Transfer (OLT) pursuant to PD 27. They are under the Leasehold System or share tenancy, as the case may be.

The Goals Of Agrarian Reform In The Watershed Area

I. In areas covered by PD 27, the objective is to transfer the ownership of the land to the tenant-tillers. This automatic transfer took effect on October 21, 1972 upon the promulgation of PD 27.

This is in consonance with the established policy of the Agrarian Reform Program which is -

> "xx To establish cooperative-cultivatorship among those who live and work on the land as tillers, owner-cultivatorship and the economic family-size farm as the basis of Philippine agriculture and, as a consequence, divest landlord capital in agriculture to industrial development; (Sec 2 (1) (RA) 6389".

II. In areas not covered by PD 27, the goal of agrarian reform Republic Act is to abolish share tenancy and institute the agricultural leasehold system. In areas devoted to rice or corn, this was converted automatically from share tenancy to leasehold system under RA 6389 approved on September 10, 1971.

III. In areas devoted to crops other than rice or corn, the goal is to establish the agricultural leasehold system and enforce the Security of Tenure of the tenant.

Agrarian Reform Policies Relevant To The Conservation Of The Buhi Watershed Area

The Code of Agrarian Reform adequately provides for some measures necessary for the productivity and conservation of the land reform areas, as follows:

1. It provides that the lessee must adopt proven farm practices.

> "x x To require the agricultural lessee, taking into consideration his financial capacity and the credit facilities available to him, to adopt in his farm proven farm practices necessary to the conservation of the land, improvement of its fertility and increase as to what proven farm practice the lessee shall adopt, the same shall be settled by the Court according to the best interest of the parties concerned; (Sec. 29 (3) RA 3844)".

2. To enable the lessee to shift to crops that will conserve the fertility of the soil and prevent erosion, landowner can propose change of crops.

"x x To propose a change in the use of the landholding to other agricultural purposes, or in the kind of crops to be planted: PROVIDED, That in case of disagreement as to the proposed change, the same shall be settled by the Court according to the best interest of the parties concerned: PROVIDED, FURTHER, That in no case shall an agricultural lessee be ejected as a consequence of the conversion of the land to some other agricultural purpose or because of a change in the crop to be planted; (Sec. 29 (2) RA 3844)".

3. The lessee is, likewise, prohibited from planting crops or use of landholding other than what was previously agreed upon.

"x x The agricultural lessee planted crops or used the landholding for a purpose other than what had been previously agreed upon; (Sec. 36 (3) RA 3844)".

4. The lessee is likewise prohibited from damaging or destroying permanent improvements nor must the same be allowed to deteriorate through the fault or negligence of the agricultural lessee.

"x x The land or other substantial permanent improvement thereon is substantially damaged or destroyed or has unresonably deteriorated through the fault or negligence of the agricultural lessee; (Sec. 36 (5) RA 3844)".

5. It is, likewise, the obligation of the lessee to cultivate and take care of the farm, growing crops, and other improvements as a good father of the family and perform all the works therein in accordance with proven farm practices.

These OLT and Leasehold areas in the Buhi watershed are on slope lands. The land is most susceptible to erosion, more so if it is planted to rice or corn. In such areas, the Ministry of Agrarian Reform (MAR) is encouraging the farmer-beneficiaries to plant fruit trees or such crops as will conserve the soil. This is made possible because PD 946 allows such conversion to other crops after October 21. 1972, provided the conversion is approved by the MAR Minister. This authority to approve conversion has been delegated to the MAR Regional Director for expediency.

"x Provided, however, that matters involving the administrative implementation of the transfer of the land to the tenant under Presidential Decree No. 27 and amendatory and related decrees, orders, instructions, rules and regulations, shall be exclusively cognizable by the Secretary of Agrarian Reform, namely:

1. x x

9. change of crop from rice and/or corn to any other agricultural crop; x x (PD 946, Sec. 12 (9))".

The most important policy I consider relevant to the conservation of the Buhi Watershed is the Security of Tenure of the Tenant.

In land under the leasehold and share tenancy system, security of tenure is provided in Sec. 49 of RA 1199 which was superseded by Sec. 36 of RA 3844 by RA 6389.

> "Sec. 36. POSSESSION OF LANDHOLDING; EXCEPTIONS. Notwithstanding any agreement as to the period or future surrender of the land, an agricultural lessee shall continue in the enjoyment and possession of his landholding except that it is final and executory if after due hearing it is shown that:

(1) The landholding is declared by the department head upon recommendation of the National Planning Commission to be suited for residential, commercial, industrial or some other urban purposes: PROVIDED, That the agricultural lessee shall be entitled to disturbance compensation equivalent to five times the average of the gross harvests on his landholding during the last five preceeding calendar years;

(2) The agricultural lessee failed to substantially comply with any of the terms and conditions of the contract or any of the provisions of this Code unless his failure is caused by fortuitous event or force majeure;

(3) The agricultural lessee planted crops or used the landholding for a purpose other than what had been previously agreed upon;

(4) The agricultural lessee failed to adopt proven farm practices as determined under paragraph 3 of Section twenty-nine;

(5) The land or other substantial permanent improvement thereon is substantially damaged or destroyed or has unreasonably deteriorated through the fault or negligence of the agricultural lessee;

(6) The agricultural lessee does not pay the lease rental when it falls due: PROVIDED; That if the non-payment of the rental shall be due to crop failure to the extent of seventy-five per centum as a result of a fortuitous event, the non-payment shall not be a ground for dispossession, although the obligation to pay the rental due that particular crop is not thereby extinguished; or

(7) The lessee employed a sub-lessee on his landholding in violation of the terms of paragraph 2 of Section 27."

Unless the tenant is secured in the peaceful possession of his landholding he will not take care of his farm and conserve its productivity. This is the best incentive for a tenant who has long been just at the mercy of his landowner.

In Operation Land Transfer areas, there is also an assurance that the landholding will remain in the ownership of the family of the farmer-beneficiaries.

Presidential Decree No. 27 provides that "x x Title to land acquired pursuant to this Decree or the Land Reform Program of the Government shall not be transferable except by hereditary succession or to the government in accordance with the provisions of this Decree, the Code of Agrarian Reform and other existing laws and regulations. x x."

Conclusion

The demand for more land of an increasing population in Buhi can definitely be reconciled with the greater demand for the conservation of the watershed.

It is, however, suggested that management of the watershed be improved.

2.5 ROLE OF THE MINISTRY OF AGRICULTURE AND FOOD IN THE CONSERVATION AND RATIONAL UTILIZATION OF BUHI WATERSHED

AGUSTIN B. MAGO
Ministry of Agriculture and Food

Introduction

Present government programs and policies are basically directed towards agicultural development, particularly increased food production. This, however, has led particularly to the removal of the technical restriction of the 18 percent slope classification of lands for economic development. Subsistence farmers have gone to the use of steep lands for agricultural production which when not properly handled will eventually lead to total degradation of land resources.

At present, several upland and watershed areas in the country are considered critical and if not properly checked may ultimately lead to total degradation. The Buhi watershed may not be considered critical at present, but with present conditions may become so if proper conservation measures are not employed.

Goals And Policies In The Conservation Of Buhi Watershed

The main goal of the Ministry of Agriculture and Food (MAF) in the conservation of Buhi watershed area is to facilitate the transfer of technology for the proper utilization of lands in the watershed area and the provision of first hand information on the physical and chemical features, as well as socio-economic conditions, of the land resources in the area. At this point, the land resources evaluation project of the Ministry plays a vital role.

The Ministry of Agriculture and Food will determine the appropriate levels of detail on a project basis (Land Resources Evaluation Project). They will pinpoint the following areas of interest:

1. land suited for grazing/ranching
2. land to be reserved for forestry/wildlife
3. lands with minor limitations which can be allotted to intensive cropping.
4. lands with major limitations that preclude any form of agricultural land use.

In addition, the conservation practices necessary will be included.

Organization

A technical team from MAF will be organized to conduct the survey in the Rinconada-Buhi/Lalo Irrigation Project. It shall be composed of or shall consider the following disciplines/expertises:

1. Geology/Geomorphology
2. Soils/Physiography
3. Land use/Farming System
4. Agro-hydrology
5. Agro-climatology
6. Water resources
7. Land development and cost analysis
8. Agro-socio-economics
    a. Marketing
    b. Socio-institutional
    c. Production economics

Methodology

Geology/Geomorphology. This discipline is aimed at identifying the rocks/rock formations and landforms in the area as it directly relates to the identification of soil physical and chemical properties.

Soils/Physiography. This is mainly geared at studying the soil physical and chemical characteristics in relation to the physiography/landforms, followed by subsequent grouping of the soils into classes. Evaluation of the soil characteristics which pose potential limitation to any agricultural use is usually undertaken.

Present Landuse/Farming System. This deals mainly with the identification and mapping of the existing land uses of the area as well as the present farming systems practiced in the area.

Agro-hydrology, climatology and water resources. This discipline evaluates the hydraulic conductivity in the soils or the rate of movement of water in the solum (permeability and infiltration as well as the determination of the soil bulk density, water holding capacity and the availability of moisture in the soil).

Climatic data is collected and evaluated for use in the determination of the best cropping pattern/cropping calendar suited in the area. Water resources are also evaluated, particularly the identification of probable sources of irrigation water and other uses.

Soil erosion, conservation, and land development cost analysis. In this discipline, the extent of soil erosion presently observed is identified and mapped. In addition, identification of potential erosion-prone areas is undertaken. Proper conservation measures that are best suited to the area are then promulgated and recommendations are made. Land development cost analysis is also undertaken to determine the feasibility of converting existing land uses to particular land uses which are best suited in the area.

Agro-socio-economics. This discipline is mainly based on the gathering of data through interviews about the present yield level of existing crops, cropping intensity, land tenure, and the farming practices in the area. Likewise, information regarding the socio-cultural profile, i.e. population, family size, traditions, and other social interaction in the area is also collected.

Policy Determination

All data gathered from these working disciplines are then collated and evaluated. From these inventories, proper classification of the lands in the Buhi watershed area can be determined and promulgated. Recommendations which will be generated however, shall consider the following: a) industries should not be sited in areas where they will cause pollution and b) critical watersheds should be rehabilitated/ reforested/ protected. The proper utilization of the lands for specific land uses as well as the proper conservation measures necessary will then be made in order to insure the conservation and rational utilization of the Buhi watershed.

2.6 SURVEYS FOR DEVELOPMENT

FLOR V. PELAYO
Bureau of Lands

The word SURVEY usually refers to line and angular measurements in order to settle boundaries or construct maps, plans or detailed descriptions of tracts of land and determine this form, extent or area. Surveying is usually connected to land surveying which, on the one hand, is the critical inspection and examination in detail of a piece of land for the specific purpose of granting titles or settling the ownership thereof (Cadastral surveys) and, on the other hand, is the operation involved in setting forth the results of such survey.

In this article, however, I would like to expand the meaning and purpose of land surveys so as to have for its general purpose the development of man and his environment. Development in this context is to unfold potentialities, to progress and to grow.

Let me therefore introduce you to some of the survey works which I consider necessary for development planning.

First, of course, is land surveying being conducted at present by the Bureau of Lands which is legally mandated to conduct surveys for titling purposes, to settle claims and conflicts over land and to determine the metes and bounds of political subdivisions. The contribution to development by this kind of survey is very limited, especially because cadastral engineers are too much pre-occupied with the science of measuring angles and distances between points on a spherical geoid which is the earth.

Advances made in science and technology give us many tools and sources which can provide us data that are otherwise not available. Production of aerial photographs and other data acquired from aircrafts and satellites is now a specialization. Remote sensing imagery is also being utilized extensively in data gathering.

An equally important tool in development planning is the accurate cartographic representation of topographic and cultural data. Cartographic education is offered by many schools but trained cartographers are very inadequate considering the demand.

Let me now proceed to summarize many kinds of surveys which are critical to development planning.

Geographical Surveys

A clear understanding of geologic features is required to evaluate and develop natural resources. In our region the combination of inaccessible terrain and shortage of skilled manpower severely limits the acquisition and analysis of geologic data. Aerial photography and other remote sensing techniques have become very important for identifying areas of possible mineralization, in hydro-geologic surveys and engineering geology for civil construction projects. Studies are available in general geological surveys, with a focus on geological photo-interpretation, for exploration and mapping hydro-geological survey and engineering geology. They include interpretation of aerial photographs, remote sensing imagery, multi-spectral scanning (MSS), solar (SLAR and SAR) and thermal infra-red (TIR) and field work. On-site investigations for civil engineering projects enable us to design, plan and supervise the projects in order to obtain results that may be presented for recommendations for engineering design.

Applied Geomorphological Surveys

Many development projects depend for their design and successful completion on the careful analysis and classification of land forms for resource studies and monitoring of environmental processes. The analysis and interpretation of aerial photographs and other remote sensing imagery provides an effective, reliable, and economical means for landscape analysis. Analysis and classification of land forms and monitoring of processes are applied to environmental and resource studies required for development projects. Data gathered are useful in watershed management and conservation, and survey and assessment of environmental hazards.

Soil Surveys

Wise use and management of our soil resources are needed to provide food for a growing population. Accurate information on soils is therefore vital and important to agricultural planning and development to indicate how the soil can be put to optimum use and its production potential preserved and even improved for future generations. Surveys and inventories of soils are very time-consuming and both manpower and funds are limited. But both can be much more efficiently used by applying interpretation of aerial photographs and other remote sensing techniques.

Forest Surveys

Population growth and economic development create an increasing demand for forest products which can be met only by proper management of the balance between economic utilization and such benefits as unimpeded stream flow, erosion control, wildlife protection and recreation. Efficient and effective management requires reliable information for forest mapping, timber inventory, damage and disease assessment and others.

Rural and Land Ecology Survey

The planning and execution of a well balanced policy of rural development requires data bases on various aspects of the rural environment, including land use, agriculture, rangeland ecology, vegetation and human settlements. Optimum utilization of the physical potential of the land also requires knowledge of both social and economic factors. Applications of space survey data are used as unique means of visualizing the natural and cultural landscape for land ecological studies and for the inventory and evaluation of rural agricultural lands and pasture lands, land use, ecology vegetation, rural settlements, and infrastructure analysis.

Survey Integration for Resource Development

The emergent need to improve the living conditions of fast growing populations makes the planned development of natural and human resources a necessity. The main focus of survey integration is to contribute toward bridging the communication gap between various specialists engaged in investigations and surveys for natural resource development (soil and water specialists, agriculture and forestry specialists, engineers, ecologists, etc.) and the decision makers and planners involved in rural development. Study possibilities offered comprise various specializations including surveys for land and water resource development, land evaluation, surveys for agricultural infrastructure and settlement planning, geo-based information systems, rural administration, project planning and surveys for rural energy planning.

Urban Surveys and Human Settlements Analysis

Population growth, social change, and economic development everywhere are related to the process of rapid urbanization. There is an urgent need for urban information systems for planners and administrators, derived from the data produced quickly and at short intervals.

Land Information Systems

Finally, a LAND INFORMATION SYSTEM should be established. It is a tool for legal, administrative and economic decision-making, and an aid for planning and development. It consists, on the one hand, of a data base containing spatially referenced land-related data for a defined area and, on the other hand, of procedures and techniques for the systematic collection, updating, processing and distribution of data. The primary component of a land information system is a uniform spatial referencing system for the data in a system, which also facilitates linking data within the system with other land related data.

In summarizing the state-of-the-art on surveying for development planning, the next task is to bring together many specialists of various disciplines to work on problems of development. I will consider this piece successful if it can stimulate efficient cooperation and discussion among planners and decision makers of the role of different professional groups in the process of development planning.

2.7 GENERAL POLICIES AND GOALS OF THE BUREAU OF FISHERIES AND AQUATIC RESOURCES IN CONNECTION WITH LAKE BUHI DEVELOPMENT

JOSE URBANO
Bureau of Fisheries and Aquatic Resources

Policy 1

It is the policy of the State to accelerate and promote the integrated development of the fishing industry and to keep the fishery resources of the country in optimum productive condition through proper conservation and protection.

Goals:

a. To determine the influences of the biological, physical, and chemical elements exerted on fish life as well as the socio-economic aspect of the Lake, to serve as a basis for the planners and policy makers in formulating appropriate policies on the proper development, management, and conservation of Lake resources.

b. To determine the lake open-fishery production and factors affecting productivity.

c. To increase to optimum level of fish production in the lake, balanced by proper conservation measures.

d. To provide continuous means of livelihood to all fishermen and effect optimum fish production in the lake, without affecting the lake's stability as a resource.

e. To attain the goals under policy No. 1. It is recommended that an ecological and environmental management monitoring system be developed and established in Lake Buhi.

Policy 2

The government shall promote and encourage the organization of, provide assistance to, and help integrate the activities of persons, associations, cooperatives and corporations engaged in the industry so that the nation may achieve the maximum economic utilization of its fishery resources. In this connection, the fishing industry shall be considered as a preferred area of investment.

Goals:

a. Provision of technical and financial support to Kilusang Kabuhayan at Kaunlaran (KKK) projects.

Some 800 units of fish cages (with common dimension of 5m x 6m x 3m or 90 cu. meters) have been financed under KKK fund. Released amount is ₱969,200.00 out of the total approved amount of ₱876,800.00. Some 400 fishermen are the beneficiaries of this KKK loan.

b. Provision of technical assistance in the organization of Samahang Nayon ng Mangingisda sa Buhi, Camarines Sur.

Policy 3

The government shall also encourage and promote the exportation of fish and fishery/aquatic products to enable the fishery industry to contribute positively to the development and growth of the national economy.

Goal:

Development of new fishery products and fish processing.

Policy 4

The private sector's privilege to utilize a fishery resource shall be exercised or continue to be exercised only under the basic concept that the grantee, licensee or permittee thereof shall not only be privileged beneficiary of the State, but also an active participant and partner of the government in the conservation and development of the fishery resource of the country.

2.8 POLICY AND GOALS OF THE NATIONAL POWER CORPORATION

RAMON ARIL
National Power Corporation

Allow me to divide my topic into two aspects. First, I mention the different acts, laws and decrees that legally lay down National Power Corporation (NPC) policies and its goals - pertaining to the development of power and conservation of watersheds in the Philippines. The second aspect deals with Lake Buhi and Barit HE Plant - as a water reservoir relative to the generation of power.

Acts, Laws, and Decrees

Commonwealth Act No. 120, approved on November 3, 1936 created the National Power Corporation as a non-stock public Corporation with the primary objective of developing hydroelectric power and producing power from other sources. This, in effect, nationalized the hydroelectric industry and reserved for the use of NPC, subject to existing rights, all streams, lakes, and springs in the Philippines where power may be developed.

On September 9, 1971, President Marcos signed Republic Act No. 6395 amending the NPC Charter and laid down as a primary objective the total electrification of the Philippines. Under this Act, NPC was given the task of undertaking the development/production of electricity from nuclear, geothermal, and other indigenous sources as well as the transmission of electric power on a nationwide scale. It was at this phase that NPC was converted into a stock Corporation wherein the authorized capital stock of ₱250,000.00 in 1936 was increased to ₱300 million.

Presidential Decree. No. 40 issued on November 7, 1972, just two months after the declaration of Martial Law, defined the basic policies for the electric power industry, whereby NPC was authorized to own and operate as a single integrated system, generating facilities supplying power to the entire area embraced by any grid it set up. Under this amendment, NPC has accelerated its energy expansion program brought about by the energy crisis in 1973.

On January 1974, PD No. 380 placed NPC directly under the Office of the President of the Philippines, to make it a more efficient arm of the government in the utilization of water resources and for total electrification of the country.

When the Department of Energy (now the Ministry of Energy) was created on October 7, 1977, NPC was given the task of serving as the government's primary instrumentality in the formation and implementation of its energy - resource development program on a unified and coordinated approach. NPC was attached to the Ministry for the purpose of policy coordination and integration with sectoral programs.

Prior to the creation of the Ministry of Energy, PD 398 and PD 1360 were issued to increase NPC capitalization from ₱300 million to ₱8 billion, thence to ₱50 billion in order to enhance its capability in implementing its power expansion program.

The Ministry of Energy was mandated by PD No. 1515 to take control and jurisdiction over watershed reservation to eventually attain the desired protection, development, management and rehabilitation. Likewise, NPC also served as the implementing arm under the decree. Watershed areas are considerably important to the lifespan of hydroelectric dams, geothermal, and other water-oriented government or ecological programs. Hence, for better protection, measures should be adopted in order to curtail the continuing destruction, denudation and deforestation of the watershed areas by the private sector. Under the Ministry's charter, no infrastructure project shall be undertaken without the Ministry's approval. These projects include dams, canals, channels, and passageways. Exemptions to this provision are those projects duly authorized and undertaken by NPC in accordance with its charter.

Presently, we have a total of 39 watersheds covering 3.6 million hectares. Twenty are in Luzon, including Buhi Lake, 11 in Visayas, and the rest in Mindanao.

Lake Buhi - Barit Hydroelectric Plant

Investigation of the feasibility of tapping Lake Buhi Barit River for development of hydroelectric power was done as early as 1930 by the Engineering Corp. of Washington D.C. whose services were engaged by the Utility Management Corporation at the instance of Manila Electric Company.

This study was further pursued by NPC in 1937 by sending a reconnaissance survey of the river system including Lake Bato. However, the project studies were interrupted when World War II broke out. But investigations were resumed after Lake Buhi was found to be a natural reservoir which can be tapped for hydroelectric power development. In February 1955 the construction of Buhi-Barit was started and completed on September 10, 1957 when its first KWH was transmitted to Naga City and later on to adjacent municipalities of Camarines Sur and Albay.

The NPC Board, through the recommendation of the System Operation Department, required Barit Hydroelectric Plant to generate 10 million KWH annually as its contribution to the total energy generation of the various plants interconnected with the Luzon Grid.

With the Ministry of Energy, NPC and other government and private sectors working hand in hand for the efficient and sound management of water utilization and watershed reservations, economic progress is bound to improve.

2.9 POLICY AND GOALS OF BUHI MUNICIPALITY

CRISPIN S. MERCURIO
Muncipality of Buhi

Introduction

We appreciate the efforts of BRBDP, PESAM, USAID, Asian Development Bank, national line agencies, and others towards the seeking of solutions to the environmental impacts brought about by the Rinconada-Buhi/Lalo Irrigation Projects, specifically to the town of Buhi.

Why would the topographic study and bathymetric survey, however, be conducted only now that the engineering works at the Tabao structure, the canalization, and distribution system at the target areas are almost finished?

Were the denudation of the watershed considered and forecasted? Siltation? Other uses of tributaries into the lake? The introduction of new fishery technology? Population pressure? We doubt if these were done in depth, if at all.

We welcome this seminar which hopefully will serve not merely to provide "lids" on everything, but to propose solutions to specific problems. And having proposed solutions, the agencies concerned should concretize the recommendations.

Documentation

All the letters, position papers and other documents relative to the degradation of our environment have been provided in a separate cover.

Policy

To support projects deriving water from Lake Buhi on a LIVE AND LET LIVE BASIS, but not for us Buhi people to be offered as sacrificial lambs on the altar of development.

Goals

1. For the Buhinon:

To be able to maximize the utilization of Buhi Lake, Upland, Forestland, Lowlands for his socio-economic and political development.

2. The Lake:

   a. Drawdown level no lower than 82 meters (Agreed upon by NIA on September 6, 1985).

   b. To maximize fishcage and other fishery practices for our economic benefit.

c. To preserve the lake through a continuing upland and watershed protection and management, and prevention of ecological degradation.

d. Compensate affected fishermen and farmers around the lake through self-reliant projects.

3. The Tabao Control Structure:

a. Come up with a memorandum of agreement among irrigators, NIA, NPC, and fishermen BEFORE ACTUAL OPERATIONS AND MANAGEMENT.

b. Provide security to the structure as vital installation.

c. Raise the agreed level to store more water, instead of aiming for a planned drawdown of 79 meters.

d. Assist/compensate affected farmers around the lake and along the Tabao River channel.

4. Funding for Continuous Ecological Conservation of the Lake Upland and Watershed:

a. A part of the 3 cavans per hectare collected and its equivalent amount contributed by irrigators be set aside for this purpose and administered by the local government through the assistance of line agencies.

b. Ditto for fishermen using lake water for fishing.

c. Ditto for NPC using lake water for power generation.

5. The Target Areas (Farms to be irrigated):

a. Reduce the total target area if the lake cannot support the project's requirement without severely disrupting fishermen's livelihood.

b. Plug leakage and losses along the system of distribution.

c. Stop the infrastructure if water will never flow in areas that cannot be sustained with lake water.

d. Don't raise false hopes among the farmers.

6. Line agencies to Fulfill the Following Promises:

a. "We must place a flood control project around the poblacion of Buhi". Minister Juinio - Cabinet Coordinator for BRBDP as he flew over Buhi Lake.

b. "From the centerline of the present Tabao bridge, we will fill up 125 meters up and 125 meters down", briefing by NIA engineers as the control structure was being built (The present project is 25 meters up and 25 meters down).

c. "We will make the dumping on the shoreline along the poblacion priority so you will have a flood control" (not done by NIA).

d. "We will not leave the place ugly", NIA. (Big boulders are an ecological blight along the road a few meters from the structure).

e. "We (BRBDP) have recommended ₱20 million worth of projects for mitigating the impacts so you can have waterworks, circumferential road, assistance to fishcage operators, etc". (Please expedite before O and M).

f. "We will construct footbridges for you in Francia, Raraquitan, and Sta. Justina across the channelized outlet", NIA. (Please expedite before you leave us).

And finally assuming that all infrastructures are finished, should we allow operations before any agreement is signed?

To decide or not to decide, rightly or otherwise, will have an immediate impact today and in the future. Let us overcome.

2.10 BUHI FISHERMENS' ORGANIZATION

EFREN SL. BON
National Media Production Center

Dr. Gordon Conway's report to the ORAD Chief (USAID) regarding the Buhi Agroecosystem after his preliminary visit in July 1985, especially his observations on the fishhrmen's plight in Lake Buhi in relation to the NIA Control Structure operationalization, is very interesting. It is, in fact, nearest to what we would like to bring to the attention of the concerned authorities. There are, however, some considerations we would like to clarify and/or point out, such as:

1) That if the Bicol Integrated Area Development III (Rinconada/Buhi-Lalo) has a general goal of improving the life of the of the rural poor how come that the poor fishermen of Buhi seem to be left out in BIAD III development projects in the area? It is noted that of several projects undertaken by said agency, nothing could be considered to be of direct importance for the advancement of the fishermen of Buhi. Does BIAD III "rural poor" mean the "tillers of the soil" only? In the NIA control structure project alone, the fishermen were made to sacrifice for the benefit of the agricultural farmers. If this situation continues, social problems may crop up and complicate matters more in the area.

2) The Buhi Lake is dying. Since 1641, which is said to be the start of its formation, there has been no serious study conducted in the area to preserve and enrich it. There were several attempts in the past but these never came into reality. The utilization of the lake at present as a source for irrigation of more than 10,000 hectares of lands in Rinconada brings more fears to Buhi fishermen than relief for their poor existence. Concerned agencies should step on this now. Not to do so is to court disasters.

3) Population management should be taken into serious consideration in the implementation of development projects in the area specially in the fishermens' plight. To preserve the lake as the source of irrigation water for the Rinconada lands directly means to implement effectively family planning techniques in the area. Not to do is to pollute more and destroy the source in no time at all. This component was left out in the NIA control structure project.

4) The very limited inputs for the total development of the fishermen and his place of work -- the lake -- can bring more adverse effects in the NIA project as fishermen tend to put the blame for their present difficulties in livelihood as the direct result of the structure in Tabao. This is true particularly for those people engaged in fishcage, "baclad" and "tambong" operations. Cooperativism as an economic tool for people's advancement should be re-introduced in this area. An in-depth and honest-to-goodness study should be conducted and serve as the basis for decisions. A table-survey is taboo. It will create a Chico Dam situation.

5) Communication component requirements for every development People's Participatory Approach (PPAs) being pursued by government agencies should be adequately provided for so people can appreciate the importance of said PPAs and even help in the concretization of same. In the NIA project, this component is neglected. People, specifically the fishermen, were left to their own estimates as to the effects, advantages and/or disadvantages of said project. Implementing agencies should thrive to bring the people closer to the government via the development projects. It is tragic that people tend to condem the government for every project it puts up in the name of development.

We hope that with the Buhi Agroecosystem Analysis Workshop everything will be in its proper place. We cannot ask for more. We trust that after this positive step, we will learn the truth behind the words of Genaro Ong, Jr.: "Development projects fail because they seek to change the environment of people rather than change the people themselves."

2.11 POSITION PAPER ON POLICIES AND GOALS IRRIGATORS ASSOCIATION OR LOWLAND FARMERS ASSOCIATIONS

ELIODORO ESTADILLA
Lowland Farmers Association, San Juan

I am very glad to be one of the participants to this Agroecosystem Seminar Workshop and at the same time represent the Pili-Bula Irrigators Association. There is no workshop without sacrifice so that, as a farmer, I am ready to bear whatever inconvenience this workshop will cause me. Foremost in my desire is to share with you my feelings, experiences and frustrations as a farmer of a rainfed rice farm.

In late 1980, the Agriculture Developement Division of the Bicol River Basin Development Board started giving us information about the irrigation project and providing us with institutional development assistance, and thenceforth our hope for a brighter farming endeavour brightened.

The informational campaign conducted by the said project made us understand the objectives and goals of the project, viz:

1. To provide the necessary infrastructural facilities that could boost rice production in this province;

2. To improve the rural income;

3. To create employment opportunities; and

4. To upgrade the living standard of the rural population in the project area through a better irrigation service and intensified developmental assistance.

We are farmers whose produce is not even enough for the consumption of our families: At times, especially during the lean months of the year, most of us buy rice for our own consumption, so that supporting the education of our children and sustaining our social obligations become practically impossible. Consequently, our children and the young labor force that are growing in number in our locality are tempted to migrate to big cities to seek for employment. We hope that when this irrigation project becomes functional, there will be added employment opportunities aside from the promise of bountiful harvests. Needless to say, irrigation will not only satisfy the needs of the growing population but will also be a source of revenue.

As a result of the project's institutional assistance, we were able to organize Farmers Irrigators Group (FIG) and finally Binobong Tagbong Irrigators' Association in September 26, 1982 which was registered with the Securities and Exchange Commission in October 18, 1983. We have potential beneficiaries of approximately 244 farmers covering an area of 384.04 hectares (as per design, Div II-RID Office). We are part of the Irrigators' Associations in Rinconada area that will benefit from the Right

Main Gravity canal covering the Barit River Irrigation System Area, Baao and Pili-Bula areas. A total of 15 Irrigators' Associations were organized in the RIDA IDA having potential farmer beneficiaries of 5,154 covering an area of approximately 8,033 hectares. These are the lowland farmers who are expecting the much needed irrigation water.

Based on my farming experience, our average harvest per hectare ranges from 44-52 cavans/ha./season which is low compared to the harvests being attained in irrigated areas. Information furnished by the project shows that there is a projected increase in yields of rice per hectare per specific cropping season. The average yield per hectare for irrigated farms are expected to increase from 44 cavans to 79 cavans during the wet season and from 52 to 86 cavans during the dry season, over a period of five years.

The farmers'/irrigators' associations are primarily organized to bring realization to the project's goal and speed up its completion. We understand, also, that we were organized to properly and effectively use irrigation water and other complementary inputs towards increased production in rice and hopefully be able to manage our own area coverage.

We are continually coordinating, assisting and cooperating but the purpose of which we were organized is still a dream. We are hopeful that after project completion, we will also experience bountiful harvests and realize yields that will be in line with 86 cavans or more per hectare. This would mean higher net returns per hectare. Hence, we could say we have attained some improvements and are on the road to development. So at this point in time let me reiterate, the Irrigators' Associations in RIDA, specifically Pili-Bula and Baao farmer beneficiaries, are really expecting that after project completion we will be served with irrigation. What is printed in the wall of the NIA Regional Training Center Hall is true. "IRRIGATION IS THE CRYING NEED OF THE HOUR". Presently, we are at the portion of a tilted basin which is dry.

Sometime in April 1985, I attended a workshop or seminar on Financial Management in La Trinidad, Iriga City and in the closing program of said seminar, we were informed by the Division Managers of RIDA, Engr. Carlos R. Martinez, that by mid 1986, the construction of the main canal, lateral canals and other appurtenant structures will be completed. Despite the unfavorable conditions, both environmental and financial, that cause delay in project completion, we are still hopeful that this project will be completed as programmed. So let us not disappoint the thousands of farmers that await the benefits from this project. And though we be assured of project completion if we will not be assured of water source, all will be in vain. We therefore must focus our attention on our water source.

The Bicol Region is rich in natural resources and one of these potentials is exemplified in the geothermal plant in Tiwi, Albay which produces electricity not only for the Bicol Region but for most parts of Luzon as well. Likewise, the Rinconada area in Camarines Sur is equally proud of the Lake Buhi which is a possible source of water that can irrigate our farms and, thus can contribute to the agricultural development and sufficiency of our staple food.

As provided for in the invitation signed by the BRBDP Program Director, Carmelo R. Villacorta, "The workshop will use a methodology of multidisciplinary analysis which was found effective in Thailand, Indonesia, Pakistan and other developing countries...." so the expected output of this workshop we hope will be effective and functional in our area for the benefit of all.

May I therefore request the inhabitants of Buhi, especially the officials and the Honorable Mayor Crispin Mercurio who I understand is one of the participants of this workshop seminar, to please hear our appeal for their cooperation and assistance. We know that Lake Buhi is the foremost source of living of the inhabitants but in consideration of the Irrigation Project that will tap their water source, the farmer beneficiaries of the NIA project appeal to your generosity - give us also water for our crops. On the contrary if at the expense of providing us irrigation water based on the feasibility study, the inhabitants, will be displaced of their conveniences, I am asking in turn the NIA Management to support either financially or technologically to suffice the needs of the Buhi-inhabitants in compensation for their generosity. So Ladies and Gentlemen, we have a very delicate task here that is, to MEET BOTH ENDS.

Fortunately, I was given the opportunity to express..." the crying need of the hour.." right at the start of this workshop-seminar, thus, on the proceeding discussions, may everybody have the idea and hear the cry where I belong.

On behalf of the farmers I am representing, I have high hopes that convening of this five-day seminar will not only bring us our important guest but through them, we will find solutions and facilitate realization of the project's future. Lastly, may I call for a pool of efforts for irrigation development and in the end provide assurance to the lowland farmers' associations of their much needed irrigation water.

PART THREE

AGROECOSYSTEM ANALYSIS

3.1 AGROECOSYSTEMS

GORDON R. CONWAY
Centre for Environmental Technology
Imperial College of Science and Technology

Rural development is beset by a large number of problems. One set of problems is created by the inevitable and ubiquitous link between agriculture and the environment. We depend on the environment, the resources of land, water, sunlight, and biological organisms for agricultural production. But in the process of agricultural development we introduce new man-made elements, such as pesticides, fertilisers, machinery, and specially bred plants and animals. These interact with the environment, often adversely and sometimes to such an extent that natural resources essential to agriculture are harmed or destroyed.

A second set of problems is created by the conflicts which arise between people over the use of natural resources. These resources are not evenly spread over the landscape. They vary in quantity and quality from place to place and also from time to time. Populations of people also vary in a similar way, although frequently the densest populations do not occur where the resources are abundant or of good quality. Development is thus not just a problem of maximising the productivity of the exsisting resources, but also has to tackle the question of how these resources and their productivity are to be shared.

A third and related set of problems results from the multidisciplinary nature of the task. Successful development requires the genuine integration of a wide range of skills and knowledge, ranging from anthropology to entomology. Bringing such varied disciplines together in an efficient and productive way to produce a common agreement on worthwhile action is an enormous challenge. It is relatively easy to physically bring different specialists together but the process of interaction may remain casual, often producing results that are superficial and mundane. Experience suggests that the generation of good interdisciplinary insights also requires organising concepts and frameworks and a relatively formal working procedure which encourages and engineers cross-disciplinary exchange.

In this chapter, I describe the underlying philosophy of an approach to these problems which I and my colleagues have been elaborating over the past seven years (Conway, 1985, 1986). In **Chapter 3.2, I provide the details of the procedure.**

Some Basic Concepts

The concepts I use are simple and basic and involve a minimal set of assumptions that are acceptable to all the disciplines participating in the exercise. The central concept is that of the system; related to it are the concepts of system hierarchy, system properties, and the agroecosystem.

A system is here defined as an assemblage of elements contained within a boundary such that the elements within the boundary have strong functional relationships with each other, but limited, weak or non-existent relationships with elements in other assemblages; the combined outcome of the strong functional relationships within the boundary is to produce a distinctive behaviour of the assemblage such that it responds to many stimuli as a whole, even if the stimulus is only applied to one part.

Systems take many forms and vary greatly in their extent and complexity. Each human being, for example, is a system and we live in systems of households, villages, towns, and countries. Planet earth is a system, within the solar system. We create mechanical systems such as the plow and the motor car. Around us are natural ecological systems such as lakes, forests, and grasslands and we have transformed these into a variety of agricultural systems.

The principal systems we have to deal with in this workshop are described in a simplified fashion in Figure 1. Together these individual systems combine to form an overall "Buhi system" which is both complicated and highly integrated. A change in one component, affects all the others and thus any intervention, produced for example by a development project, can have ramifying consequences.

Buhi also illustrates the point that systems are often arranged in a nested hierarchy (Figure 2). Systems higher in the hierarchy tend to control those beneath them and, most important for the task of analysis, the behaviour of higher systems is not readily discerned simply from a study of the behaviour of lower systems. Each level in the hierarchy has to be studied in its own right.

In agricultural development, natural ecological systems are transformed into hybrid agroecosystems for the purpose of food or fibre production. The transformation involves several significant changes. The systems become more clearly defined, at least in terms of their biological and physico-chemical boundaries. These become sharper and less permeable; the linkages with other systems are limited and channelled. The systems are also simplified by the elimination of many species and various physio-chemical elements. A good example is the ricefield (Figure 3): the bund forms a strong, easily recognisable boundary, while the irrigation inlets and outlets represent some of the limited outside linkages. The great diversity of wildlife in the original natural ecosystem is reduced to a restricted assemblage of crops, pests and weeds. The key functional relationships remain essentially ecological in character, involving such processes as competition (eg. between the rice and the weeds), herbivory (eg. of the rice by the pests) and predation (eg. of the pests by their natural enemies). But overlying these are new processes, cultivation, and harvesting, subsidy by means of fertilisers or manure, and control of water or pests. These processes, in turn, are usually the result of

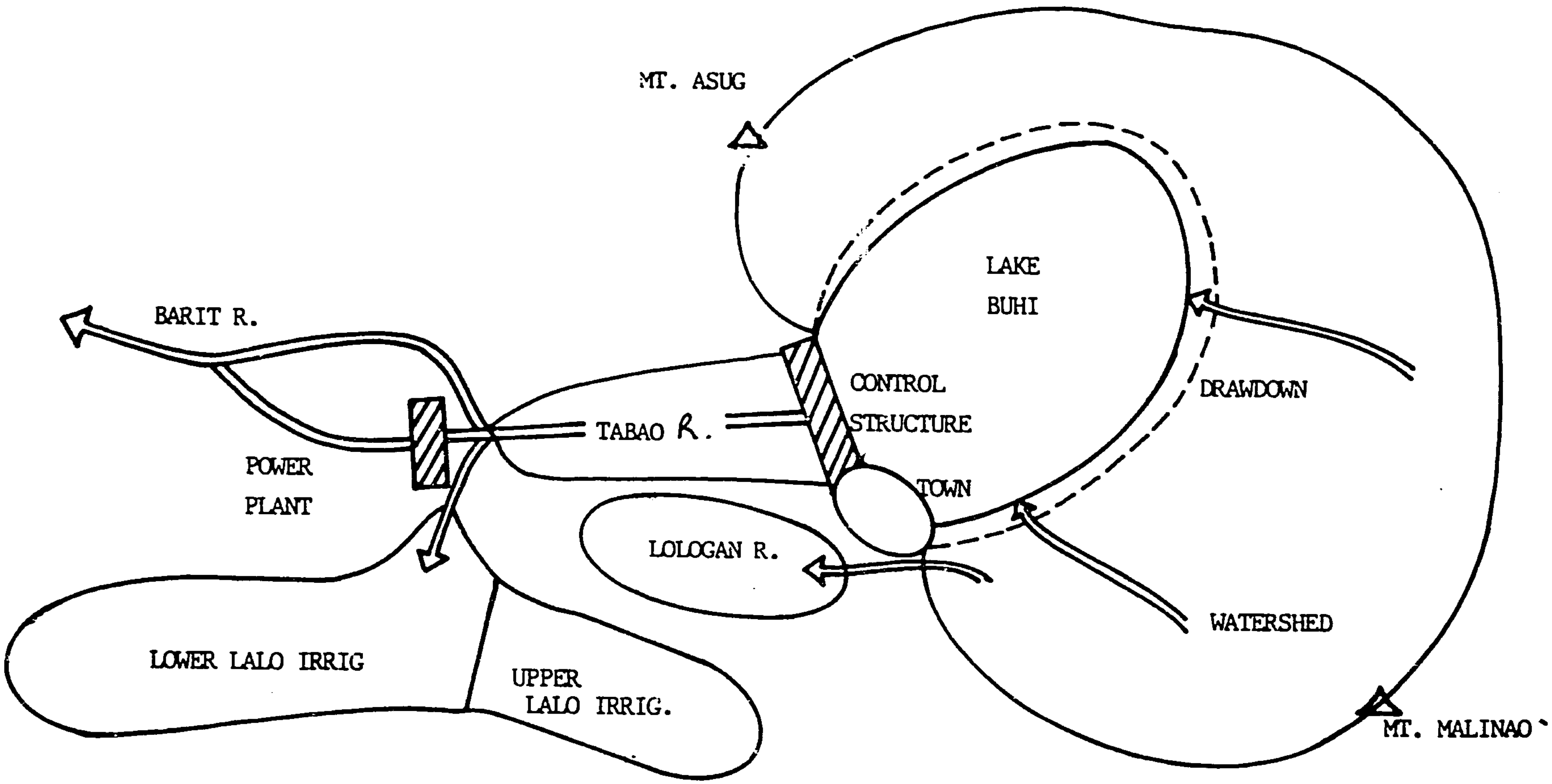

FIGURE 1. The Buhi System

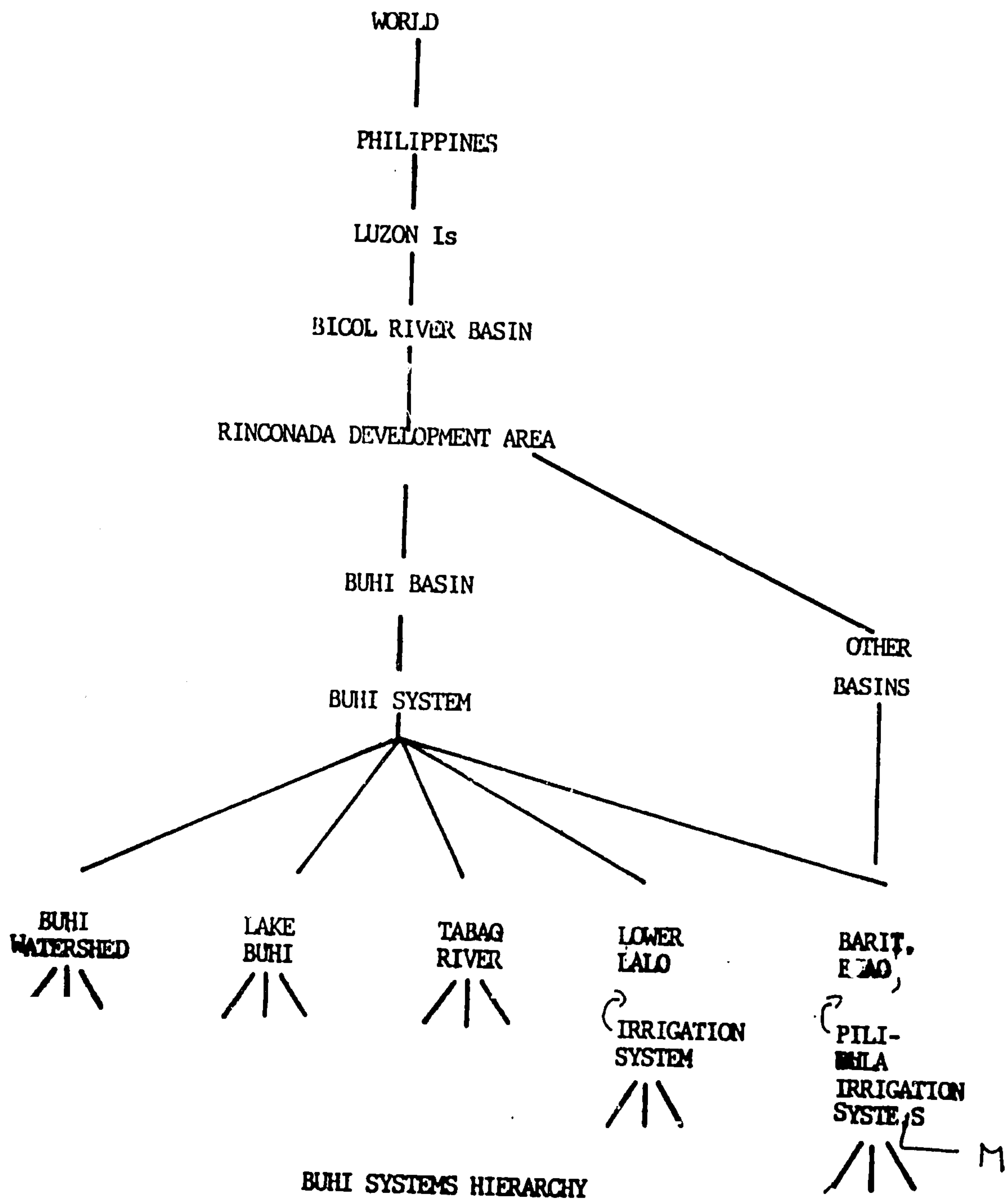

Figure 2. The Buhi Systems Hierarchy

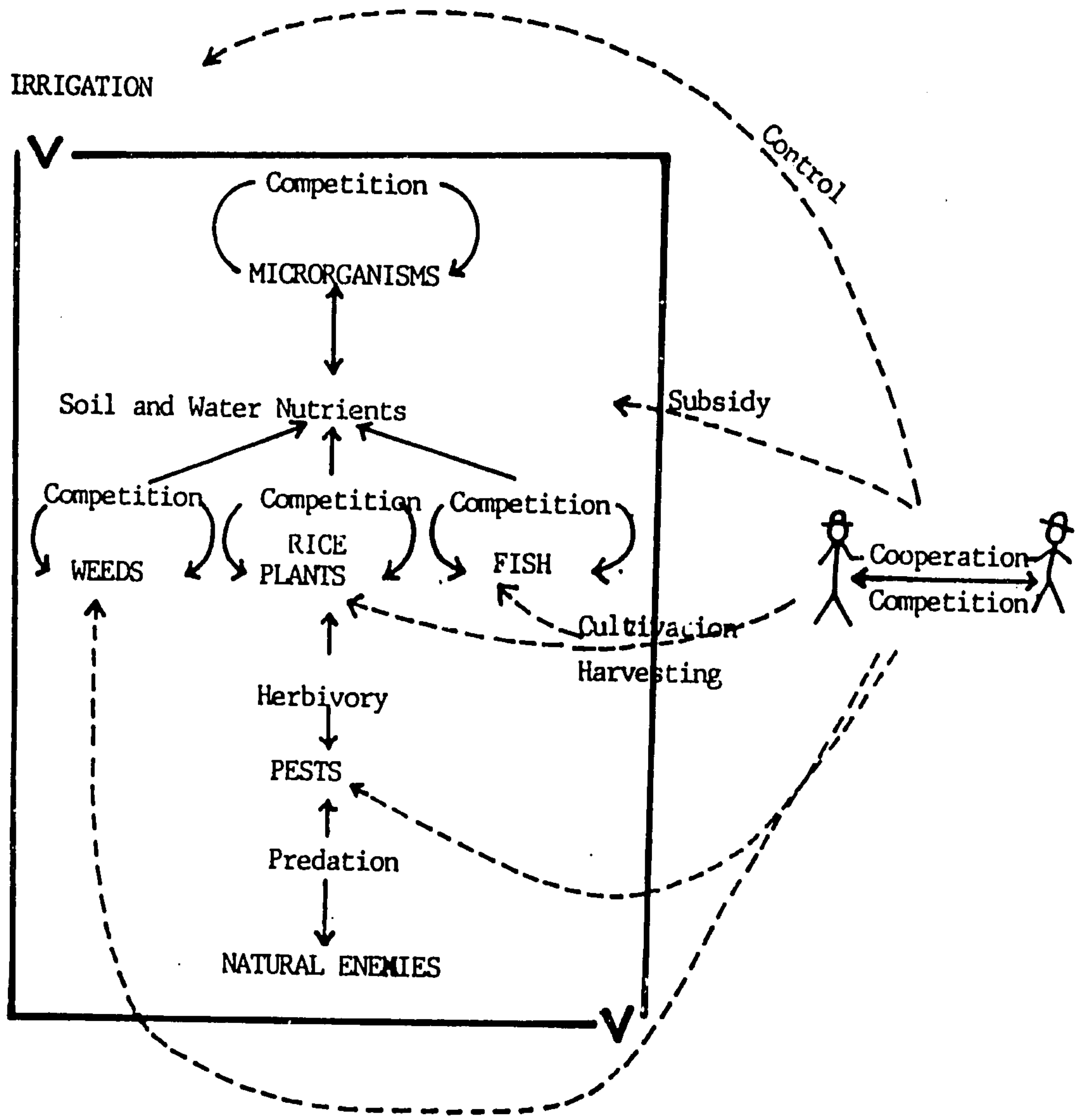

Figure. 3 The Ricefield Agroecosystem

human interaction, which may be cooperative or competitive in nature. It is this new complex agro-socio-economic-ecological system that I call an agroecosystem.

We can similarly regard a fished lake as an agroecoystem in these terms (Figure 4).The shoreline forms the boundary. The biological and chemico-physical processes are to some extent simplified (although not to the same extent as in the ricefield): many of the indigenous fish are lost, new fish species are introduced and the inflow of nutrients and pollutants from human activity around the lake tends to reduce the species diversity. As in the ricefield, the natural ecological processes are clearly discernible, as are the overlying human manipulations through harvesting, control and subsidy.

Essentially the same conceptual picture can be drawn for higher levels in the hierarchy, for the farm, village, watershed or region, but the increasing complexity of the interactions makes a simple representation difficult, if not impossible.

System Properties

I have suggested that agroecosystems can be characterised by four interconnected system properties (Conway, 1985, 1986) These are productivity, stability, sustainability, and equitability.

Productivity

The productivity of an agroecosystem is defined as the net ouput of valued product per unit of resource input. A common measure of productivity is yield or net income per hectare but, clearly, there are a large number of different measures possible, depending on the nature of the product and of the resources being considered. Yield may be in terms of kgs. of grain, tubers, leaves or of meat or fish, or any other consumable or marketable product. Alternatively it may be converted to value in calorie, protein or vitamin terms or to its monetary value at the market. The three basic resources are land, labour, and capital, and to these may be added energy and technological inputs such as fertilisers and pesticides.

Each possible permutation of output and input is a measure of the efficiency of production. In combination these individual productivities measure the productivity of the agroecosystem as a whole. Assessments may be made in terms of individual productivities or of overall productivity at different levels in the hierarchy of agroecosystems, for example of the field or farm or village or watershed, region or nation. Also comparisons may be made between agroecosystems of different types (eg. between irrigated and upland ricefields or between a lake and a river).

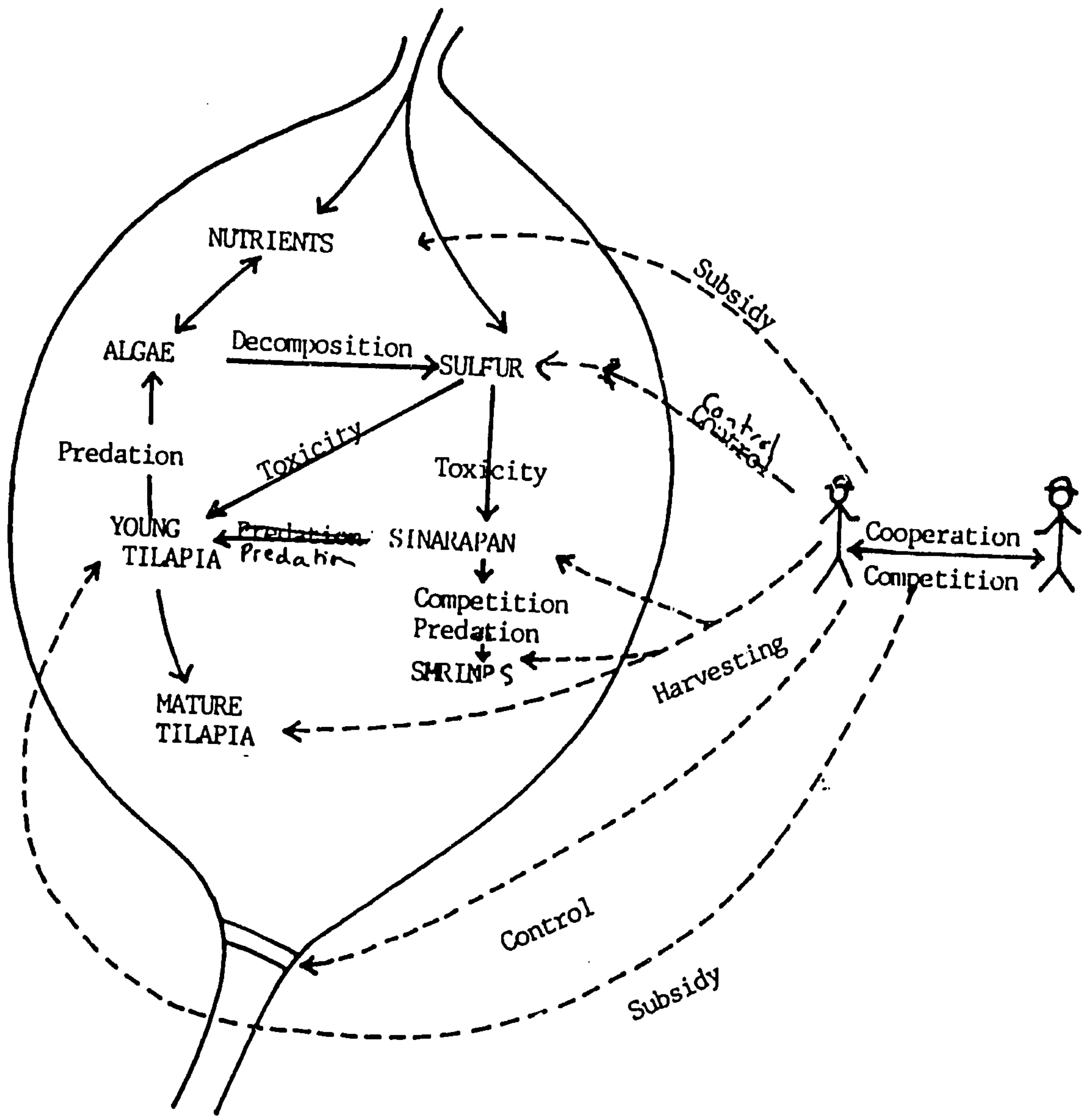

Figure. 4 The Lake Buhi Agroecosystem

Productivity may be measured as the mean or total over a period of time and may be static, increasing or declining (Figure 5). It may be high, equal or low with respect to similarly measured productivities of other agroecosystems.

Stability

The stability of an agroecosystem is defined as the constancy of productivity in the face of small disturbances caused by the normal fluctuations of the surrounding environment. The environment is here regarded as including physical, biological, social, and economic variables lying outside the agroecosystem. The fluctuations may, for example, be in the climate or in the market demand for agricultural products. Productivity may be defined in any of the ways described above and its stability most conveniently portrayed in graphic form or measured as the reciprocal of the coefficient of variation, determined from a time series of productivity measurements.

We may thus have measures of the stability of yields or net incomes per ha or of yields per man hour or yields per kg fertiliser, on a weekly, monthly or annual basis.

Since the trend of productivity may be rising, falling or relatively level the stability will refer to the degree of variability about this trend line. Over time the stability may be increasing, decreasing or may remain the same (Figure 6).

Sustainability

The sustainability of an agroecosystem is defined as its ability to maintain productivity in spite of a major disturbance. Once again productivity is defined in any of the ways described above. The disturbance may be an intensive stress where stress is defined as a regular, sometimes continuous, relatively small and predictable disturbance which has a cumulative effect. For example a stress may be caused by acidity or toxicity or by indebtedness. A perturbation is an infrequent, relatively large, and unpredictable disturbance which has an immediate impact. Examples of perturbations include a rare drought or flood or a new pest or the sudden collapse of a market.

Stresses and perturbations may be natural or man made. For example, pruning is a stress to an individual tree while the process of repeated harvesting is a stress to the field agroecosystem.

Following such a disturbance the productivity may be completely unaffected or fall and then return to normal, or settle to a new lower (or sometimes higher) level, or may disappear altogether (Figures 7 and 8). Sustainability can be portrayed graphically and by the various measurements that have been defined by Orians (1975) and Westman (1978).

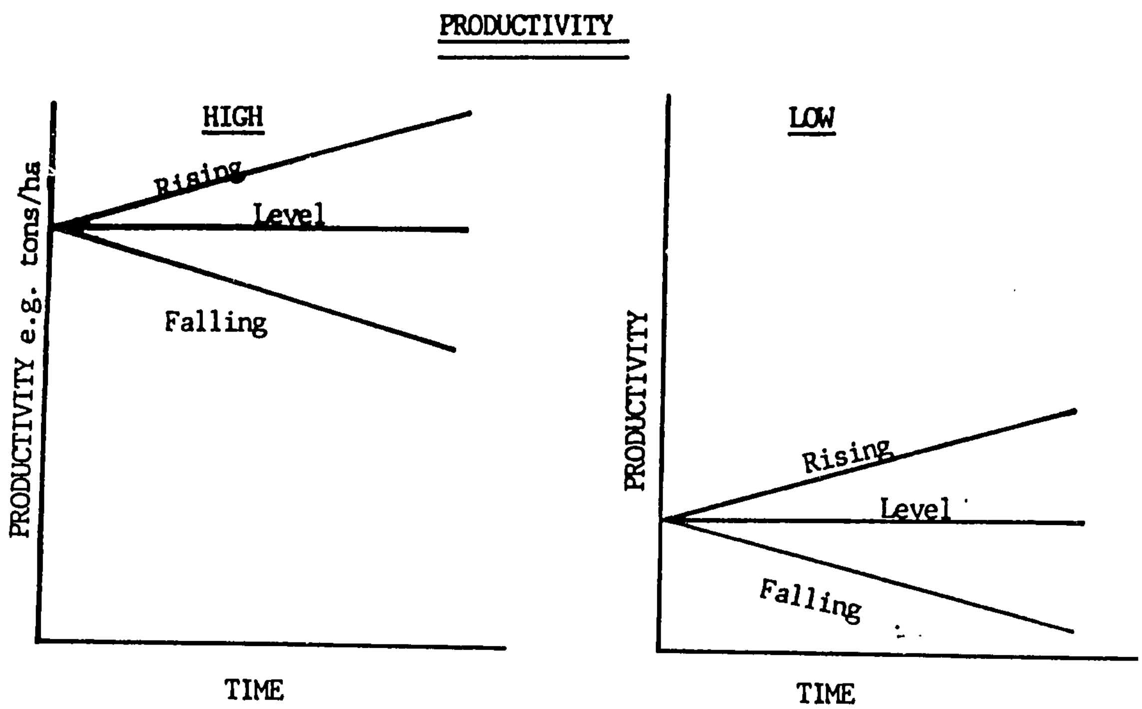

Figure. 5. Agroecosystem Productivity

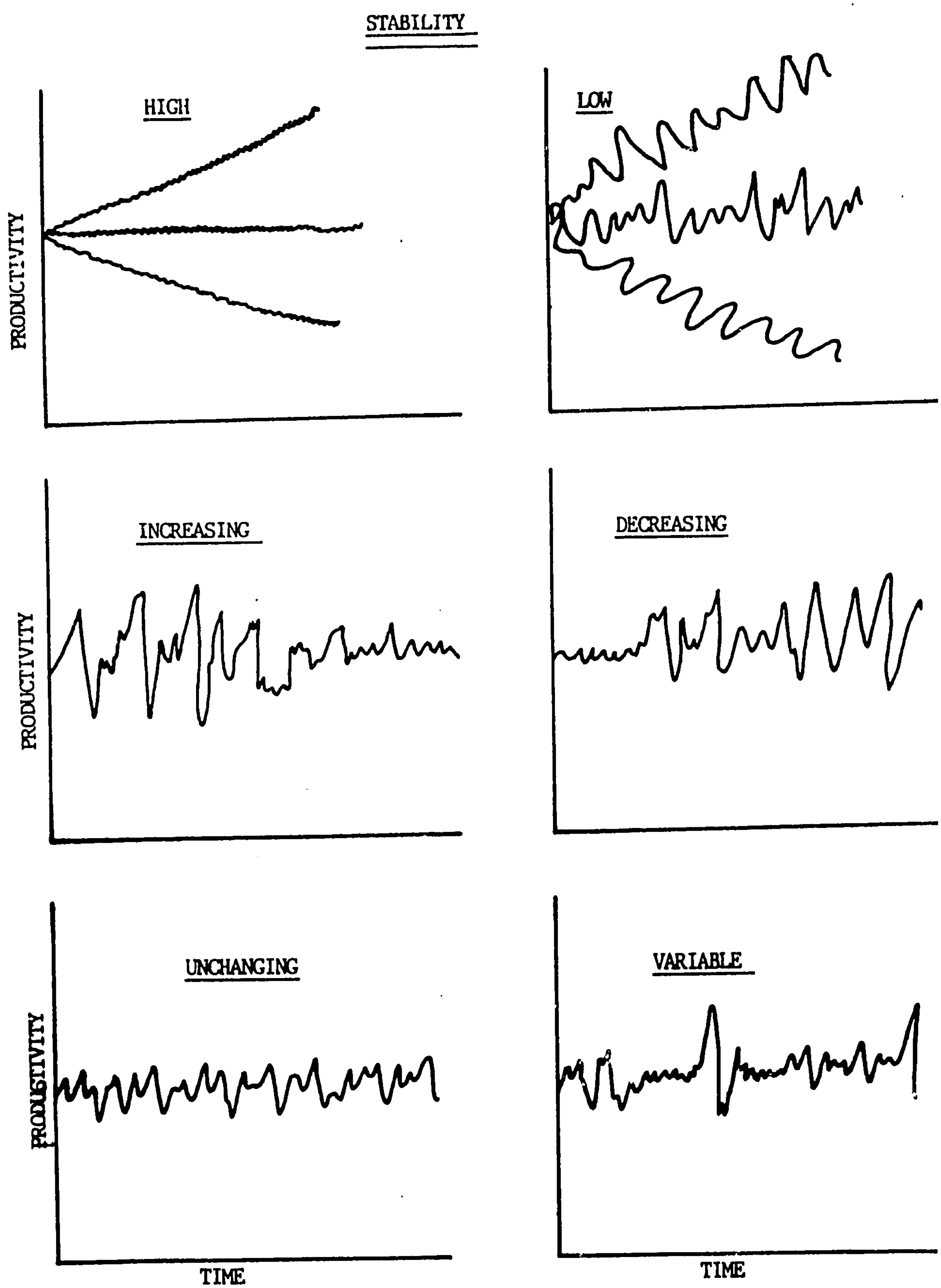

Figure. 6 Agroecosystem Stability

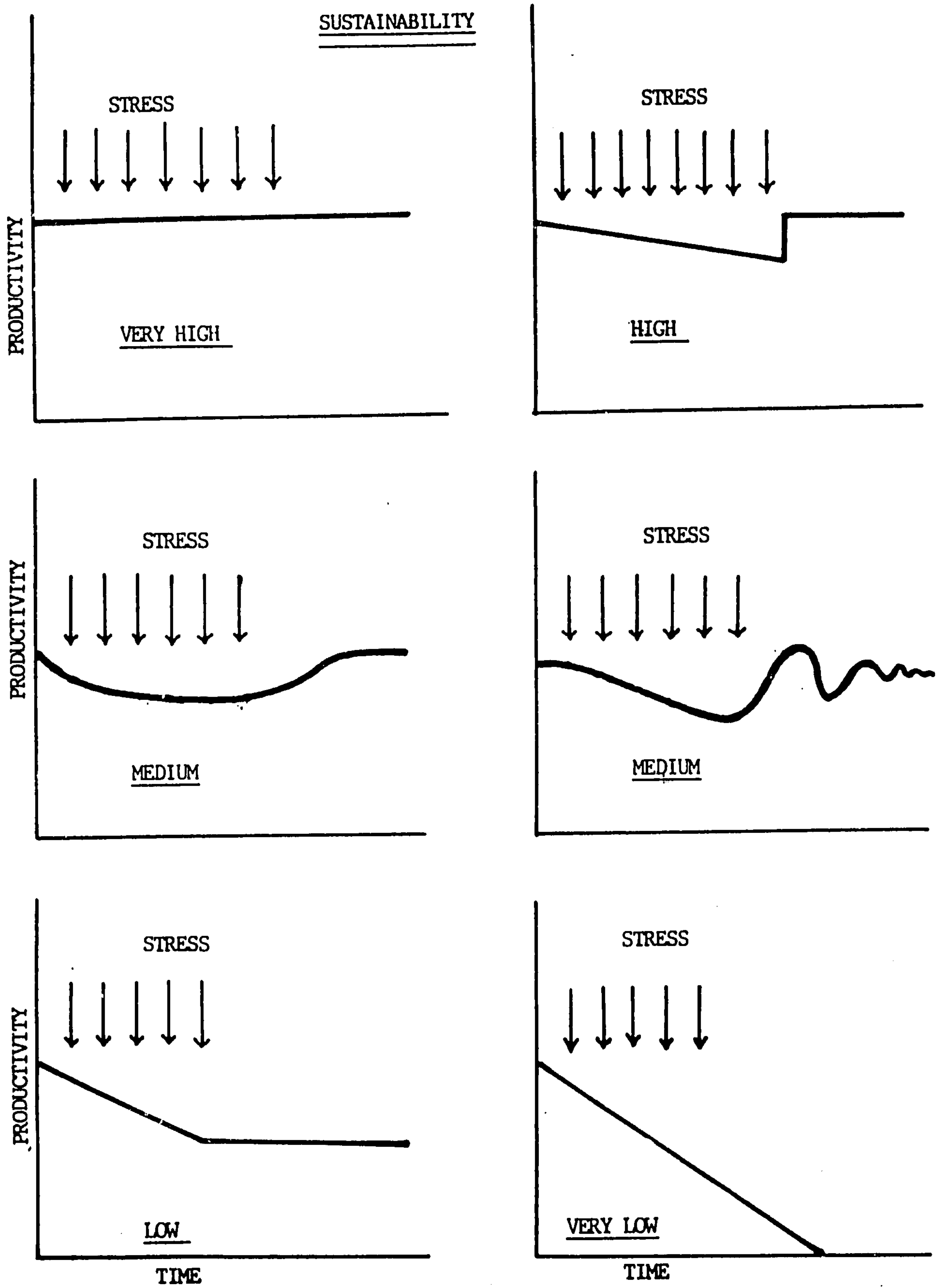

Figure.7 Agroecosystem Sustainability under Stress

SUSTAINABILITY

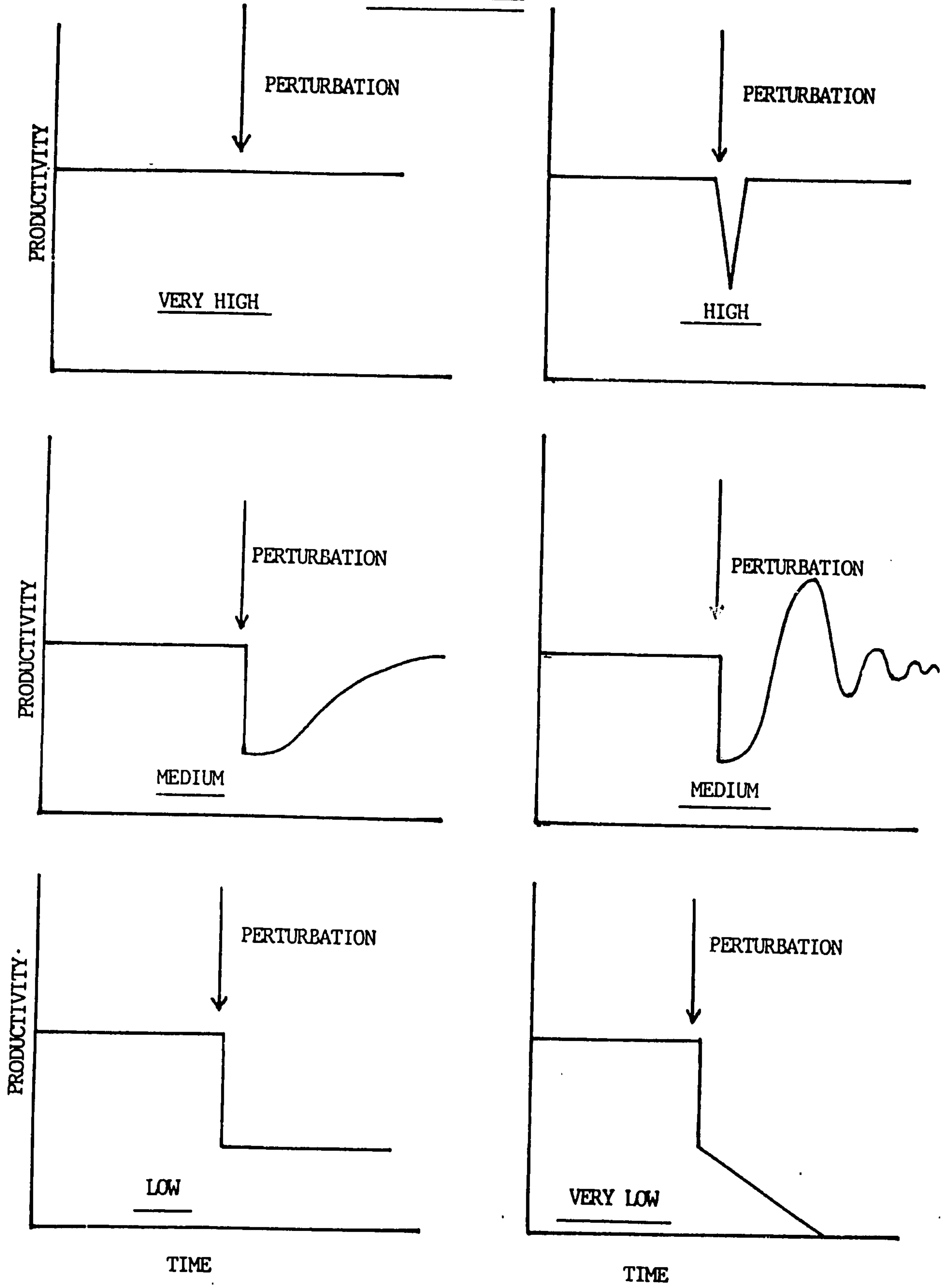

FIGURE 8 Agroecosystem Sustainability under Perturbation

Sustainability, described in this way, is very similar to the resilience of an ecological system as originally defined by Holling (1973). Agroecosystems, however, differ significantly from natural ecological systems in that they are all subject to a level of man-made inputs designed to produce a particular set of outputs. This significantly alters the way we look at their resilience properties. Thus sustainability is the resilience of a man manipulated ecological system, ie one subject to man-made inputs, and refers specifically to the resilience of the desired outputs, ie the productivity of the system.

The most ubiquitous form of input to an agroecosystem is the subsidy, usually in the form of the application of fertiliser. A stress or perturbation to the system may then follow and the question is whether the productivity produced by the original input is maintained. If the disturbance is the process of harvesting then the productivity may only be regained by a further input, for example a renewed application of fertiliser. In this case the sustainability is only maintained by repeated inputs. However the input may be the introduction of a new kind of plant to the system, for example a nitrogen fixing, perennial legume. Then the productivity of the agroecosystem may be maintained without any further input (Figure 9).

Another common form of input is of a control agent. For example an agroecosystem may be subject to stress from pests which, without intervention, will result in a drop in productivity. Use of a pesticide may restore the level of productivity but in the face of further pest attack this will only be maintained by further pesticide applications. However, introduction of a biological control agent, for example a parasitic wasp which attacks the pest population, may result in permanent control and hence a maintained productivity without further intervention (Figure 9). In both the biological control and introduced perennial legume situations the agroecosystem may be regarded as intrinsically highly sustainable, at least with respect to pest control and nitrogen levels, respectively.

In some cases the man made input may directly or indirectly produce the disturbance which threatens the sustainability of production. For example, pest populations may evolve increasing resistance to a pesticide. The number of applications may have to be increased, but in the end productivity may still collapse (Figure 9). In this case pesticide use leads to non-sustainable pest control and hence non-sustainable productivity.

Equitability

The equitability of an agroecosystem is defined as the evenness of distribution of the productivity among the human beneficiaries. Once again the productivity may be defined in any of the ways described above, but will be most commonly measured as the total yield or net income for the agroecosystem under consideration, ie the farm, the village or the nation. The human beneficiaries may be the members of the farm household or the villagers or the population of a nation. The productivity may be evenly shared among the beneficiaries producing a high

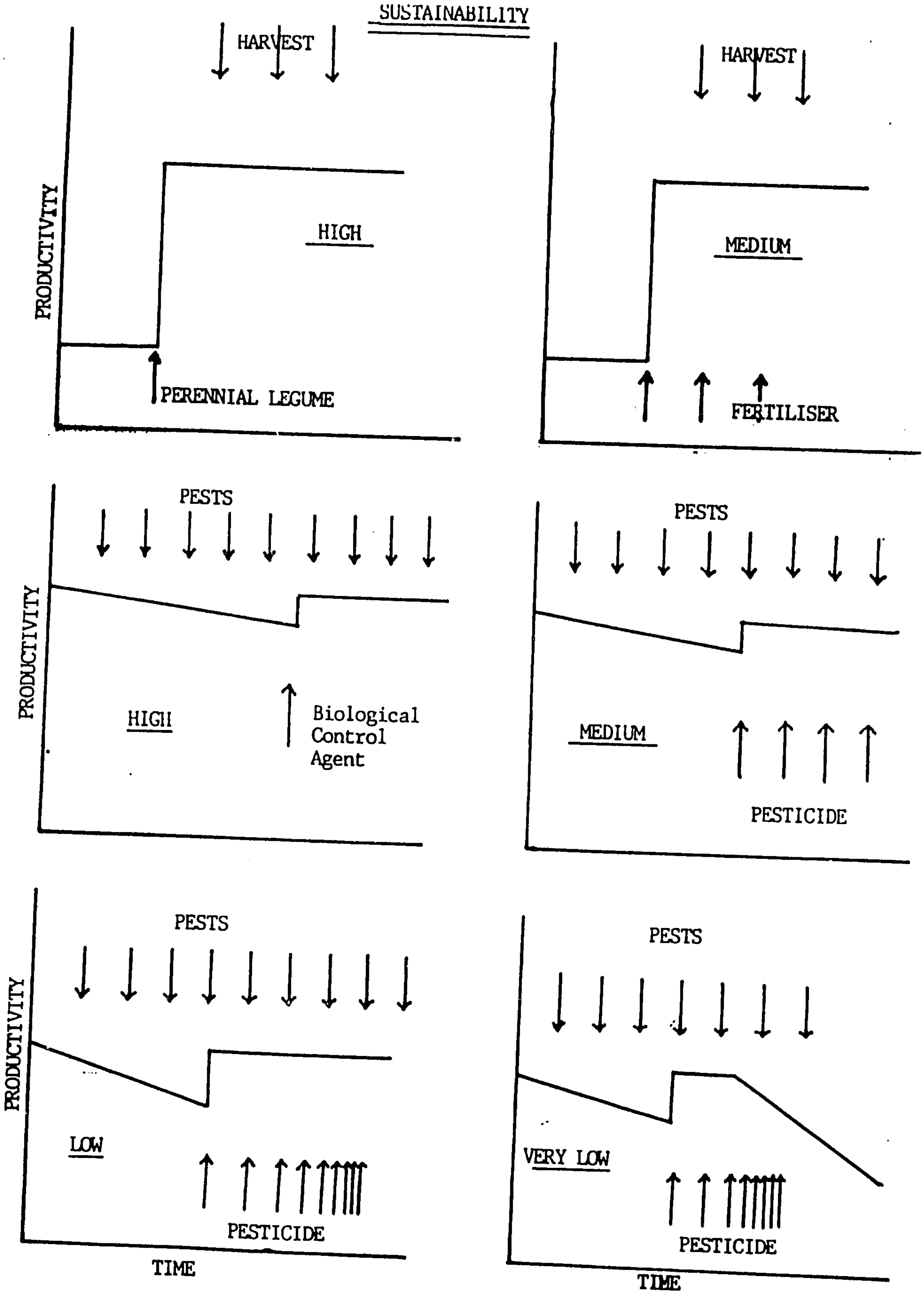

Figure.8a Agroecosystem Sustainability subject to Inputs

equitability or may be unevenly shared, with some receiving more than others, and perhaps some receiving very little or none.

Equitability may be described graphically (Figure 10) or by means of a Lorenz curve or the statistic known as the Gini ratio or coefficient.

Factors Affecting System Properties

Figure 11 presents a highly schematic diagram of a Filipino lakeside village agroecosystem on which are superimposed some of the important factors and processes that affect the agroecosystem properties. In general the main causes of low productivity are lack of inputs or resources, while the main causes of low stability are climatic and market fluctuations and the variable effects of pests and diseases. The factors affecting sustainability range from overfishing and illegal logging to new pests and diseases. The equitability of the system is affected by the rights to cultivate land or to harvest trees or fish.

Agroecosystem Development

The four properties are clearly interlinked but often in quite complex ways. For example, frequently there are significant trade offs between them. An attempt to achieve greater productivity may be at the expense of sustainability or equitability. Too much emphasis on equitability may inhibit gains in productivity. On marginal lands stability may have a higher priority over productivity, and so on. In development terms the agroecosystem properties can now be regarded as indicators of performance.

The trade offs between these indicators are illustrated by the recent history of development in the Buhi region. The building of the control structure at the outlet of the lake has resulted in a variety of benefits, namely:

1. Increased agricultural production downstream
2. Increased power production
3. Flood control in the Tabao River
4. Improved communications (bridge over control structure) and eventually
5. Greater commercial prosperity of Buhi township from the marketing of the increased production and inputs.

All of these represent direct or indirect increases in productivity of one kind or another.

But there have been a number of adverse consequences which represent declines in stability, sustainability or equitability, or various combinations of these. Some of the consequences are temporary, others more permanent and yet others are possible exacerbations of long standing problems:

EQUITABILITY

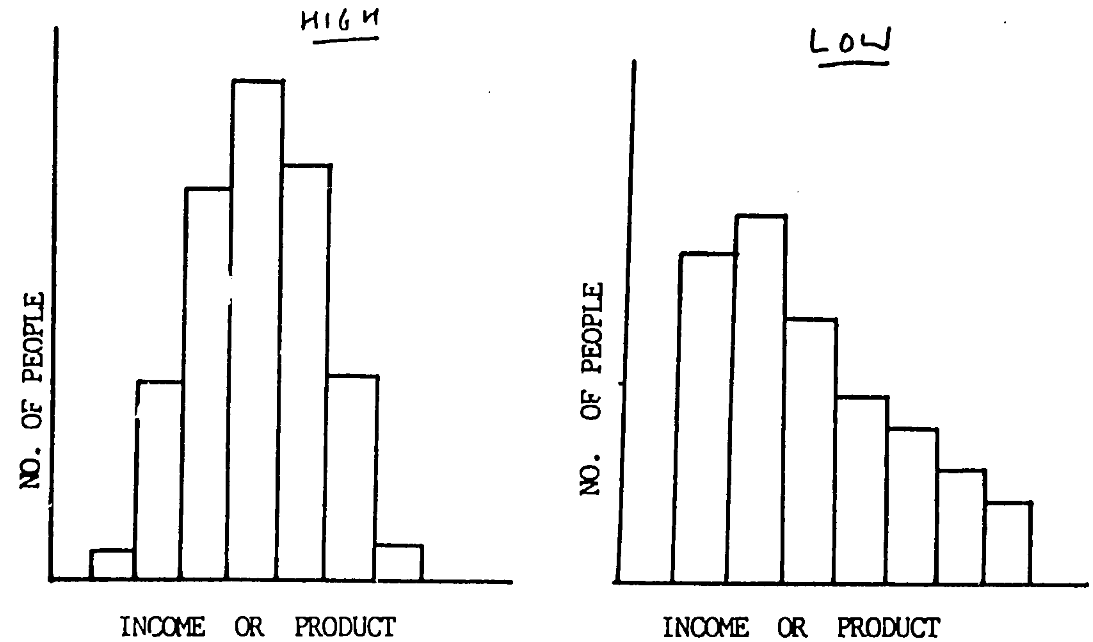

Figure 10. Agroecosystem Equitability

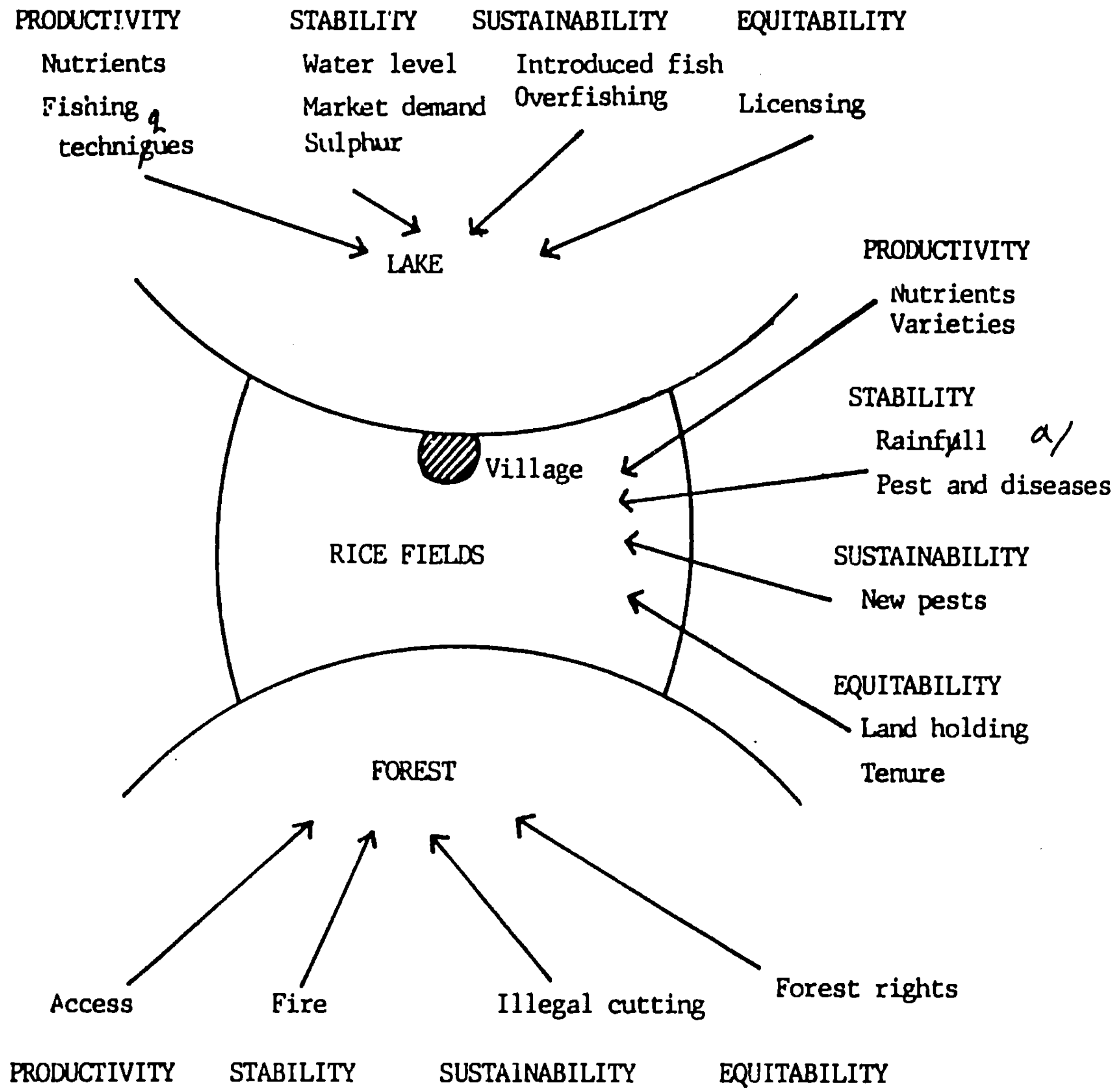

Figure 11. Factors affecting productivity, stability, sustainability and equitability of a lakeside village agroecosystem

I. <u>Temporary Problems associated with the Construction Phase</u>

A. Unexpected rises in lake water level
   1. Flooding of rice fields

B. Unexpected falls in lake water level
   2. Drying out of fish cages

II. <u>Permanent Problems associated with Control Structure Operations</u>

A. Use of full water level capacity of lake (83.5m)
   1. Periodic flooding of dwellings
   2. Periodic flooding of cropped land

B. Use of low water level capacities of lake (below 81.4m)
   3. Periodic drying out of fish cages
   4. Drying up of shallow groundwater wells in Buhi municipality
   5. Drying up of dock at Poblacion
   6. Loss of lake transport capacity
   7. Drying up of Buhi Freshwater Demonstration Fish Farm
   8. Drying out of spawning grounds at Barangay Sta. Cruz and around lake generally
   9. Health problems from domestic refuse exposed in drawdown

C. Deepening of Tabao River
   10. Loss of fish cages in Tabao River and East Channel
   11. Loss of Tabao River transportation

D. Construction of Control Structure
   12. Growth of water hyacinths in lake

III. <u>Long Standing Problems</u>
   1. Loss of migratory fish
   2. Decline of traditional fishery
   3. Low productivity of fish cages
   4. Declining water quality
   5. Sulphur upwellings
   6. Decline to near extinction of Sinarapan
   7. Typhoon damage
   8. Erosion and sedimentation
   9. Declining yields on Mt. Asug and spread of cogon grass

The development of the Buhi system can thus be seen as a series of major changes in agroecosystem properties or indicators of performance (Table 1). In this workshop we have to define the goal of future development, in terms of these indicators, and to decide the priorities for research and development that will ensure its achievement.

Table 1 Development of the Buhi system in terms of agroecosystem properties. Productivity can be regarded as total yield of the system.

	Productivity	Stability	Sustainability	Equitability
A Pre-construction	Low/ Medium	Low	Low/ Medium	Medium
B Construction phase	Low/ Medium	Very Low	Low	Low
C Post-construction	High	Low	Medium	Low
D Goal	High	Medium/ High	High	Medium/ High

3.2 DETERMINING RESEARCH AND DEVELOPMENT PRIORITIES

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Each individual involved in rural development, whether he or she be farmer, fisherman, extension agent, development specialist or research scientist, usually has a clear idea of what should be the immediate priorities from his or her perspective. But each individual has, necessarily, a narrow perspective, restricted to only one geographic part of the agroecosystem or to only one aspect of its behaviour. As we have already seen the Buhi region contains a number of highly complex agroecosystems subject to many conflicting demands. If the livelihoods of the people that these systems support are to be improved and maintained on a sustainable and equitable basis, there has to be a collective agreement by all those involved as to the priorities for research and development. Without this, development will be slow, money will be wasted and, most importantly, the benefits will be poorly distributed.

Agroecosystem Analysis

In recent years I have been involved with a number of colleagues, in several Third World countries, in the design of a technique for multidisciplinary analysis of agroecosystems which is aimed at producing agreed programmes of research and development. I call this technique Agroecosystem Analysis. Full details are given in Conway (1985, 1986), while its applications over the past seven years are described in a number of publications (see Conway et al 1985; Gypmantasiri et al 1980; KEPAS 1985a,b,c: KKU-Ford Cropping Systems Project, 1982a,b; Limpinuntana and Patanothai, 1982). Here I will only highlight the main features, concentrating on its application to the needs of development.

The procedure rests on the concepts described in Chapter 3.1 and on four further assumptions:

1. It is not necessary to know everything about an agroecosystem in order to produce a realistic and useful analysis.

2. Understanding the behaviour and important properties of an agroecosystem requires knowledge of only a few key functional relationships.

3. Producing significant improvements in the performance of an agroecosystem requires changes in only a few key management decisions.

4. Identification and understanding of these key relationships and decisions thus requires that a limited number of appropriate key questions are defined and answered.

Since there can be no simple formula for identifying and defining these key questions the most productive approach is for a multidisciplinary team to attempt to collectively identify and define them through a structured but flexible process of system analysis. The basic steps of such a process are described in Figure 1. Experience has shown that the procedure is best followed in a seminar or workshop environment in which meetings of the whole team are interspersed with intensive work sessions involving small groups of individuals.

The earlier versions of this procedure (see Conway, 1985) were designed to determine research priorities, so that the final outcome was the set of key research questions. However, recently, the procedure has been modified so as to allow the simultaneous determination of development priorities (Conway et al, 1985). Separate, but interlinked, key questions for research and development are identified, which lead to research hypotheses, on the one hand, or to guidelines and working hypotheses for development, on the other. These hypotheses and guidelines are then evaluated and from them the final lists of research and development priorities are produced.

The key to success in Agroecosystem Analysis lies in clear communication between the different disciplines present. We have found that in the Pattern Analysis phase, in particular, it is important for the participants to strive to present their disciplinary and specialist knowledge in such a way that all other members of the workshop can easily grasp its significance. This is greatly helped by the use of diagrams of all kinds.

Objectives and Definitions

Objectives

As in all exercises in systems analysis the quality of the final results depends crucially on a having a definition of objectives at the outset which is couched in simple, precise and unambiguous language and is acceptable to all members of the team. An appropriate objective for the present workshop is:

"To identify research and development priorities for the agroecoystems of the Buhi region that will lead to improvements in the productivity of the region and the livelihoods of the people on a stable, sustainable and equitable basis."

System Definition

This phase involves identification of systems, system boundaries and system hierarchies. At the outset this is subjective and tentative. The biological and chemico-physical boundaries are often fairly clear: the ricefield is bounded by a bund; the lake by the shoreline; the river valley by the extent of the watershed. But the cultural and socio-economic boundaries are more elusive. For example, defining a farm household solely in terms of the farm itself - the land that is cultivated or

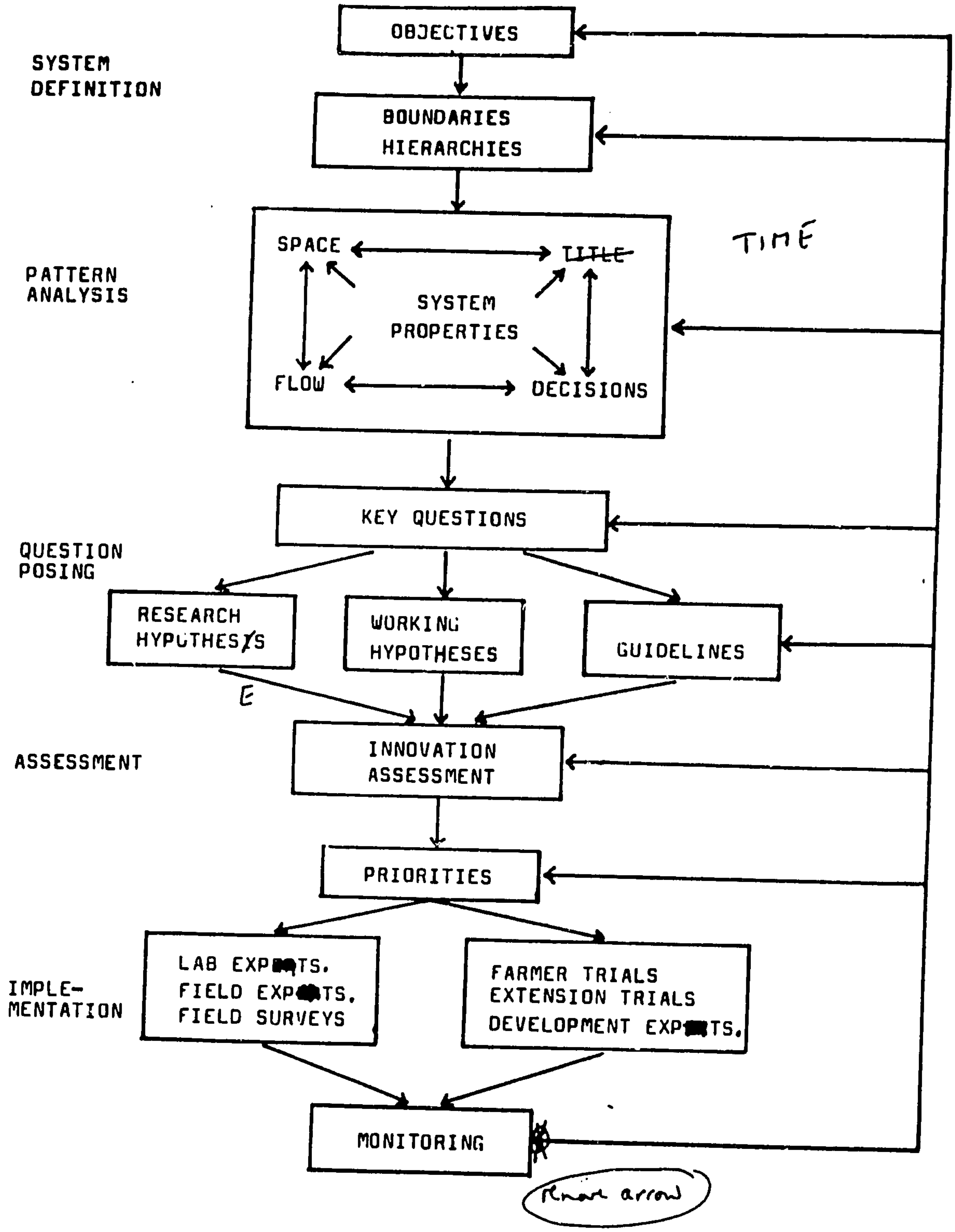

Figure [illegible].1, The Procedure of Agroecosystem Analysis for Research and Development.

otherwise exploited - is frequently inadequate. A member of the farm household may be deriving income from far away; the sale of produce may depend on distant markets. The answer is to translate these, as far as possible, into physical or geographic terms and to elaborate system hierarchies that link or combine systems whose boundaries are defined in different terms.

Pattern Analysis

Four patterns are chosen as likely to reveal the key functional relationships that determine system properties. Three of these - space, time and flow - are known to be important in understanding the properties of ecological systems. All three are significant factors in productivity. Variability or heterogeneity in space is also an important promoter of stability and sustainability. Variability in time, however, can be destabilising; systems with long time lags are often very unstable. Flows are either stabilising or destabilising, depending on whether the feedback loops are negative or positive. The fourth pattern - decisions - reflects the processes of human management of agroecosystems and its analysis contributes to an understanding of all four system properties. Although this pattern is primarily the province of socio-economic analysis, experience shows that it generates lively discussion among both social and natural scientists. One further advantage of these particular patterns is that they are largely neutral with respect to different disciplines so that everyone participating in the workshop can join in their description and analysis.

An important aid in pattern analysis is a number of conceptual tools - graphs, transects, crop calendars, time trends, flow diagrams and bar diagrams. Considerable use was made of such tools in the workshop and examples are given in later chapters.

Space

Spatial patterns are most readily revealed by simple maps and transects. Overlays are particularly useful in determining the different zones within an agroecosystem. Transects are useful in identifying the location of important problems and the important spatial relationships both between and within farms.

Time

Patterns in time are best expressed by simple graphs. Three patterns are important. The first is that of seasonal change and can be analysed by calendars in which cropping sequences, livestock and fishery cycles, labour, credit peaks, prices etc. are graphed against various agrometeorological variables. This helps, in particular, to identify those periods in the year where the timing of operations and the availability of resources are critical for productivity and stability.

Longer term changes, in prices, production, climate, demographic parameters etc., can be graphed in a conventional manner (10 years of data is a minimum requirement). These reveal trends in productivity and a measure of stability, possible time lags in the system and other causes of instability, and any signs of lack of sustainability.

The final pattern in time is of the response of important variables to stress and perturbation. Stresses, as defined earlier, include soil deficiencies and toxicities, pests, diseases and weeds, indebtedness, etc. Perturbations include major floods or droughts or a sudden outbreak of a pest or disease.

Flow

Included under this heading are the patterns of flows and transformations of energy, materials, money, information etc. in the agroecosystem. The sources of income and the nature of expenditure for each household are particularly important and these can be summarised by bar diagrams. Production and marketing patterns are also important. These may be described by conventional flow diagrams which can also be used to trace out the impacts of particular changes or innovations in an agroecosystem. The aim of producing flow diagrams, however, should not be to trace out all the detailed relationships. Flows should be principally analysed for the major causes and effects and for the presence of stabilising or destabilising feedback loops. The flow diagrams should thus be kept as simple as possible.

Decisions

Decisions, ranging from those of national agricultural policy to the individual farmer's day-to-day choices, occur at all levels in the hierarchy of agroecosystems. Two patterns are important. The first is of the choices of different livelihood systems made in a given agroecosystem under differing conditions and is best described by means of a decision tree. Construction of the tree helps to reveal both the goals of the farmer and the constraints on choice that are present in the agroecosystem. The second pattern is of the spheres of influence of individuals and institutions involved in decision making. Here the aim is to identify the critical decision makers and the extent to which they interact with one another. The degree of contact and overlap that occurs can be portrayed readily by Venn diagrams.

System Properties

Discussion of system properties should guide the form of pattern analysis, helping to indicate the likely key relationships and decisions. However at the end of the pattern analysis phase it is useful to summarise what has been learnt of system properties and to tabulate the most important contributing relationships and variables (Table 1 and see Figure 11 in Chapter 3.1)...

Table 1 Key Variables and Processes affecting the System Properties of an Agroecosystem

Positive		Negative
	PRODUCTIVITY	
Factors increasing productivity		Constraints, limiting factors
	STABILITY	
Stabilising factors		Destabilising factors
	SUSTAINABILITY	
Processes preventing collapse		Stresses and perturbations
	EQUITABILITY	
Factors increasing equitability		Factors producing inequity

Key Questions, Guidelines and Working Hypothese

Key questions, guidelines and working hypotheses arise throughout the procedure, during system definition, pattern analysis and the discussion of system properties. They should be noted down as they emerge and then collectively revised by the participants in the light of all the information available.

A key question for research might be of the form:

"Is overfishing or reduced nutrients the cause of low fish productivity?"

while a development key question might be of the form:

"H[illegible] can productivity of the drawdown be maximised?"

These questions then generate h[illegible]ses and, in the case of the d[illegible]opment questions, guidelin[illegible]search hypotheses are of the form:

"Reduction in fish productivity is largely due to lack of nutrients."

ie they are expressed in such a way that they can be readily tested. Guidelines for development are based on well established knowledge, derived from experience in the area or elsewhere, or reflecting fundamental principles of development.

A guideline relating to the above development key question might then be:

"Use early maturing rice varieties with an ability to withstand both drought and submergence"

The related working hypotheses reflect a greater uncertainty about development. They are based on knowledge and experience and on the previous steps of analysis but still need to be tested. A working hypothesis related to the key question might be:

"The productivity of the drawdown can be maximised by transplanting rice variety X in the middle of month Y at a spacing of Z inches between the plants."

Each set of key questions, guidelines and working hypotheses should be justified by a detailed discussion.

Innovation Assessment

Contained, either explicitly or implicitly, within the various hypotheses and guidelines will be a number of proposed innovations. The next step is for these innovations, which may range from the technological to the socio-economic, to be assessed by the whole workshop team on a number of criteria. One set of criteria is the system properties or indicators of performance. Each innovation should be evaluated for its impact (positive or negative) on productivity, stability, sustainability and equitability. Estimates also need to be made of the cost of the proposed innovation, the time horizon over which its benefits can be expected and its technical and operational feasibility (Table 2). These assessments are made in terms of the overall target agroecosystem eg., in terms of village level productivity, or the cost to the village. Once this is done for all the innovations they can then be ranked by the workshop participants in terms of priority and this ranking used, in turn, to assign priorities for action to the research and development hypotheses.

Implementation

The remaining phase of the procedure is one of conventional research and development. The hypotheses are tested as appropriate: by laboratory or field experiments, by surveys, or by farmer or extension trials, or by development experiments. All such trials and experiments will require careful monitoring. The multidisciplinary activity of the workshop may or may not extend into this phase; many of the hypotheses will be phrased in terms of single disciplines and are best tested by the appropriate specialists. To this extent the outcome of the workshop may

Table 2 Innovation Assessment

Innovation	Effects on System Properties: Productivity	Stability	Sustainability	Equitability	Cost	Time to effect	Feasibility	Pri-rit
Floating fish cages	+	++	+++	-	Med.	Med.	Med.	?
Itbog water supply	+	++	+++	--	High	Long	High	?

appear superficially similar to research and development programmes arising from a collection of individual initiatives, but will crucially differ in that the individual projects are the direct consequence of a multidisciplinary systems analysis and the results feed back to and modify that analysis. The subsequent work has thus a better contextual basis and is likely to be more appropriate and relevant.

PART FOUR

THE BUHI AGROECOSYSTEMS

4.1 THE WATERSHED

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PERFECTOR BRAGAIS JR.

Introduction

System Definition

The upland of Lake Buhi Watershed is almost 11,000 hectares. It has three major zones: Mt. Asog (also Mt. Iriga), Poblacion and Mt. Malinao (Figure 1). Mt Asog and Mt. Malinao zones have the same sub-zones based on landscape position along the slope and subdivided according to dominant landuse or vegetative cover. Mt. Asog zone, on the western side of the watershed, consists of Barangay Salvacion, de la Fe, Cabatuan, Tambo and part of Burocbusoc (Figure 2). The other barangays constitute the Mt. Malinao zone on the eastern side. Poblacion zone is mainly a built-up area.

Spatial Relationships

Topography and Soils

The area is predominantly hilly to mountainous, except the southern portion near the poblacion which is a piedmont plain. The elevation of the watershed is about 100 to 1800 m above sea level (Figure 3). It is underlain with volcanic materials of various geologic ages (Figure 4). The areas with 0-3, 3-8, and 8-15% slope are 13, 12, and 29% of the watershed, respectively (Figure 5). The area with 15-40% slopes and generally suitable for agroforestry is about 46%. The area of very near steep slope, greater than 40%, is about 19%.

Tigaon clay and Macolod sandy loam are the dominant soils in the upland (Figure 6). These are deep, with medium to high organic matter content, slightly acidic, and high in available potassium, but low in available phosphorus. Soil erosion is very serious, particularly in the Mt. Malinao zone and corn growing areas of Mt. Asog zone (Figure 7). This is very critical in coconut areas where clean culture is practised between trees, in kaingin, corn fields, grasslands and even in secondary forests with slopes greater than 15% (Figure 8).

Vegetation and Crops

The irrigated lowland rice areas are situated on the alluvial and piedmont plains of the watershed. Coconut is very extensive in the Mt. Asog zone and corn is even grown in between the coconut trees. The remaining forest cover is about 15% of the watershed and concentrated on the upper slope of Mt. Malinao. The secondary forest of Mt. Asog zone is situated on steep areas, with slopes greater than 15%. Abaca is grown mainly in the Mt. Malinao zone. The primary forest cover of the forest land has

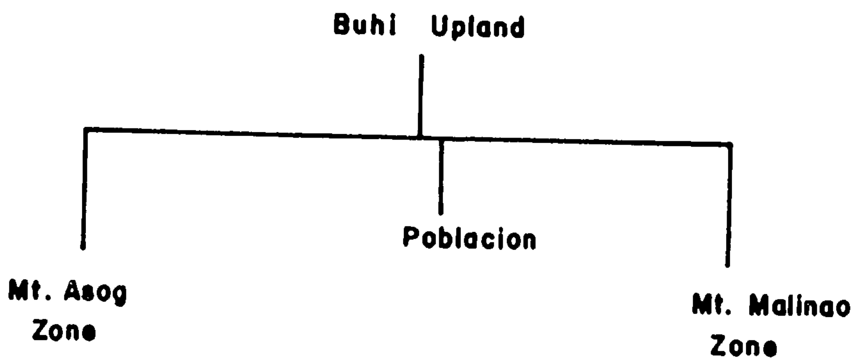


Figure 1. Major Zones of Buhi Uplands

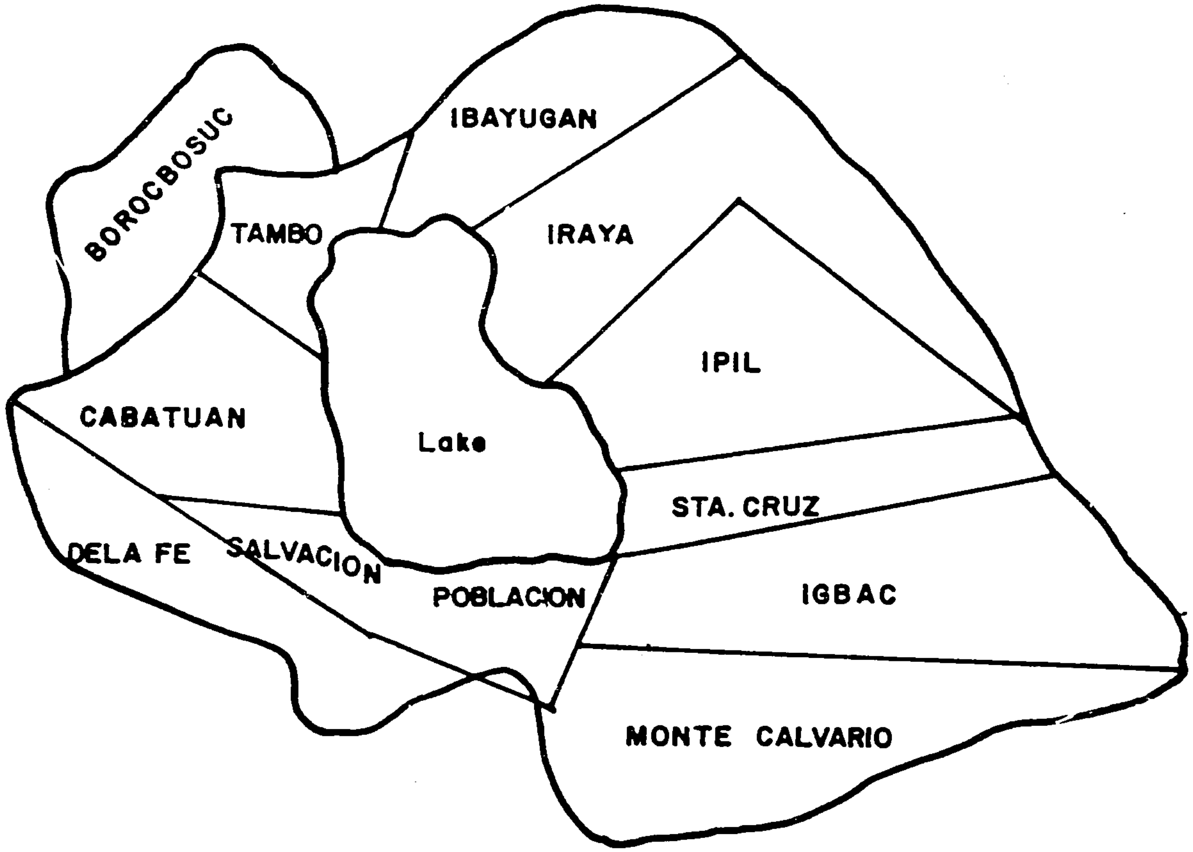


Figure 2. Barangays in the Buhi Watershed

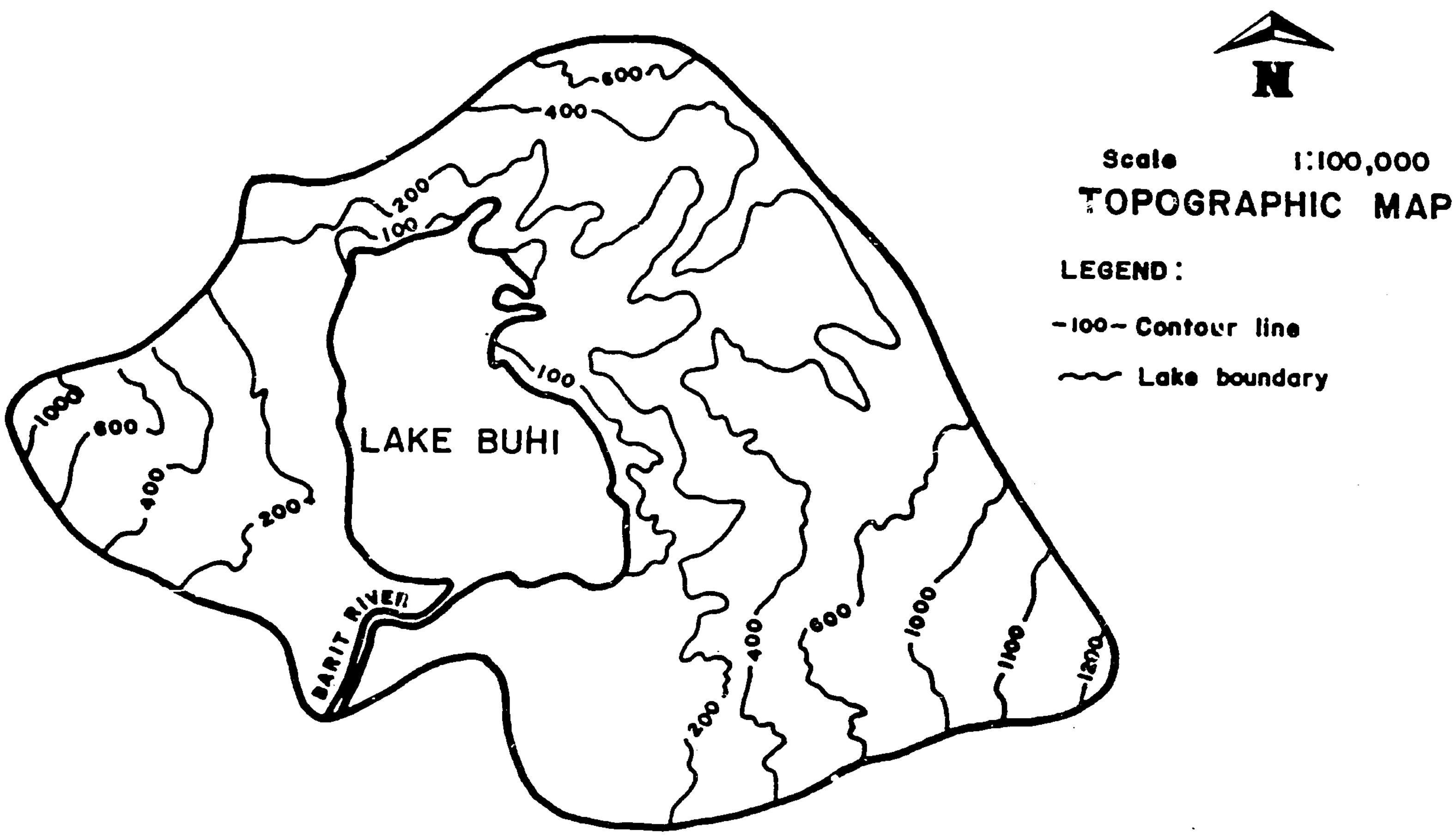


Figure 3. Topographic map of Buhi Watershed. (Ref)

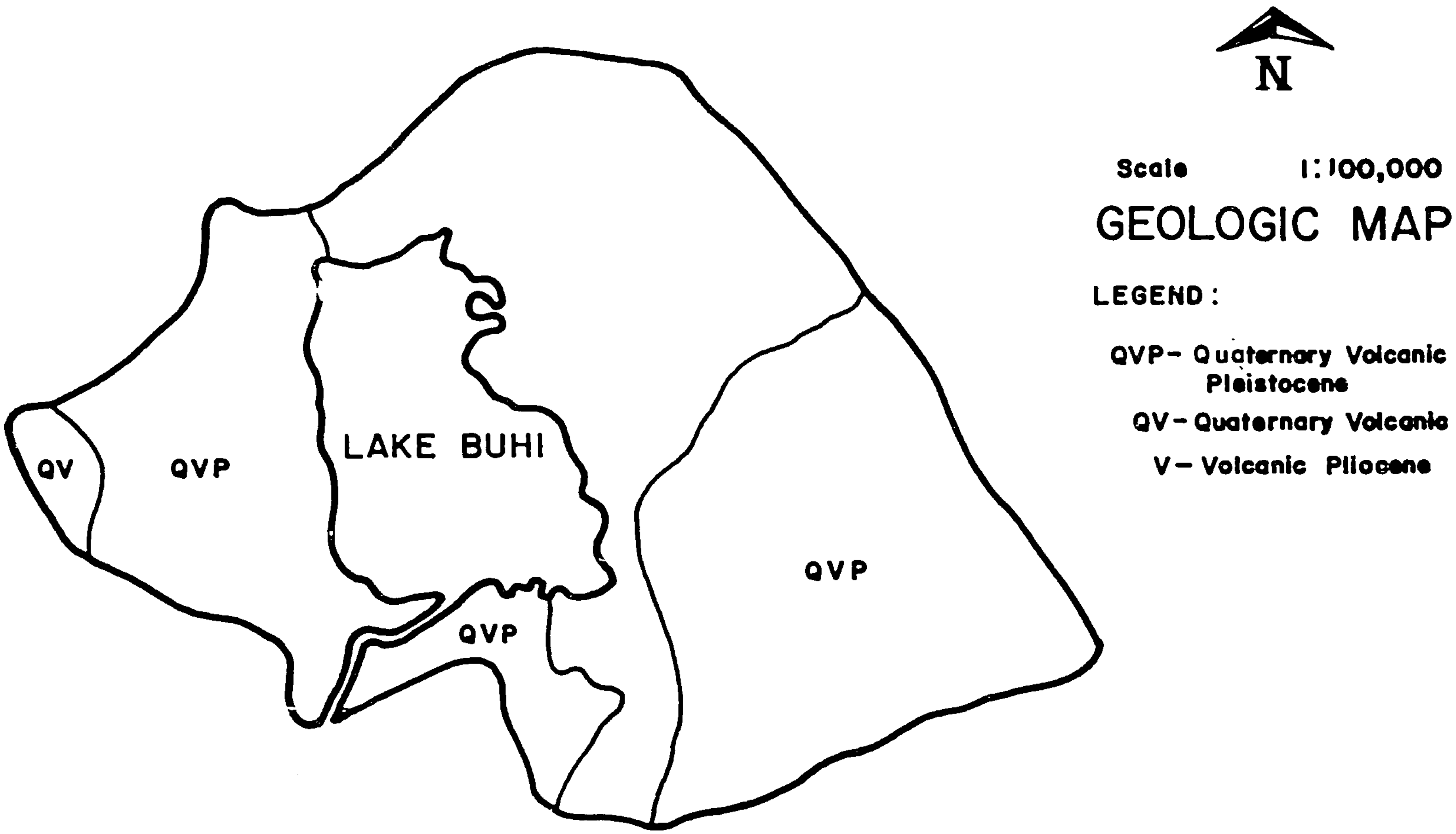


Figure 4. Geologic map of Buhi Watershed

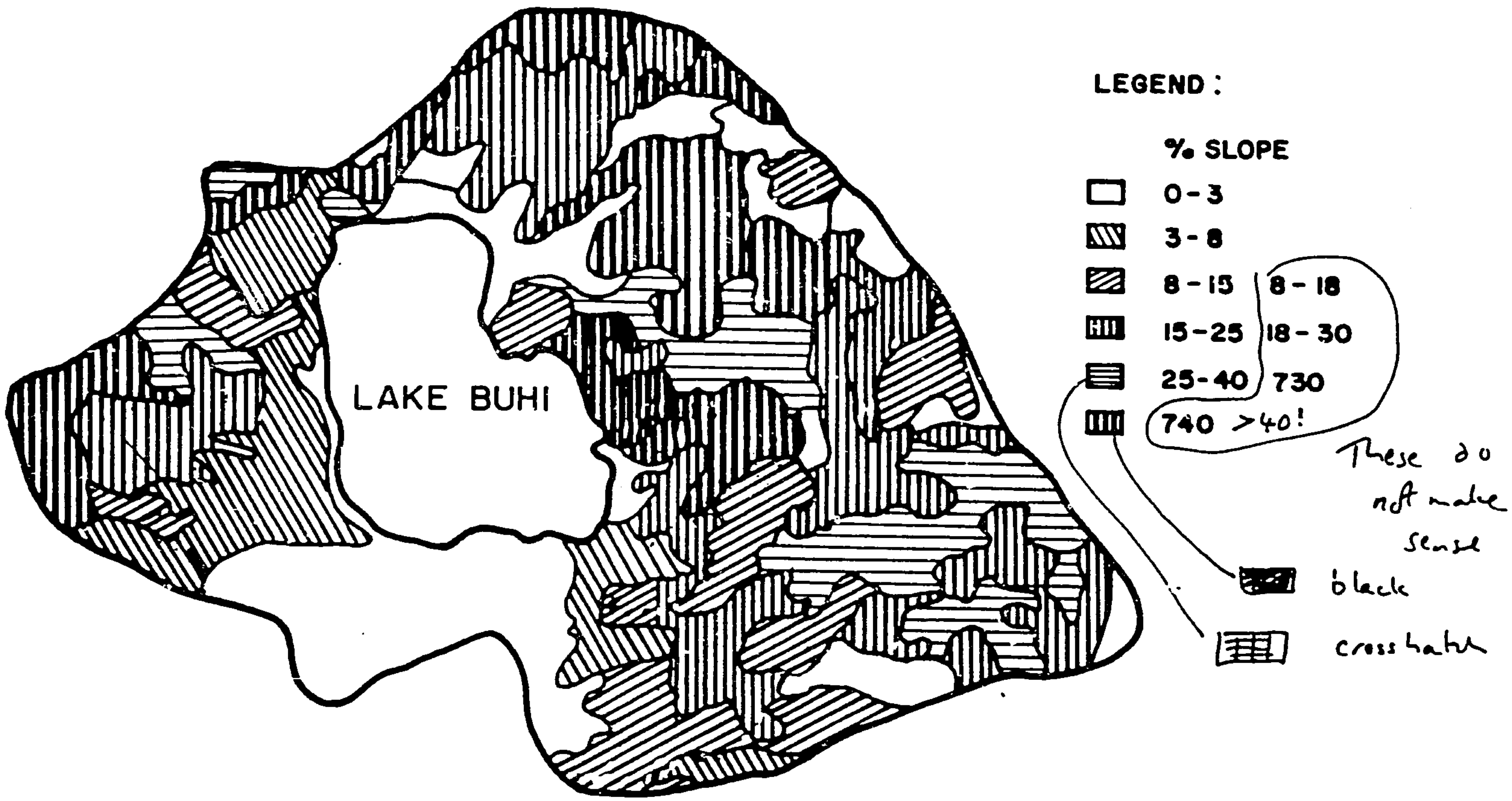


Figure 5. Slope map of Buhi watershed (reference)

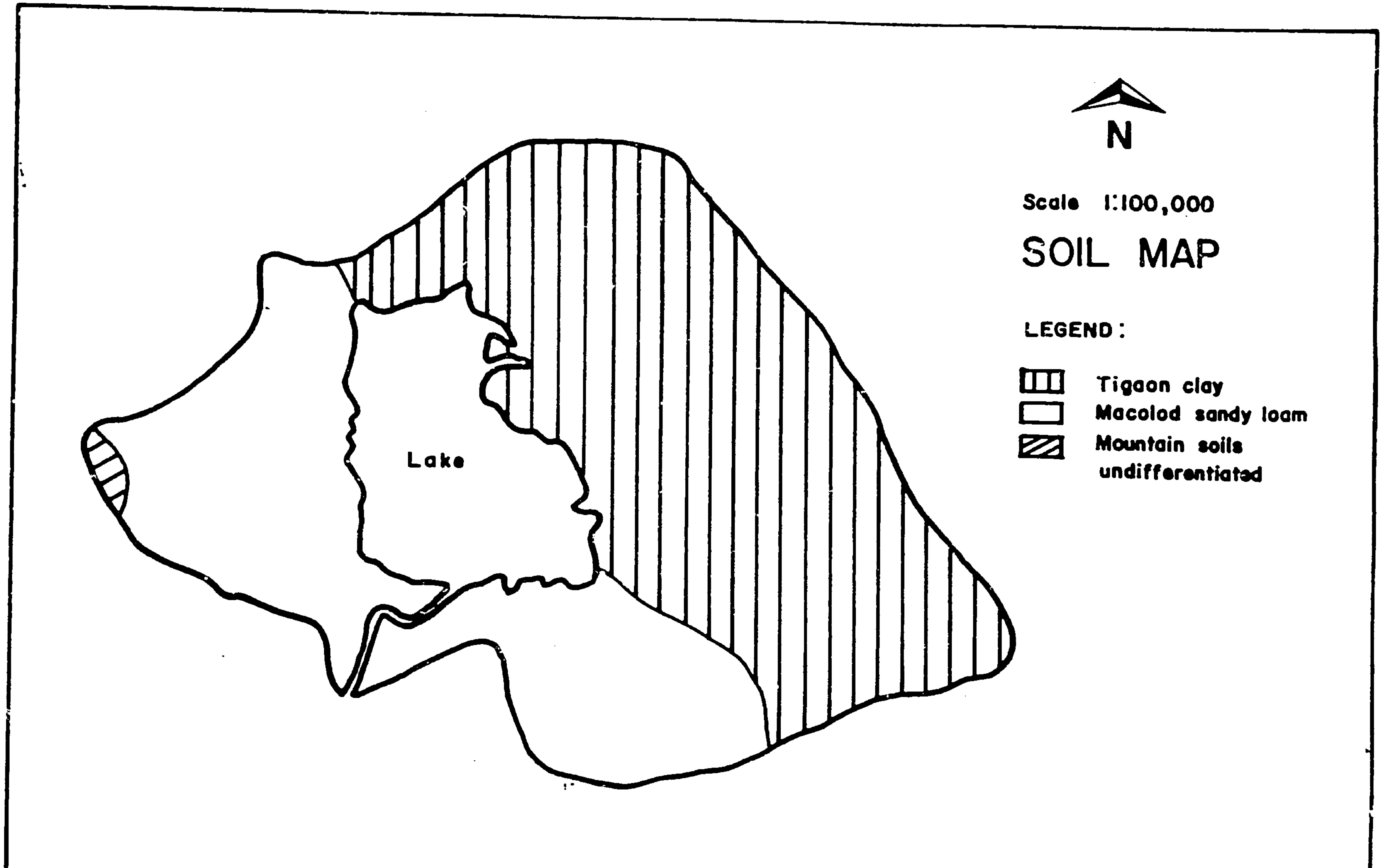


Figure 6. Soil type map of Buhi Watershed, Camarines Sur (reference)

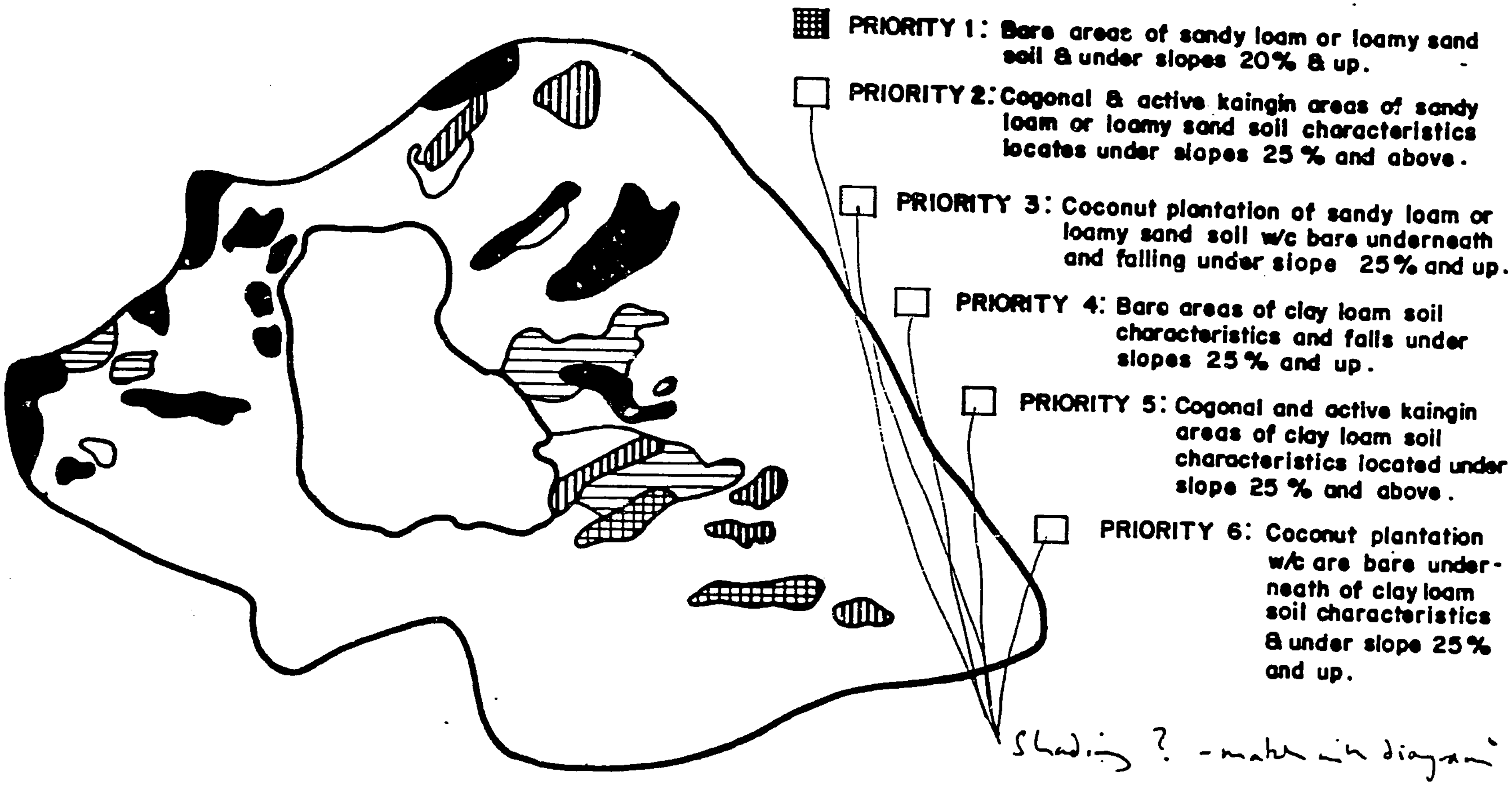


Figure 7. Soil Erosion Potential Map (reference)

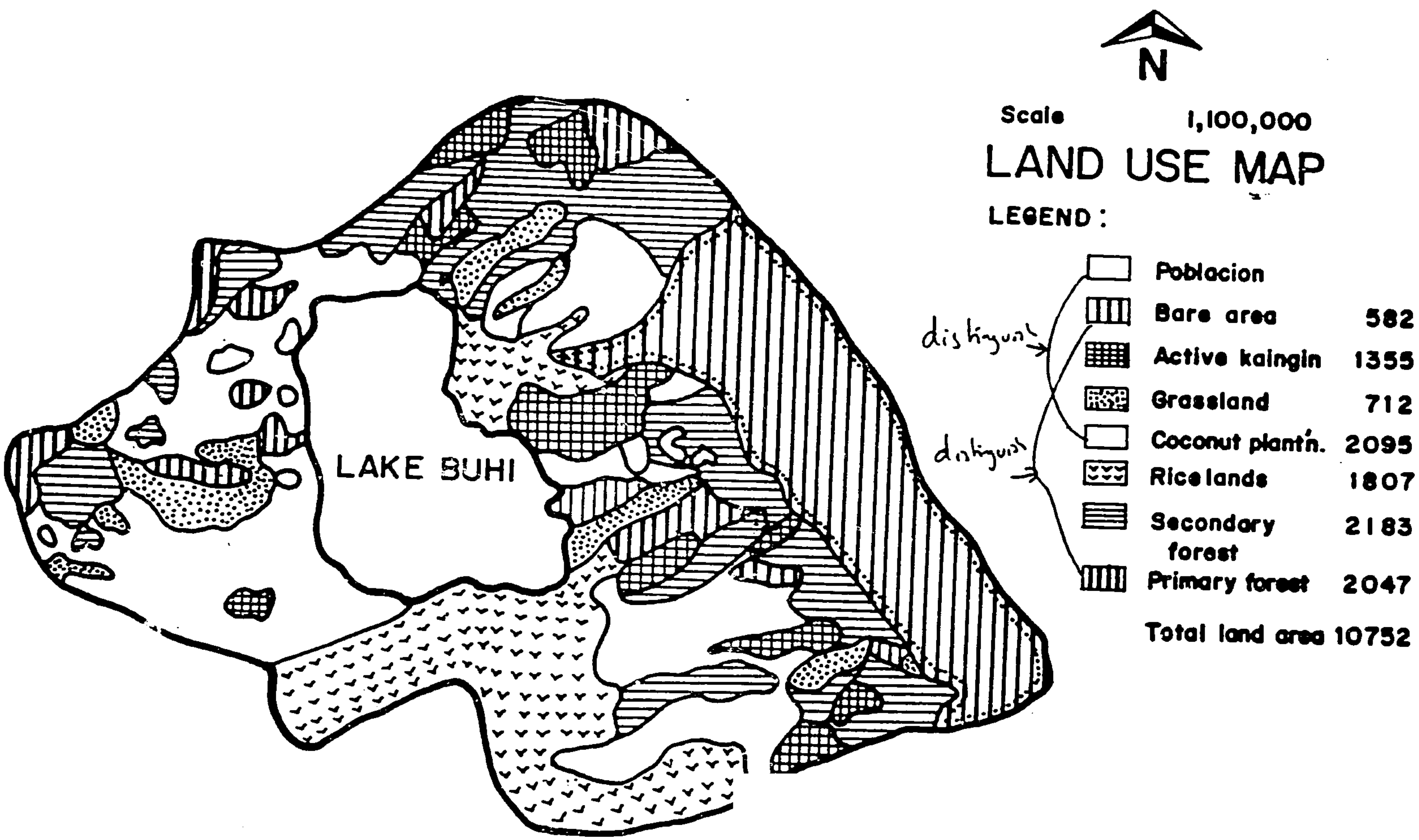


Figure 8. Land use map of Buhi Watershed (FORD-BRBDP, 1980).

diminished and been replaced with secondary forest, coconut, and kaingin (Figure 9).

The annual crops grown in the area are lowland and upland rice, corn, cassava, sweet potato, gabi, peanut, and others. Abaca, banana, coffee, coconut, mangoes, cacao, avocado, lanzones, jackfruit, pili nut, calamansi, and chico are some of the permanent crops grown.

Rattan and almaciga are available in the forests. The Nabua-Monte Calvario Association of Rattan Gatherers has a concession of 1,323 has in Buhi Watershed. According to key informants, almacija is present on the crest of Mt. Malinao. Other activities in the forest lands include illegal logging and orchid gathering. Shifting cultivation and planting perennial crops like abaca are commonly practised on sloping secondary forest.

Climate

Type II and Type IV climate is present in Mt. Asog and Mt. Malinao zones respectively (Figure 10). In most months, Mt. Malinao zone has a higher amount of rainfall than Mt. Asog zone (Figure 11). February to March are the low rainfall months.

Drainage

Iraya River, Binaugan River, Sta. Cruz River, and Sawang River are the major rivers that provide water in the lake (Figure 12). The sulfur spring which drains into Iraya River is the probable contributor of kanuba in the lake.

The Itbog Falls, which drain into Sta. Cruz River, are the proposed source of domestic water supply for Poblacion and several barangays around the lake. They are is also planned to be the source of water supply of Iriga City and other adjacent towns. Aside from this, Itbog Falls could be developed for a mini-hydroelectric plant. There are no available data on streamflow of each creek and river and the hydrologic characteristics of the watershed. Erosion control structures, comprising loose rock check dams and gabions wrapped with cyclone wire, are proposed for Iraya, Binaugan and Sta. Cruz Rivers (Figure 13).

Population

Figure 14 shows the population of the upland barangay of Lake Buhi Watershed. More than three-quarters of the residents are natives of the place. A few came from various towns of Camarines Sur and other provinces in the Bicol region. Even fewer come from Luzon and the Visayas. Ninety six-percent speak the Bicol dialect and 98% are Roman Catholic in religion.

Figure 9

Missing

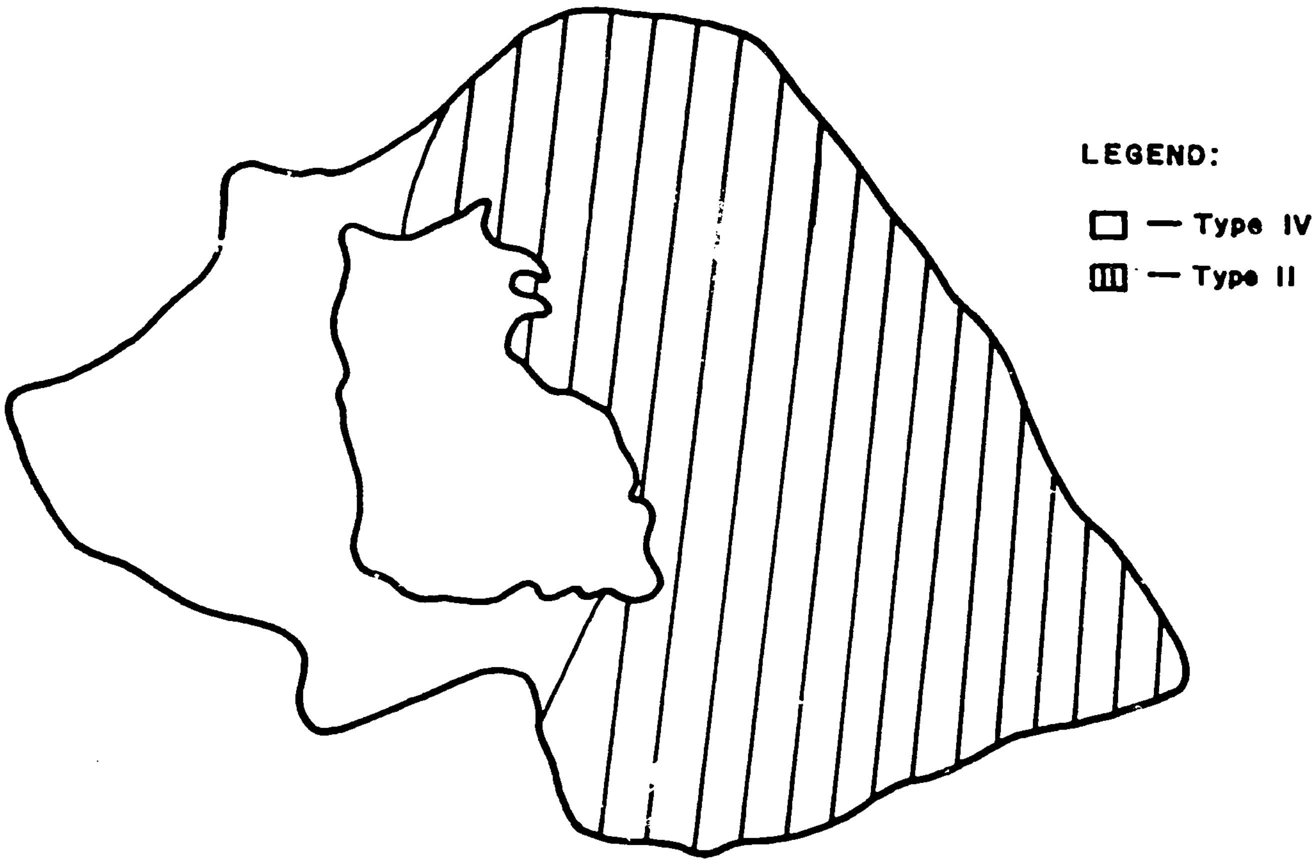


Figure 10. Climatic types in Buhi Watershed

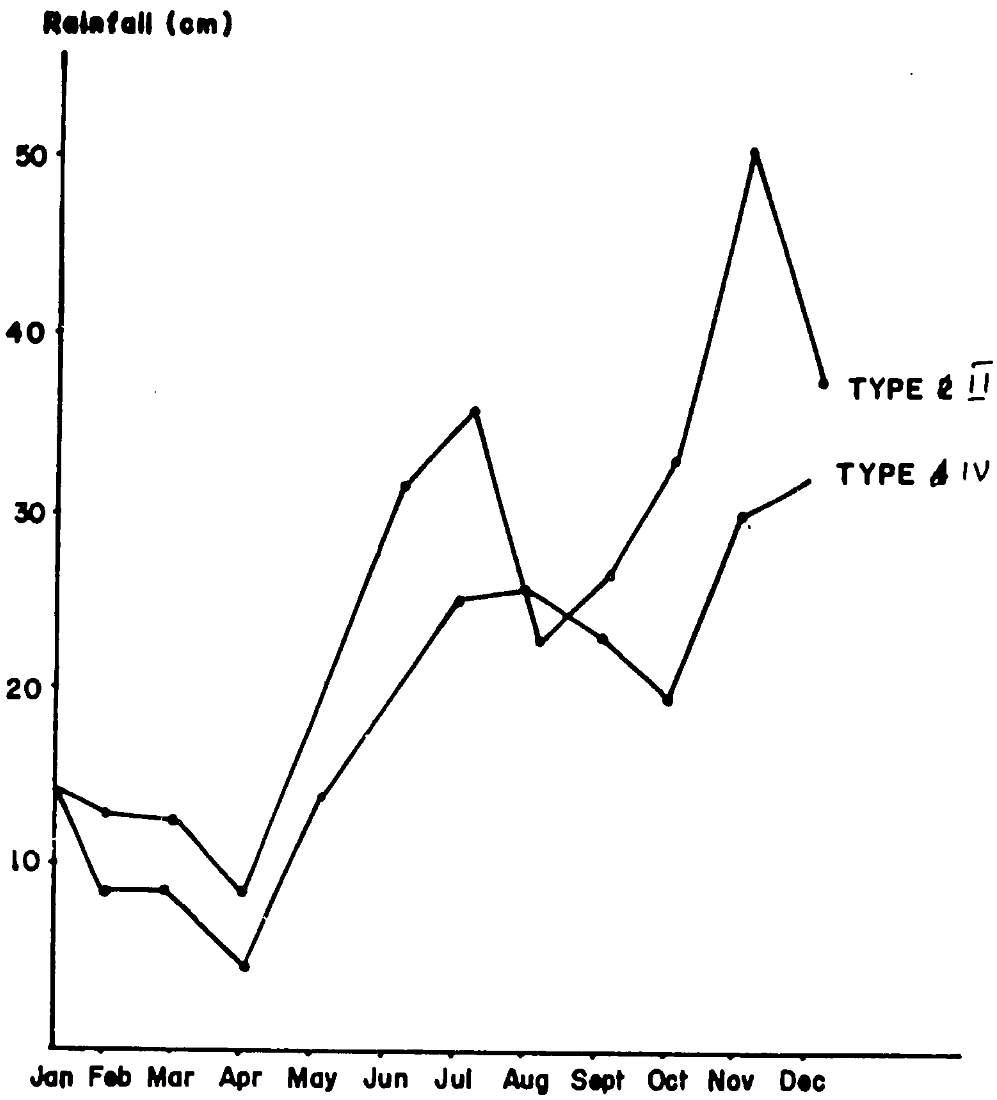


Figure II. Mean monthly rainfall of two climatic types in Buhi watershed.

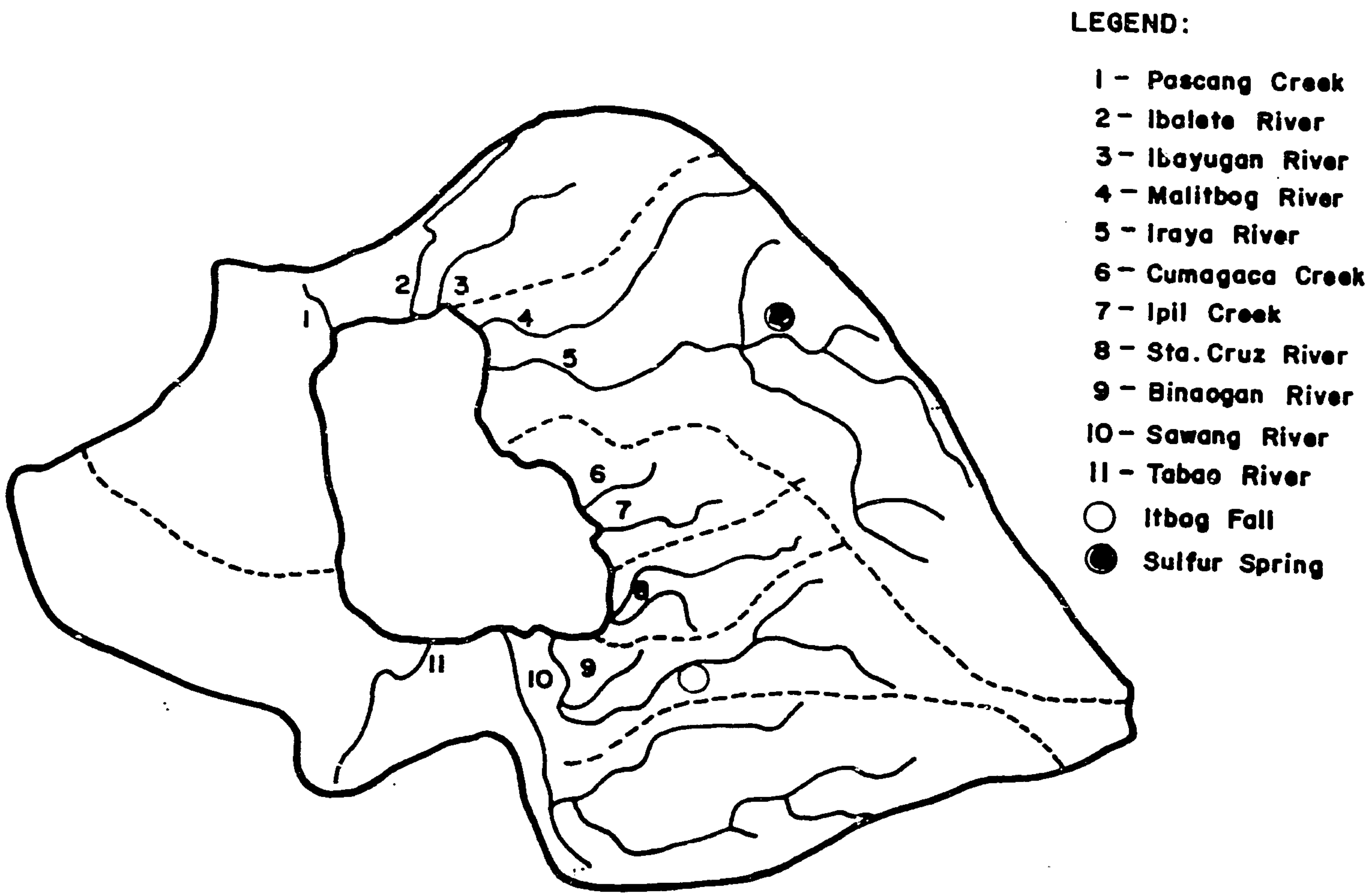


Figure 12. Drainage System of Lake Buhi

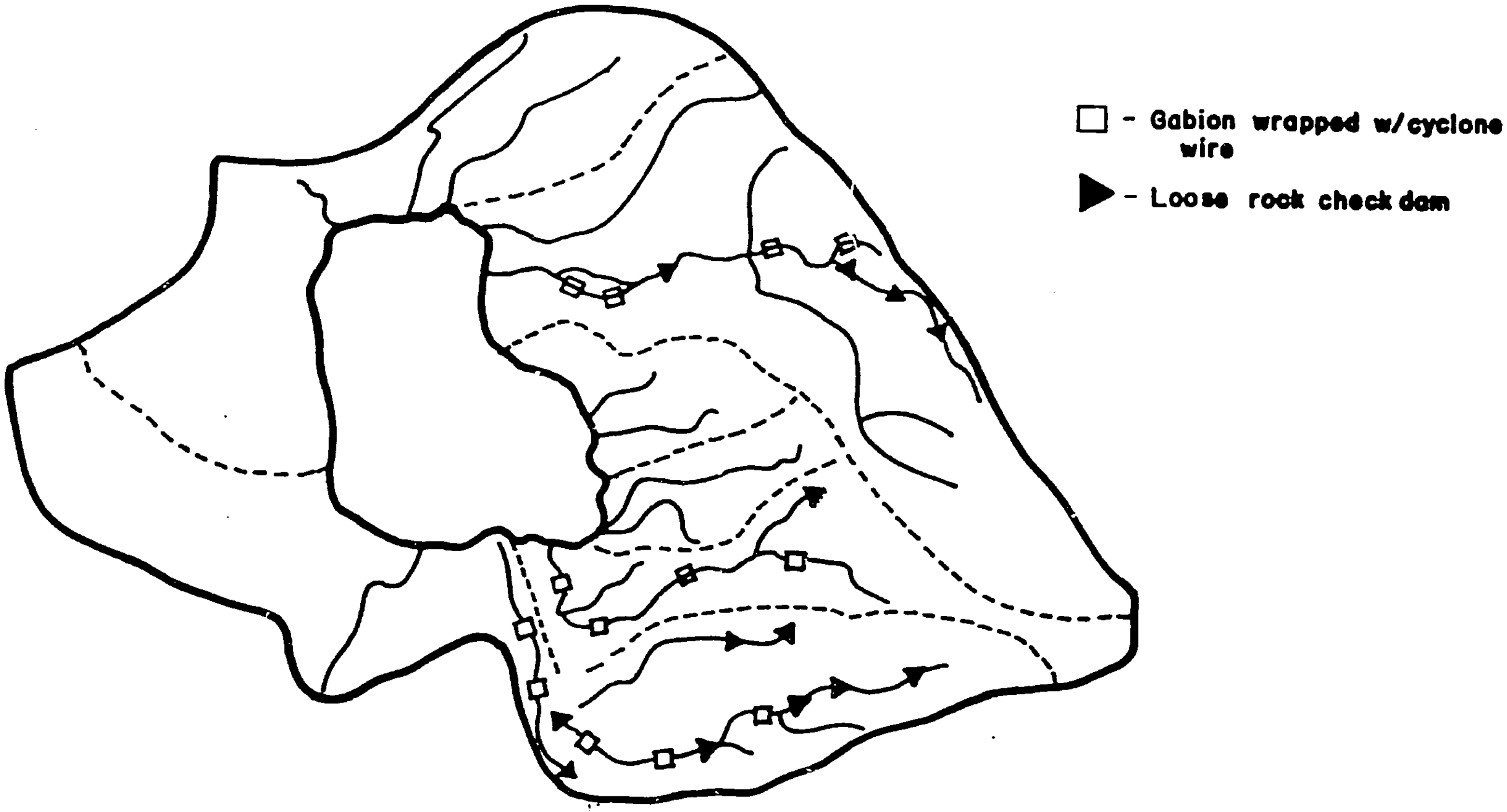


Figure 13. Proposed Erosion Control Structures (Ref)

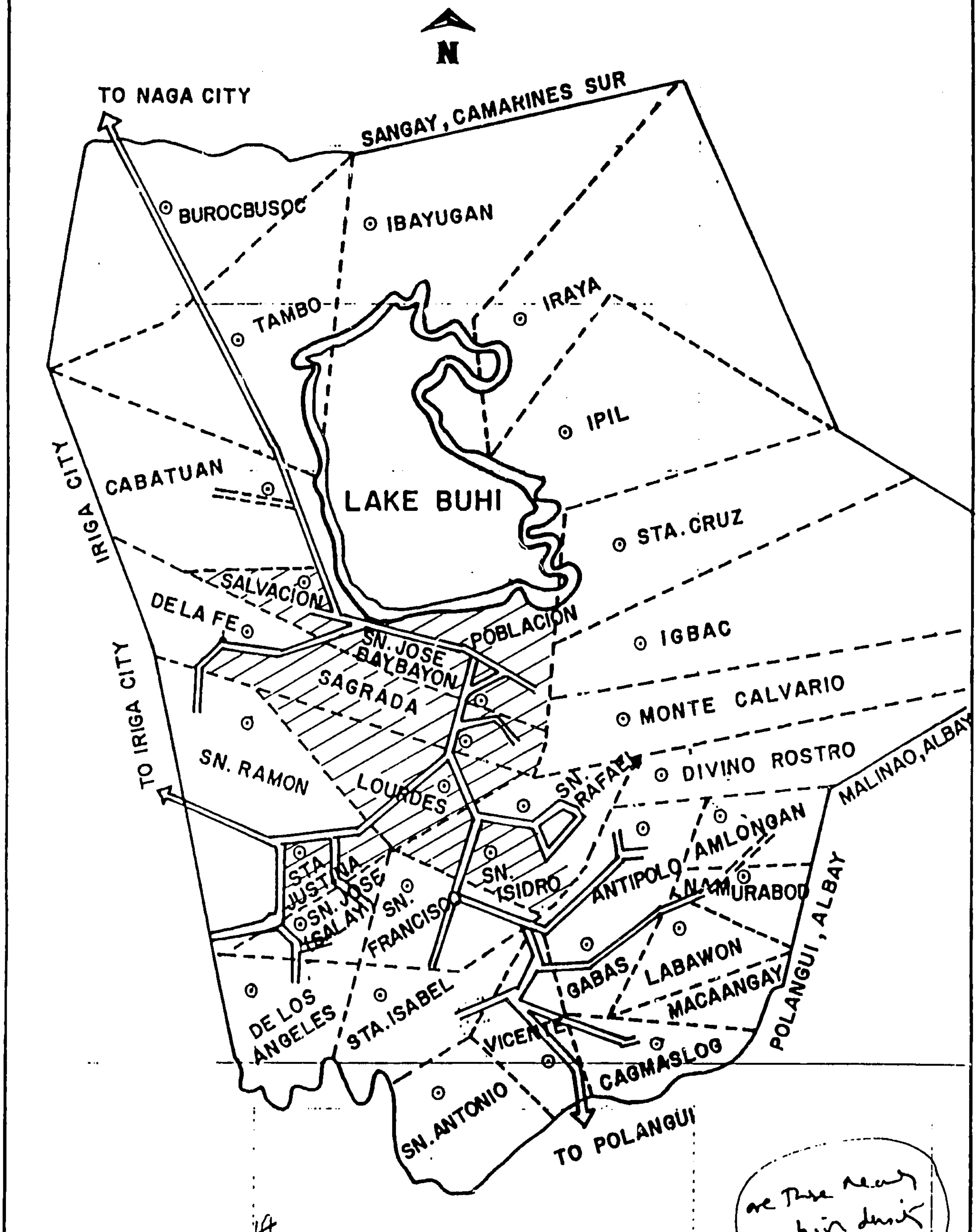


Figure ~~8~~ 14. Barangays with higher population density

are these really high density barangays

(see Fig 2 ch 4.5)

Transects

Figures 15 and 16 show Sta. Cruz and Pascang Tambo transects, respectively. Inundation of the lowland rice paddy at the lakeshore is a problem when the control structure is closed. Soil erosion, land tenure and natural calamities are common problems in the two zones. Marketing transportation and lack of capital are the major problems in the Mt. Malinao zone, but not in the other zones. Flash floods are a major problem only in the Mt. Asog zone.

Temporal Patterns

Cropping

Various kinds of cropping systems are practised in the area. In the irrigated area of about 142 has, rice is continuously grown (Figure 17). Relay and intercropping systems are being practised. One of the typical relay croppings is corn-rice-sweet potato. Root-crops are intercropped with corn. In the Mt. Asog zone, corn is grown during the dry and wet season. The corn areas of Barangay Tambo, Cabatuan and San Salvacion are 392.65 has and 18.5 has. respectively. Farmers are using hybrid corn and IPB corn varieties. Corn production is about 45 cavans/ha. The better off farmers are using four bags of complete fertilisers and two bags of urea per hectare of cornfield to get this production level. The corn growing area at Mt. Asog was formerly abaca plantation.

With the introduction of the Masagana 77 program, abaca was changed to corn. During the first five years corn yield was at least 77 cavans/ha but decreased to as low as 22 cavans/ha due to decrease in soil fertility and soil erosion. Most farmers do not plant during the windy months of September to December, even though there is adequate soil moisture.

In the kaingin, abaca is planted after one or two crops of upland rice. Anei is planted together with abaca to provide shade. Abaca is also intercropped with coffee. Bolo, hoe, and crowbar are used to cultivate the kaingin.

Flows

Sources of Income

If we assume that the FORI-BRBDP (1979) socio-economic and Attitudinal Survey is representative of the Buhi Watershed inhabitants, then the characteristics of the 400 respondents from 10 barangays can be said to be true of watershed inhabitants. The majority have some elementary education. Household size ranges from 3 to 10 and the modal household size is 8-9 members.

Forty percent are engaged in farming, 14% in fishing, and 3% are not employed. The average annual household income is bimodal. Eighty nine percent have less than ₱3,000 and 11% have over ₱6,000.

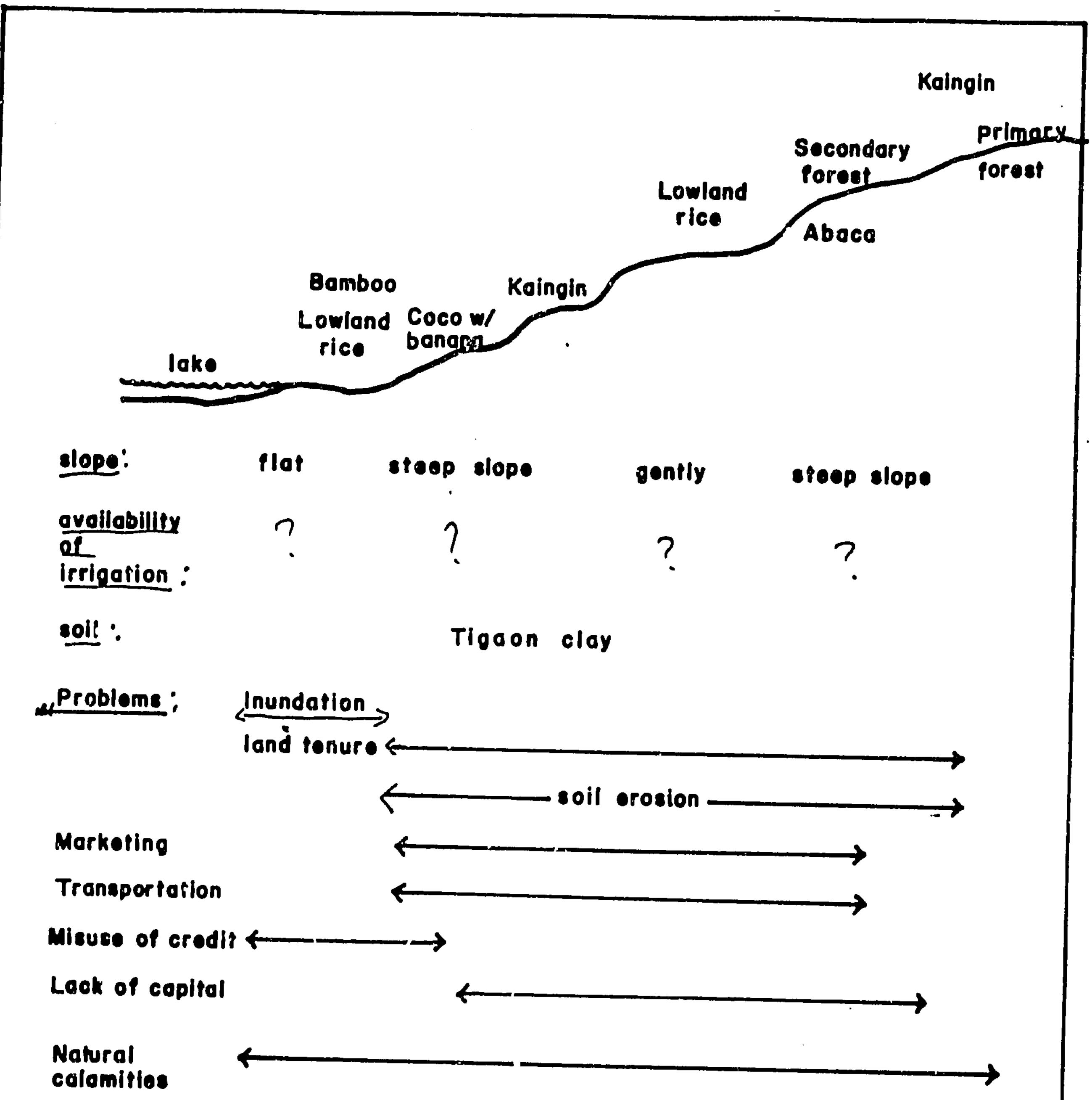


Figure 15. Sta. Cruz Transect

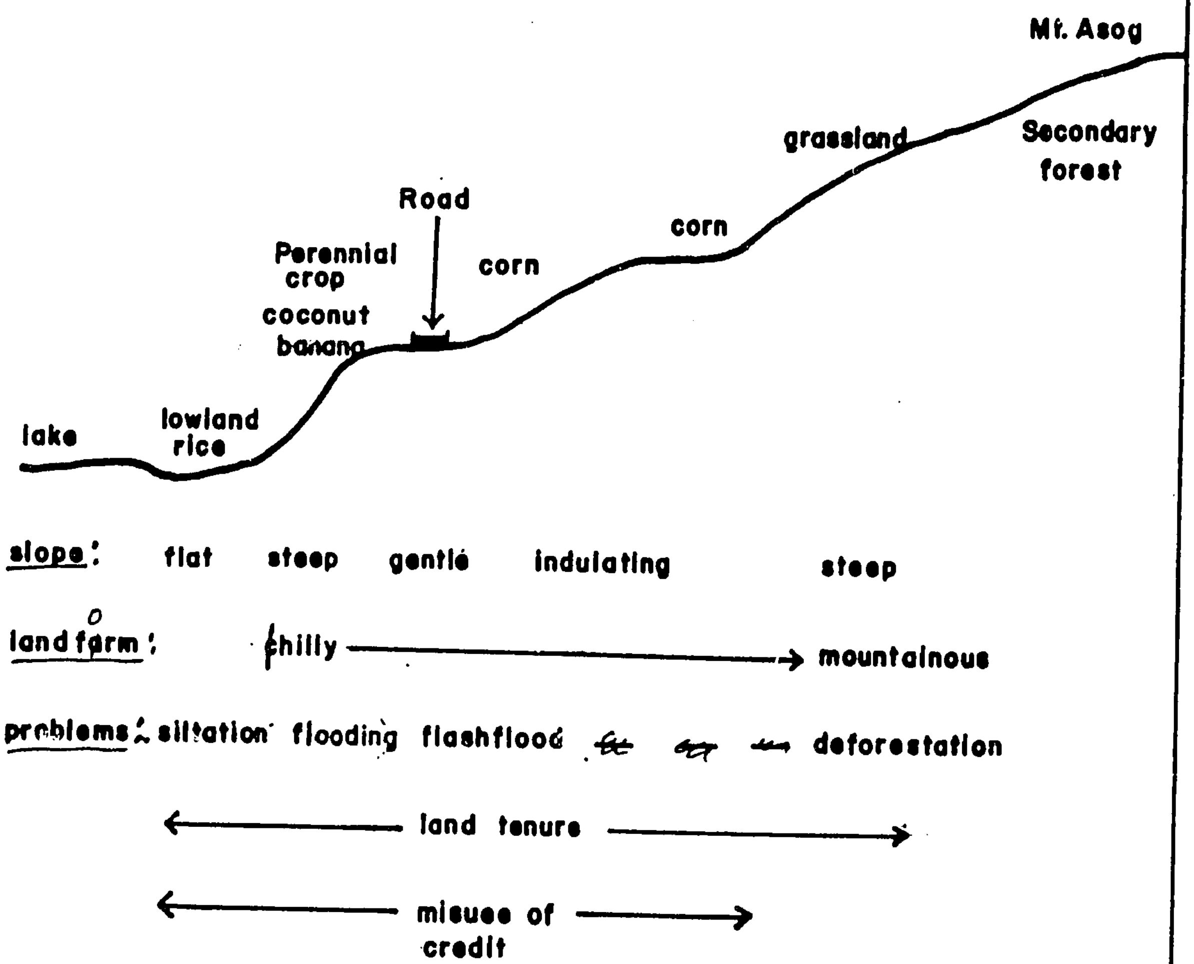


Figure 16 Pascang - Tambo Transect

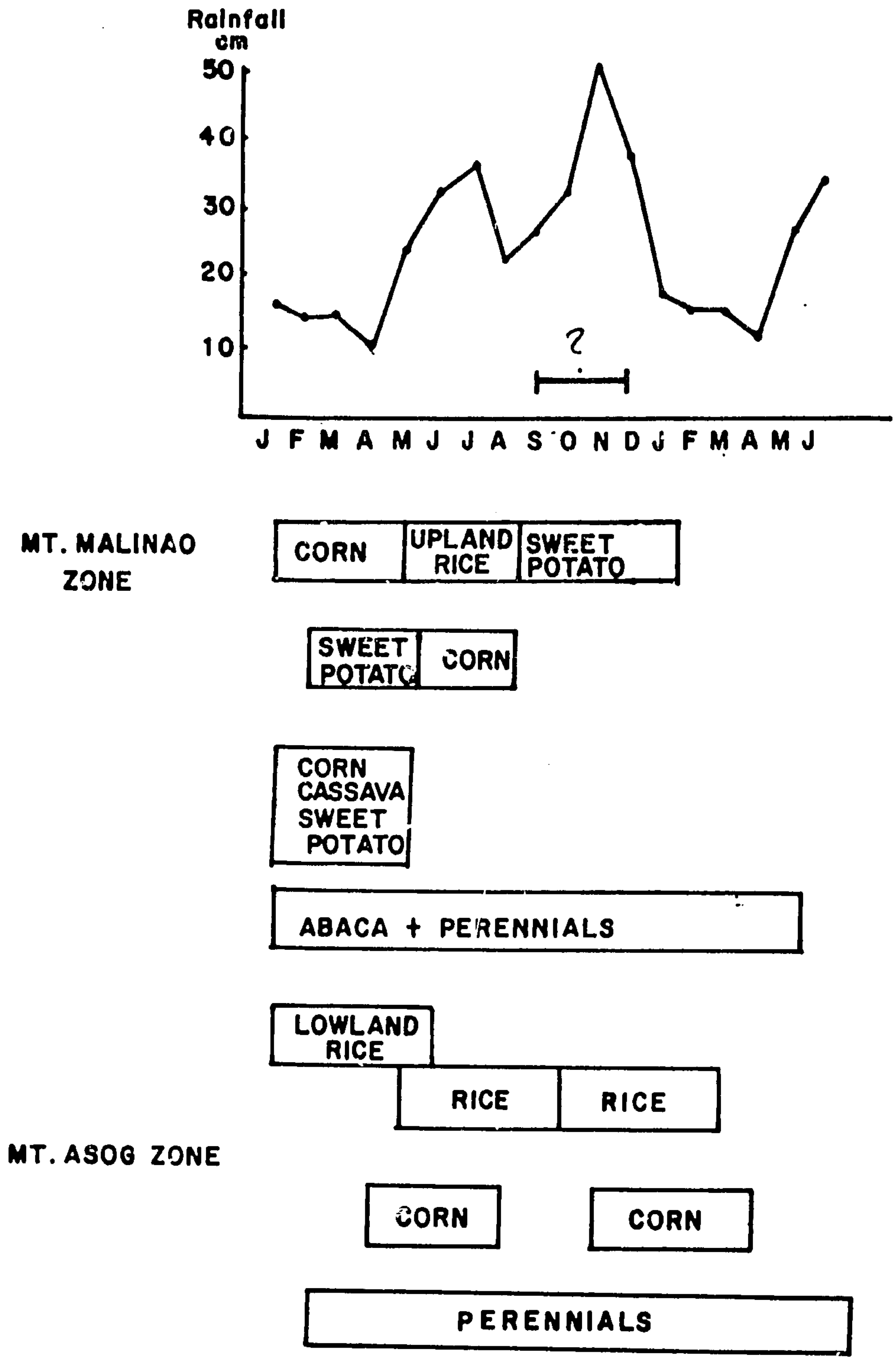


Figure 17. Cropping Pattern and Rainfall

Among the more common household furnitures are tables, chairs, beds and cabinets. Seventy nine-percent have transistorized radios. The banca is one of the most important modes of transportation and is essential for fishermen; forty-seven percent possess a banca. There are a few sleds, motorboats, bicycles, and tricycles. Almost all (97%) own carabaos, 35% have plows, 25% have harrows. A few have sprayers and one owns a hand tractor.

Production

Most of the farm production areas in the Buhi watershed have been declared as alienable and disposable. These include areas on steep slopes. A large portion of these farms are cultivated by tenants. Informants from eastern barangays in the watershed estimated the percentage of tenant farmers to range from a low 30% in Ibayugan to a high 95% in Igbac. Around 70% of farmers in Ipil and 80% in Iraya are tenants. Land tenure seems to be related to the adoption of specific measures to conserve soil and water. Among tenants, about a third of their farm produce is shared with the landlord. There is thus little incentive to plant permanent crops for soil and water conservation. Annual crops are preferred. A farmer-leader expressed his preference for annual over perennial crops because the latter get easily uprooted by strong winds and typhoons and it takes a longer waiting time to realize a return from these crops.

The perceptions of farmers are varied on the relationship between cultivation and soil erosion and siltation of Lake Buhi. At one extreme there are those who regard the siltation of the lake and attendant fishing problems as the least of their concerns. At the other extreme, there are a few who feel the urgent need to plant trees and increase farmers' awareness of their value in conserving soil and water. In addition, low productivity of farms is attributed to erosion of top soil.

Marketing

Exchange of livelihood commodities between upland and lowland communities through the market system, include agricultural and forest products like flitches which are transported to nearby towns and province (Figure 18).

Most of the corn, coconut, abaca, and bush sitao are sold in the market as staple foods. About 20% of the sweet potato is sold at the town market and 10% is sold at the farm gate (UPLB-PESAM, 1985).

Farmers expressed the problem of lack of farm-to-market roads. Particularly in Mt. Malinao zone farmers have to carry farm produce on their backs to bring these to the market in the poblacion. Some hire people to carry these for as much as ₱20 for a cavan of rice.

In addition to lack of roads in upper portions of barangays and low productivity of farms, farmers also cite the problem of illegal cutting of trees in the remaining forests. The

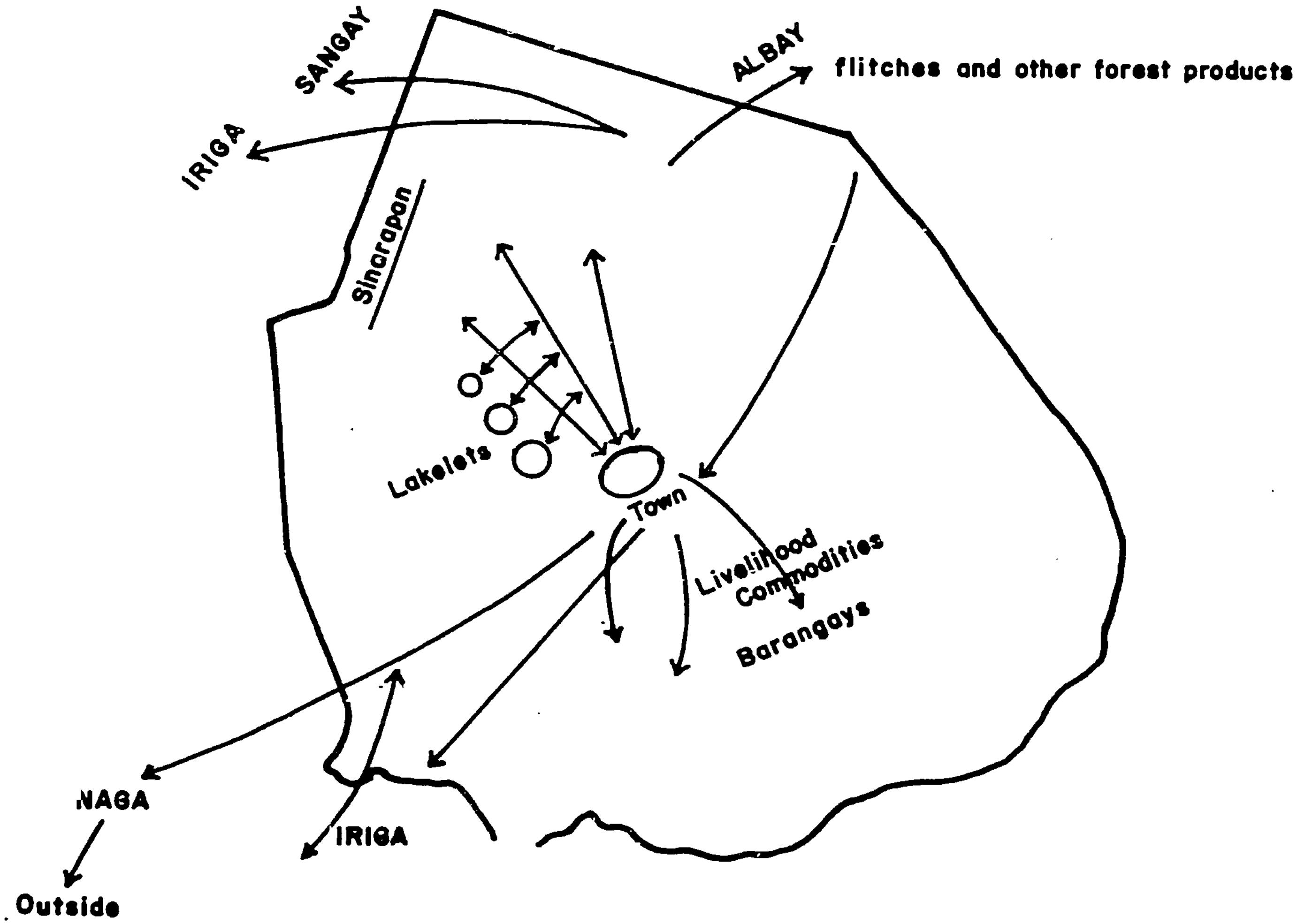


Figure 18 Major Product (Material Flow Patterns)

realization of the proposed 10-km barangay road around the lake (Figure 19) and the Buhi-Tiwi road would facilitate the transport of agricultural products from upper Sta. Cruz to Poblacion and shorten the distance of Buhi Town and Legazpi via Tiwi.

Erosion

The FORI-BRBDP survey measured the attitudes and activities of inhabitants toward the watershed. Results show that most respondents believe the watershed prevents soil erosion and is an important source of water. A few respondents gave importance to the watershed as source of their livelihood and wood for the community. It also helps prevent pollution and flooding. Although only a little over a quarter of the respondents were aware of the Buhi watershed management project, about half of them expressed willingness to cooperate with the project.

Although about two-thirds know of some measures to protect and rehabilitate their watershed, only a little over a third translate this knowledge to specific activities. The most common activity mentioned is planting trees. Using a Likert Scale consisting of 26 items, the FORI-BRBDP survey found that respondents have a slightly to strongly favorable attitude toward the Buhi watershed, specifically its protection and rehabilitation. Of the 10 barangays studied, those of Burocbusoc and the De La Salle expressed strongly favorable attitudes.

From direct observation and responses of key informants it can be gathered that only a few farmers have adopted soil conservation measures like contour strip planting and bench terracing. These farmers are members of the Upland Farmers Association. Observation of selected farms located in northern and northwest barangays, however, reveal extensive soil erosion. Rock materials and rill formation are evident in some farms. Landslides have occurred, destroying the graded trails that lead to some sites.

Decision Making

Livelihood Systems

Upland farmers with no capital have no option but be tenants or work on somebody else's farm as hired labor (Figure 20). Farmers with capital can farm their land or construct fishcages. The slope of the land and availability of irrigation water determines the kind of annual crop to be planted.

Social Organization and Institutional Involvement

There are several formal organizations and government agencies in Buhi. Among the formal organizations are the Parent-Teacher Association, Kabataang Barangay, Rural Improvement, Samahang Nayon and Mr. and Mrs. Club. In 1982, four Upland Farmers Associations were organized. These associations are

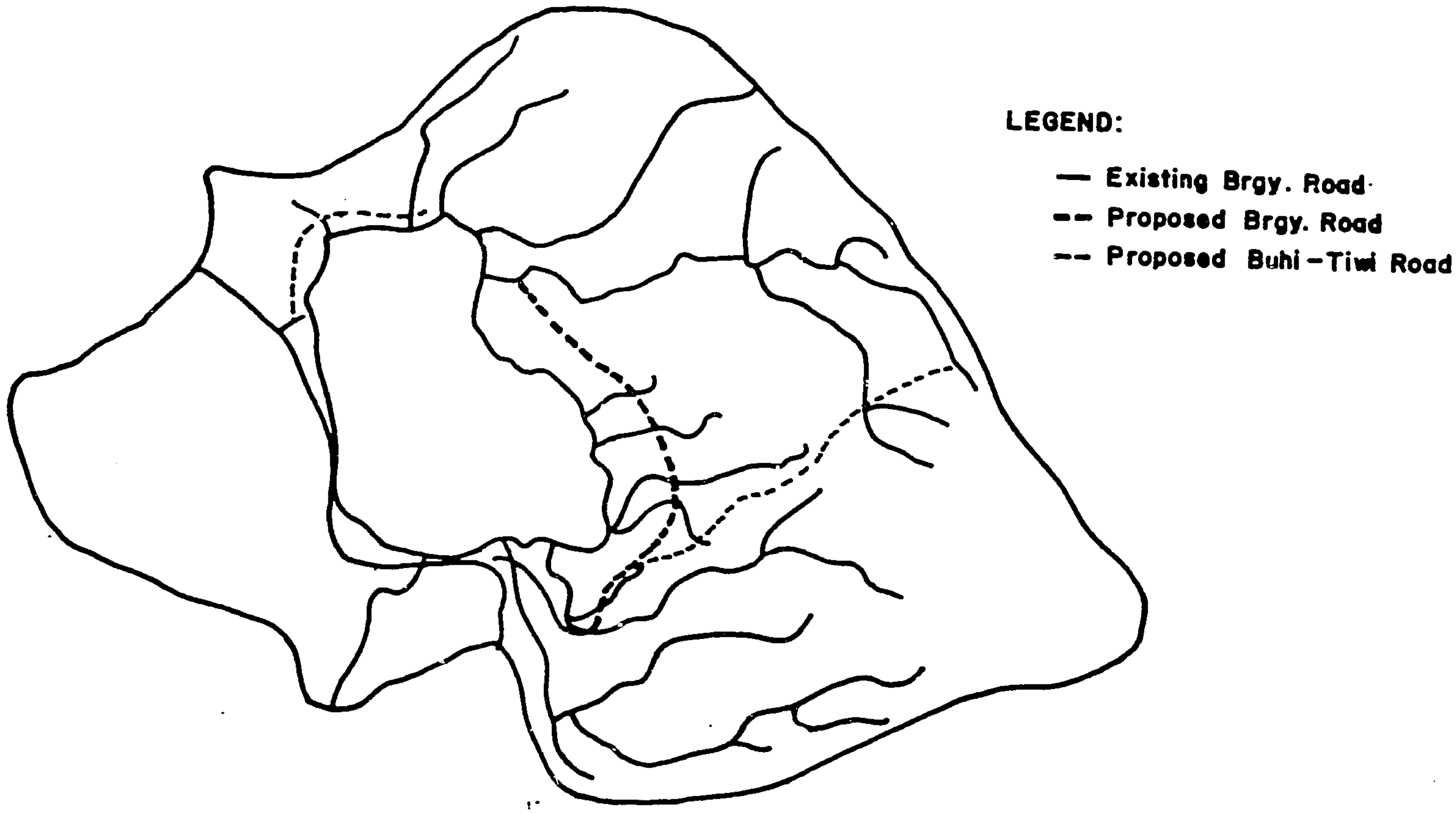


Figure ~~18~~ 19. Proposed Road Project

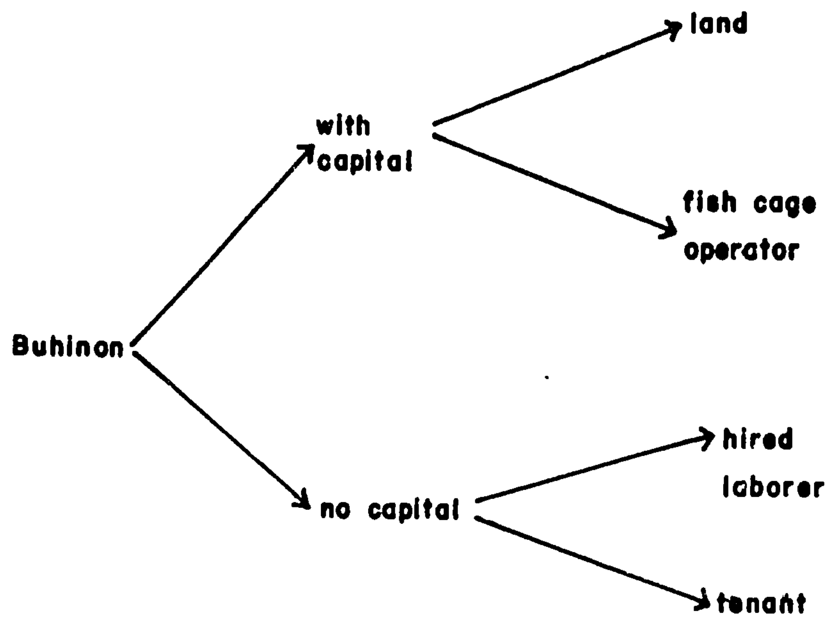

land
with capital
fish cage operator
Buhinon
hired laborer
no capital
tenant

Figure ~~14~~. 20

engaged in trail construction and livelihood related activities, specifically on agricultural production. They also aim to promote soil and water conservation. In 1984 these associations hosted the Convention of the Federation of Upland Farmers. A couple of Peace Corps Volunteers are engaged in community organizing activities among the Agtas. It was through the efforts of a Peace Corps Volunteer that some communities in Iraya and Ipil have become project areas of the Integrated Social Foresty Program (ISF). On August 29, 1985 forty project participants were awarded individual certificates of stewardship contract.

Among the government agencies operating in the Buhi Watershed are the Ministry of Education, Culture and Sports, the Bureau of Forest Development, the Ministry of Local Government and Community Development, the Rural Health Unit, the Bureau of Lands, and the Bureau of Plant Industry.

Figures 21 to 24 show overlapping institutional involvement in the implementation of projects and policies on resource use in the uplands of Buhi. The role and function of each institution must be properly defined to avoid conflict between the local government and the line agencies, and among line agencies.

Leadership and communication patterns are important aspects of social organization. The FORI-BRBDP Survey asked respondents to indicate the most likely person to act as leader when the community plans to undertake a project. The barangay captain was mentioned by 64% of the respondents. The other people to whom respondents would go to for help in solving problems include barangay councilmen, government officials, family members and friends. The heads of formal organizations are also recognized leaders in selected areas of concern.

Radio is the most common communication medium. Many inhabitants in the watershed own transistorized radios. News and information are also disseminated in community meetings called by or through the barangay captain. In addition, news or information spreads by word of mouth from informal discussion points like sari-sari stores or the front yard of houses strategically located at crossroads.

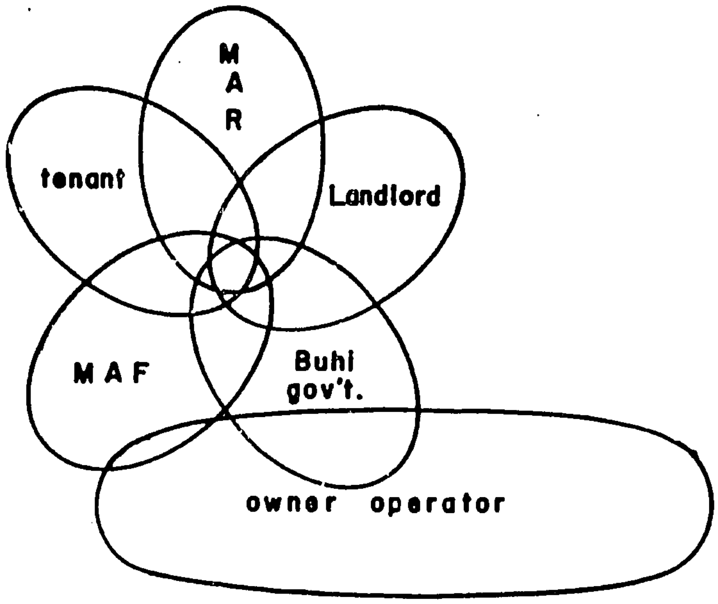
System Properties

Future Trends

Continued exploitation of the upland resources will result in decrease in streamflow, genetic resources, forest products and cover over time (Figure 25). Soil erosion and siltation of the lake will also increase. Although agricultural lands, may expand, it will not result in proportional increase in agricultural products because of rapid degradation of land.

Table 1 shows research and development problems or issues in the uplands of Lake Buhi watershed. The factors that have positive or negative effects on productivity, stability, sustainability, and equitability of the upland are shown in Table 2.

Institutional Involvement on Agricultural Land Use (A & D Land)



NIA proposed agro forestry project of the watershed

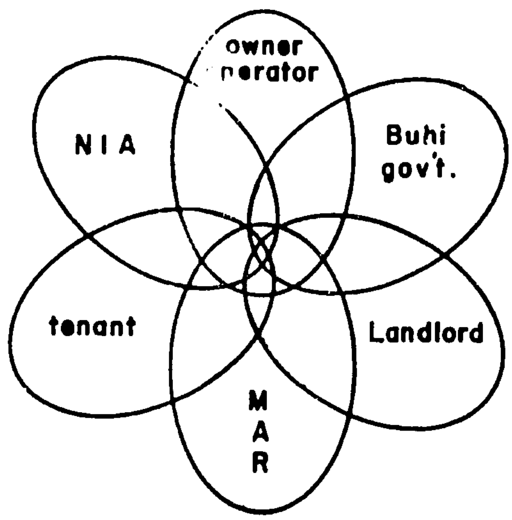
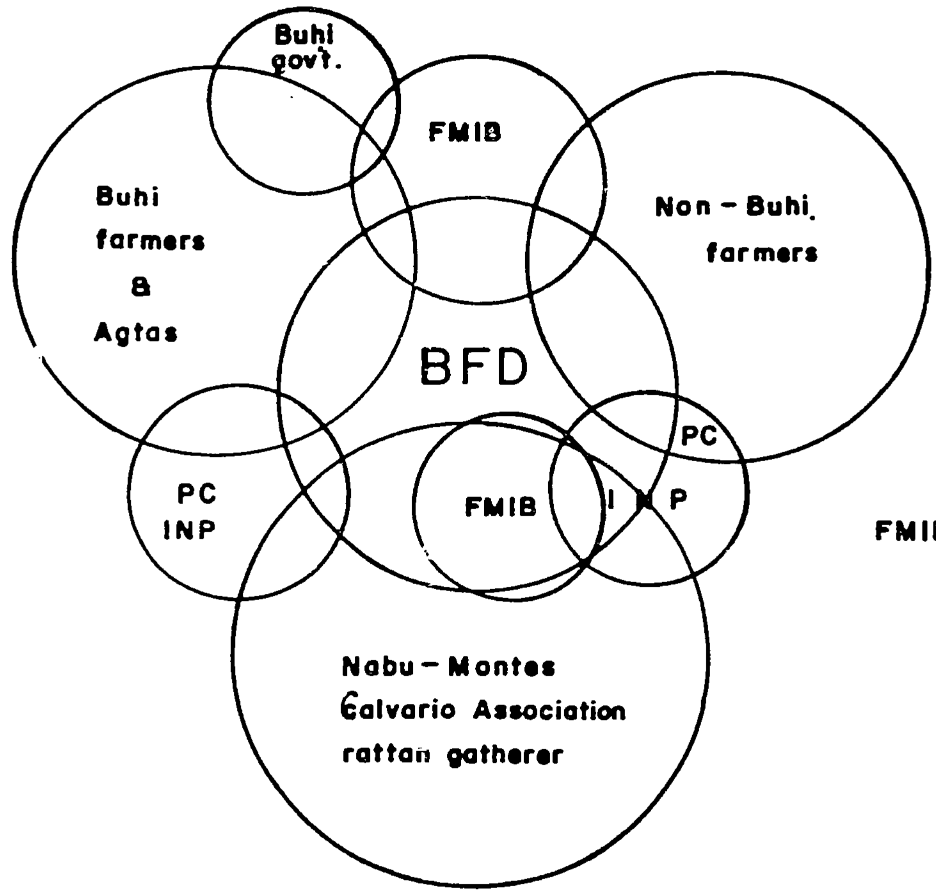


Figure 21



FMIB - Finance Ministry Intelligent

Figure 19. Institutional Insolvement on Forest Resource Utilization

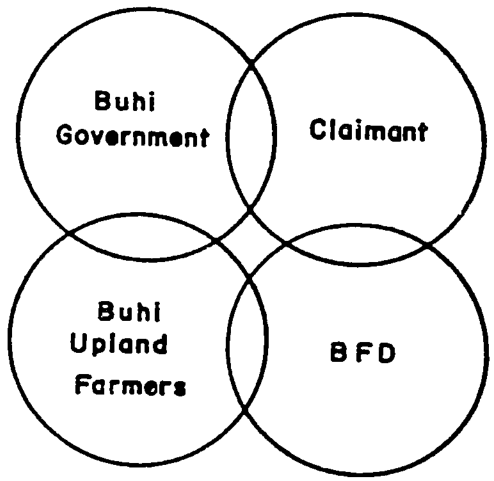


Figure 2-3 Institutional Involvement in ISF Program

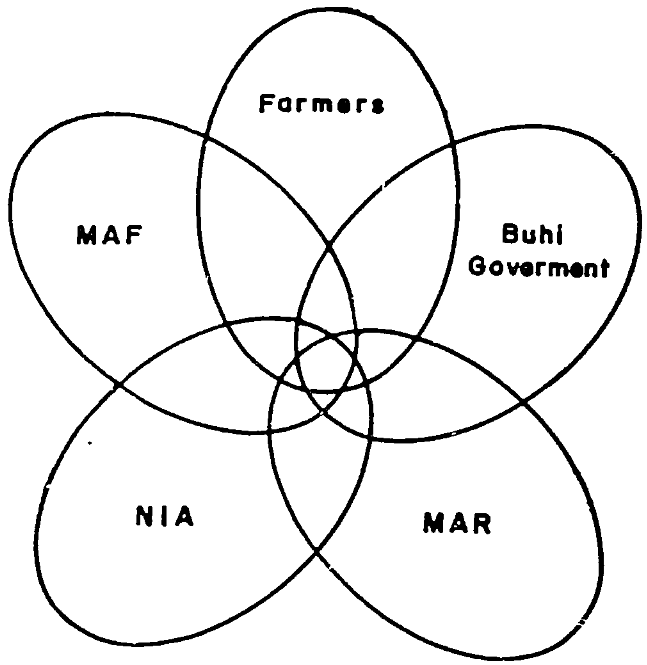


Figure 24. Institutional Involvement on Drawdown Areas of the Lakeshore

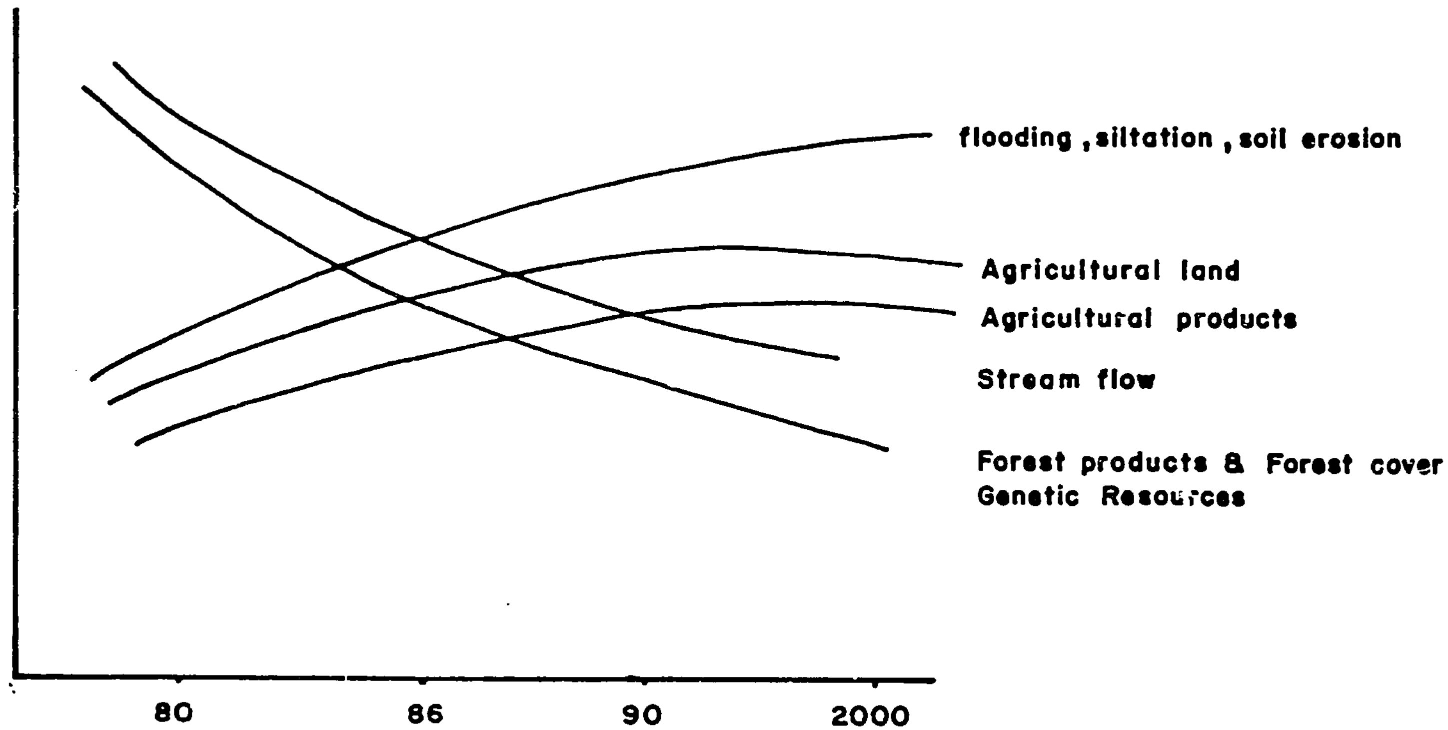


Figure 25 Future trend without intervention

4.2 LAKE BUHI

ROGELIO N. TAGARINO, MARLITO L. CARDENAS and
ZANAIDA B. CATALAN

Introduction

Historical Profile

Lake Buhi is of peculiar interest for allegedly it was formed during historic times. An excellent account of the various major physical events that occurred in the lake and their immediate influence was prepared by Gindelberger (1981). It discusses how the physical events such as the damming of Tabao River, the use of motorized push nets and fish corrals, and the introduction of several fish species affected the lake's fishery productivity. The dam which was constructed in 1955 across the Tabao River, to generate hydroelectric power, prevented not only several migratory fish species from entering the lake but also some of the indigenous fish species from moving to their respective spawning grounds along the Tabao-Buhi rivers. Some of the fish species introduced into the lake are predatory species, that have affected the indigenous fish species, particularly the sinarapan.

The more recent developments in Lake Buhi are fishpen and fish cage operations and the construction of a hydraulic control structure at the mouth of Tabao River. Fishpen and fish cage operations were introduced by the Bureau of Fisheries and Aquatic Resources (BFAR) in early 1980 to provide an alternative source of livelihood for the people in the area. The hydraulic control structure was constructed by the National Irrigation Administration (NIA) to impound more water in the lake for irrigation. The over-all developments in the lake and their influence are indicated in Figure 1.

System Hierarchies

In order to generate a better understanding of the different characteristics of the Lake Buhi system, we have defined it according to geographical zones. The lake system is delineated into five zones: southeast, northeast, northwest, southwest, and a central water zone as shown in Figure 2. In this zonification, the central water zone is assumed to be the deepest portion of the lake. It is only an assumption since the necessary information about the shape of lake bottom is yet to be generated. And the only information available is that the eastern side is shallower than the western side of the lake. As indicated in the figure, the other four zones are considered in this report as nearshore zones.

The basis for comparison, i.e., the distinguishing features, between the different lake system zones are presented in Figure 3. In terms of uses, the central water zone is distinct from the other zones since no significant activities except open fishery

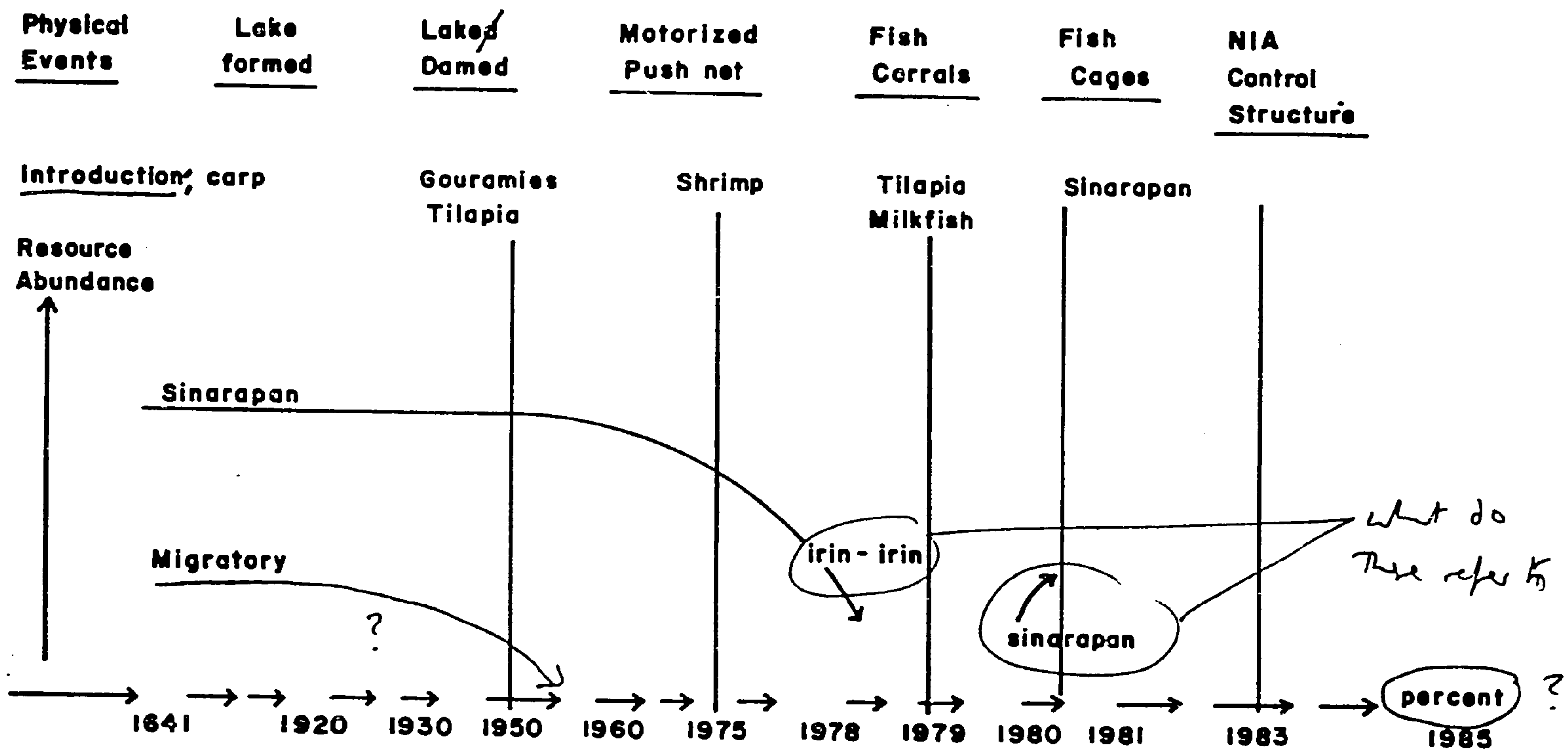


Figure 1. A historical diagram of Lake Buhi fisheries (Source : Gindelberger, B. 1981)

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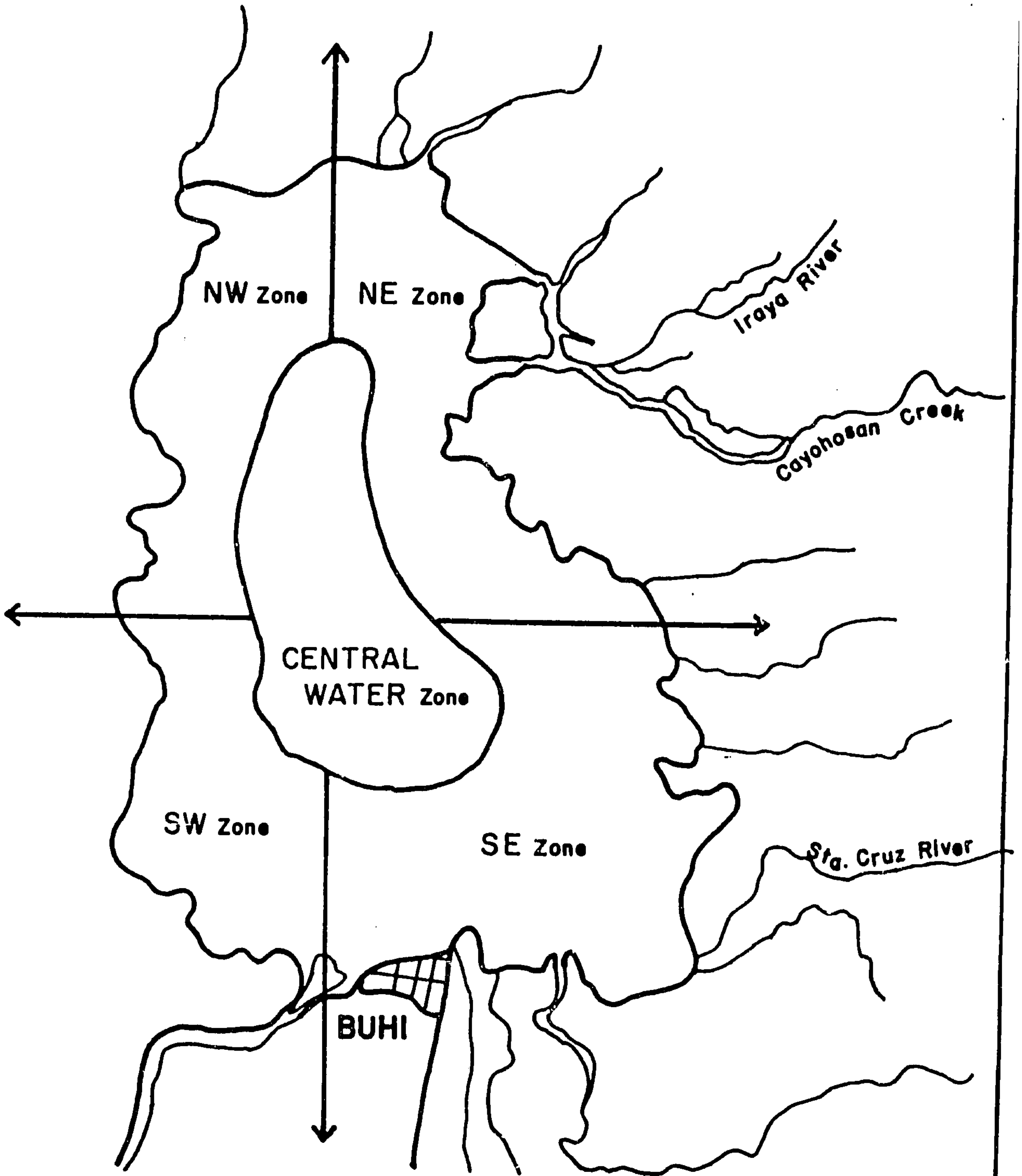


Figure ~~13~~ 2. Base map indicating Lake Buhi subsystem hierarchies

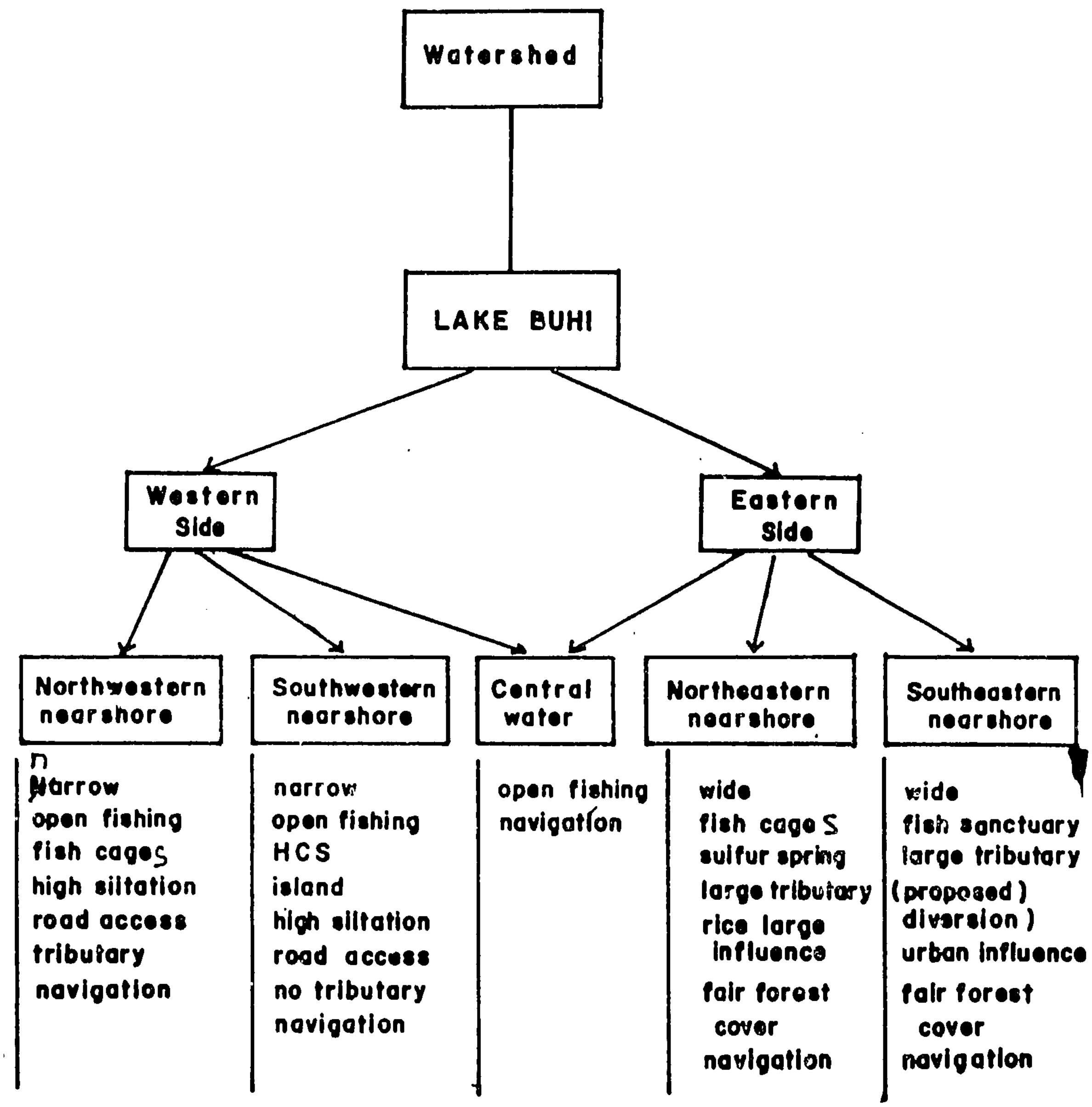


Figure ~~14~~ 3. Lake Buhi subsystem hiearchies and navigation are being undertaken. In the near future, when tourism is developed, the central water zone may be used for recreational purposes, such as scuba diving and water skiing. Significant human activities are being carried out in the nearshore zones. These include fish cage operation, capture fishing, agricultural production, etc. The differences in the nature and extent of human activities which are being undertaken in the different nearshore zones can be generally associated with the differences in the bio-physical properties of the different zones.

Spatial Relationships

Bio-physical Characteristics

A comparative analysis of the different lakes zones with respect to the different bio-physical, features/properties are presented in Table 1. Generally, the eastern zones (southeastern and northeastern zones) have wide nearshores since these portions of the lake are shallowing up due to high siltation. Fishery activities in this side of the lake are more extensive than in the western side. A significant number of fish cages and fish corrals are concentrated in the southeastern zone where the fish sanctuary is also located. Hence, the fishery preservation zone i.e., the fish sanctuary, is not really officially implemented.

As indicated in Table 1, the zones of the lake system are distinctly different with respect to several features such as the number of tributary inflows, siltation, pollution, settlement influences, fishery activity, productivity and many others. In terms of level of income, health and nutrional status, people in th southeastern zone are generally better off than those in the other zone.

A more comprehensive account of the physico-biological properties of the lake is yet to be generated. Bathymetric data which are useful in determining the water volume storage capacity of the lake are still being generated by NIA and the National Power Corporation (NPC). Table 2 presents some of the general physical and technical properties of Lake Buhi.

Table 1. A comparative description of the different lake system zones according to uses and bio-physical features.

	NW	SW	CENTRAL WATER	NE	SE
Width of nearshore	narrow	narrow		wide	wide
FEATURES					
Tributary (inflow)	+	0		+++	++
Outflow	0	+++		0	0
Siltation	+	0		+++	++
Pollution	+	0		++	+++
Road access	++	+++		0	+
Water access/navigation	+	0		+++	++
Islands	0	+		0	0
Control structure	0	+		0	0
Settlement influence	++	++		+	++++
FISHERIES					
Open/capture	++	+++	++++	++	++
Corral	+	++		+++	+++
Cage (Proposal)	+(++)	++(+)		++	+++
Sanctuary	0	0		0	(+)
LAKE LEVEL					
Drawdown	+	+		++	+++
Inundation	+	0 +		+++	+++
PRODUCTIVITY					
Fish	++	++	+	+	+++
Water hyacinth	+	+++	0(+)	+	+
Plankton	?	?	?	?	?
LIVING STANDARD					
Income	+	+++		+	++++
Health and Nutrition	+	++		+	+++

<u>Legend</u>:

+ - Low
++ - Medium
+++ - High
++++ - Very high
0 - None

Table 2. General physical and technical description of Lake Buhi, Camarines Sur, Philippines.

Particular	Statistics
Area (ha)	1,500 - 1,800a/
Depth (m)	
average	7.30
maximum	11.61a/
Surface Elevation (m)	75.00b/
Outline	irregular
Water temperature oC	28.85 - 31.40a/
Water pH	7.6 - 8.7c/

a/ PCARDD, 1981.

b/ Pratt, W.E.

c/ BFAR, Fisheries and Aquatic Resources Survey.

Population and Livelihood Patterns in Lakeside Barangays

Most of the residents of the 11 lakeside barangays are engaged in fishing, either as a primary or secondary occupation. The total population in these barangays is 18,216 in 3,108 households (Figure 4). The average household size is 5.8. It should be noted that most of the barangays are characterized by a common feature of sloping topographic condition.

Those who depend on fishing as a primary source of livelihood reside in the lower portion of the barangays. Key informants in the study area suggested that residents within 2.0 km from the lake shoreline generally undertake fishing activities, either fish capture or fish culture or both, as an important source of livelihood. Not all of these residents, however, are engaged only in fishing for there are 142 has of lowland farms around the lake. The general livelihood pattern in lakeside barangays is indicated in Table 3. Those barangays with higher number of fishermen are indicated by the shaded portion of Figure 4.

Transport

There are 26 lanes designated for navigational purposes. Most of these have a width of 30 metres and if combined together, they would occupy a significant portion of the lake's surface area. In addition to small fishing boats, there are 15 passenger boats operating in the lake (Table 4).

As indicated in Figure 5, the lanes are generally designated from the shoreline toward the center of the lake. Only a few go along the shoreline. The number of navigational lanes on the eastern side of the lake is much greater than on the western

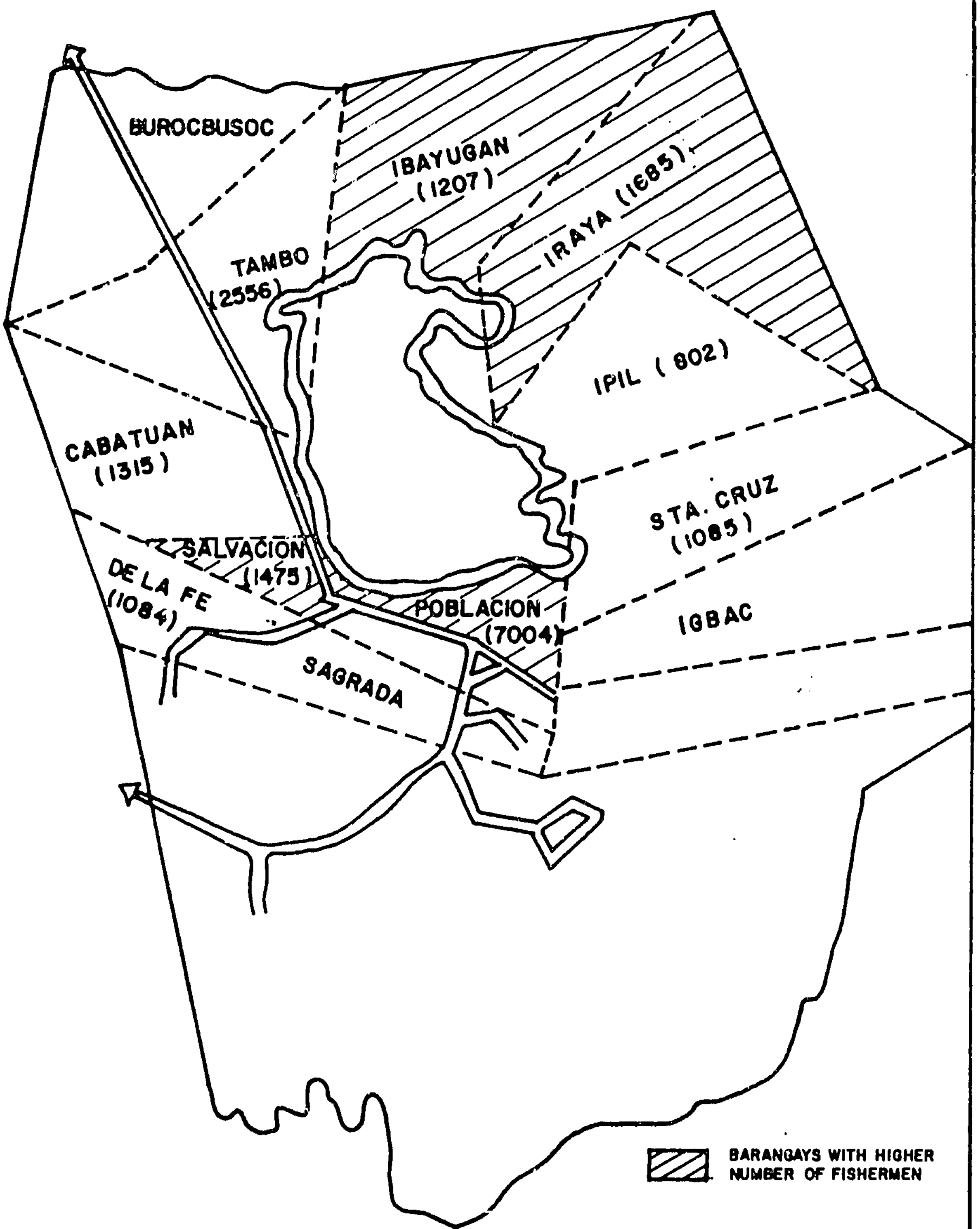


Figure ~~2~~ 4. Population of Lakeside Barangays

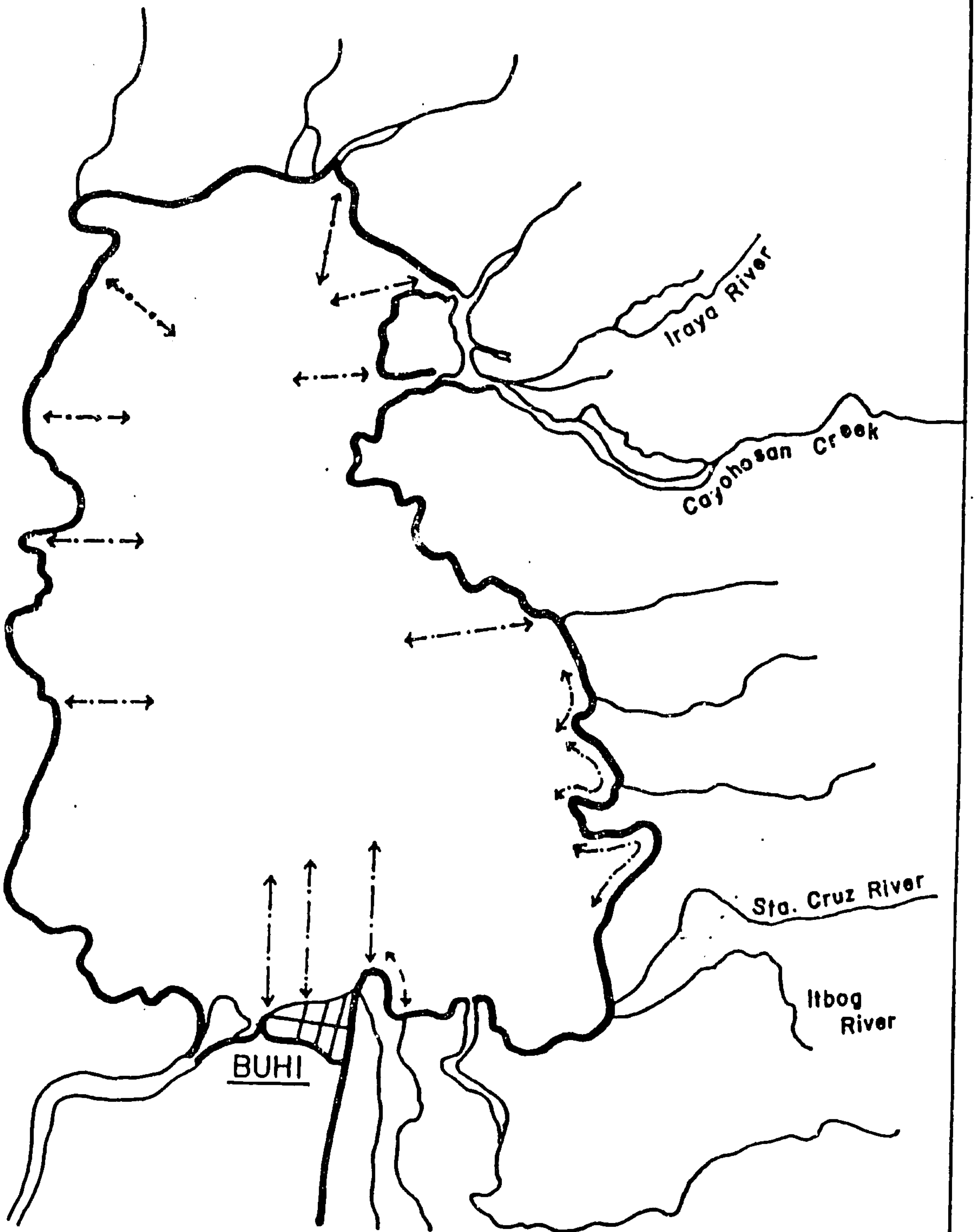


Figure 5. Lake Buhi's Navigational Lanes.

Table 3. Population, households, livelihood patterns and lowland farm area around Lake Buhi, Camarines Sur.

Lakeside Barangay	Number of Population/Household		Lowland Farm Area (ha)	Livelihood Pattern
Sta. Cruz	1,085	181	15 (125)	F > A
Ipil	802	134	15	F > A
Iraya	1,685	281	87 (20)	F > A
Ibayugan	1,207	201	20	A > F
Tambo	2,556	393	5	A > F
Cabatuan	1,315	219		A > F
Salvacion	1,478	246		F > A
Sta Clara	1,850	404		F > A
Sta. Elena	2,993	369		F > A
San Buena	2,21	499		F > A
De la Fe	1,084	181		A > F
Total	18,266	3,108	142 (+45)	

Legend: F > A - Fishing as major source plus farming as supplemental source of household income

A > F - farming as major source plus fishing as supplemental source of household income side, which is already supplied with an access road. The access road on the eastern side of the lake has not yet been developed, and thus the residents are still very much dependent on water transport.

Table 4. Number of passenger boats by location, fare from poblacion, maximum ferrying capacity, and frequency of trip, Lake Buhi, Camarines Sur.

Barangay	No. of Boats	Fare (₱ passenger)
Iraya	6	2.00
Ibayugan	4	2.00
Ipil	2	2.00
Sta. Cruz	2	2.00
Baybay	1	2.00
Total	15	

Ave. maximum ferrying capacity	= 50 persons
Ave. number of passengers/trip	= 25 persons
Frequency of trips	
During market days	= 2 round trips
During ordinary days	= 1 round trip
Ave. HP rating of passenger boats	= 10-16 Hp
Cost of License to operate	= ₱200.00/yr.

Personal interview of key informants in the study are, November 1985.

The designation of certain parts of the lake's surface area for navigational purpose is very important to lakeside barangays, most especially those in the eastern side. The question as to whether the navigational lanes are properly designated has not been raised by people in the study area. However, the installation of markers for the lanes and the development of landing ports can significantly contribute to the improvement of the water-transport system in Lake Buhi.

Irrigation and Hydroelectric Power Generation

The water supply of Buhi watershed drains into the lake through several creeks and rivers. Sta. Cruz and Iraya rivers are the major inflows. Lake Buhi water level is regulated by a hydraulic control structure (HCS) at the head of Tabao river which is the only water outlet of the lake. Water outflow is towards the south-western side of the lake where the Tabao river and HCS are located (Figure 6).

The impounded lake water is released to the Tabao river channel and passes through the NPC hydroelectric turbine, toward the irrigation canal networks. Hence, lake water outflows are used to provide additional irrigation water supply for about 9,000 hectares of ricelands in the Rinconada irrigation service area and, at the same time, generate additional power for the Daraga Hydroelectric Power Plant of the National Power Corporation (NPC) that feeds into the Southern Luzon Power grid. The development of irrigation and hydroelectric power uses of Lake Buhi water supply is under the Bicol Integrated Area Devevlopment (BIAD-Rinconada-Buhi/Lalo) Project which is funded through a loan from USAID. The project was started in 1980 and will be operational in early 1986. The project infrastructure cost was estimated to be ₱73M (BRBDP, 1980).

Fish Cage Culture

Fish cage culture involves more than 3,000 fish cage units with an average dimension of 5 x 8 x 4 m each. The total lake surface area presently covered by these cages is only about 15.12 has. Hence, an additional 44,970 of cages could still be established (Table 5), if 10 percent of the total surface area of the lake is used for fish cage production. The distribution of registered fish cage operators according to lakeside barangays are indicated in Table 6.

The location of fish cages and corrals is shown in Figure 7. A significant number of small to medium-sized fish cage farms are situated in the south eastern side of the lake. Fewer fish cage farms are in the north eastern side but are of medium to large farm size. The least number of cages is in the western side which is proposed to be a fish cage belt. Deep water condition and rocky bottom make the cost of establishing fish cages in this part of the lake expensive.

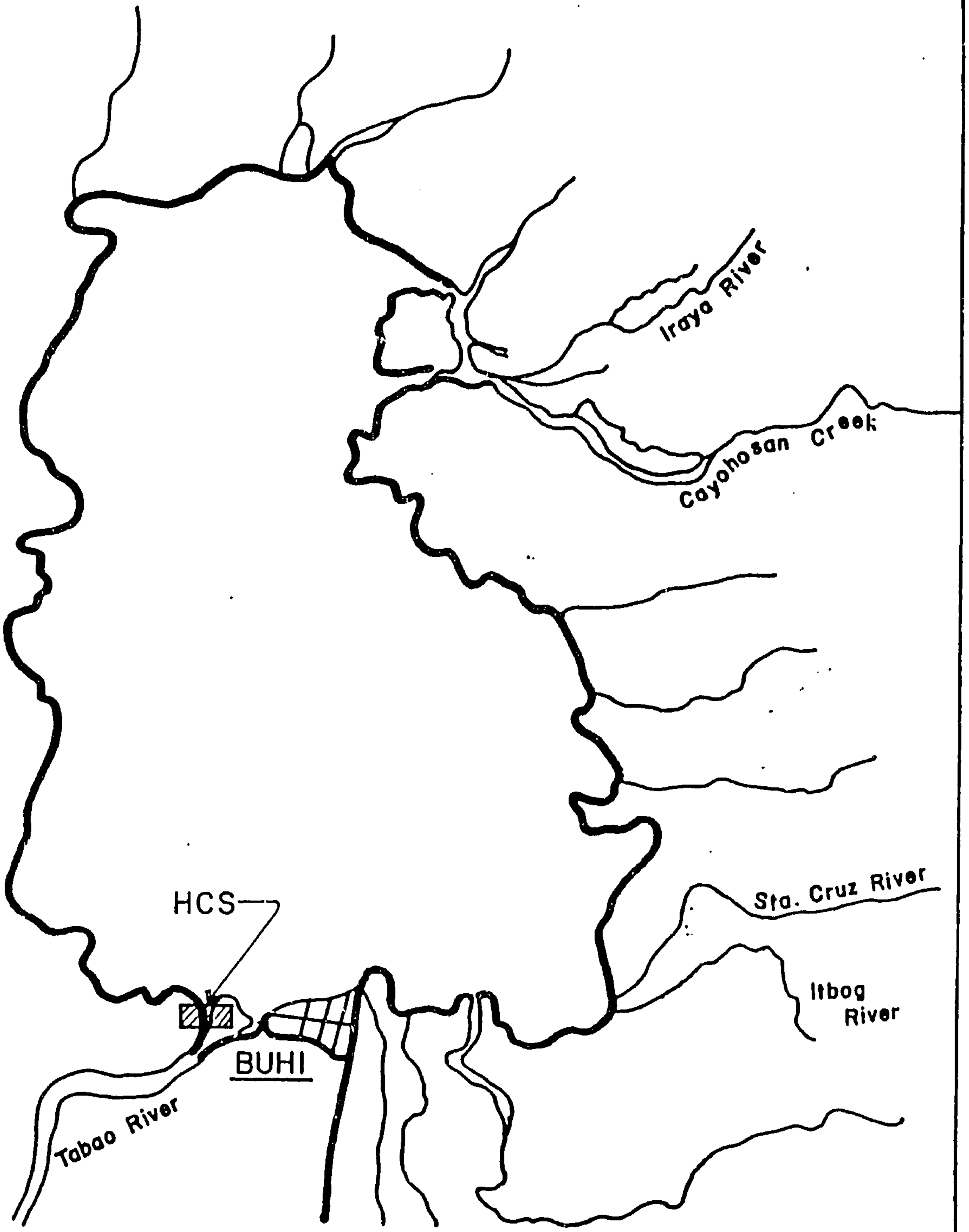


Figure ~~4~~ 6. Location of the NIA Hydraulic Control Structure

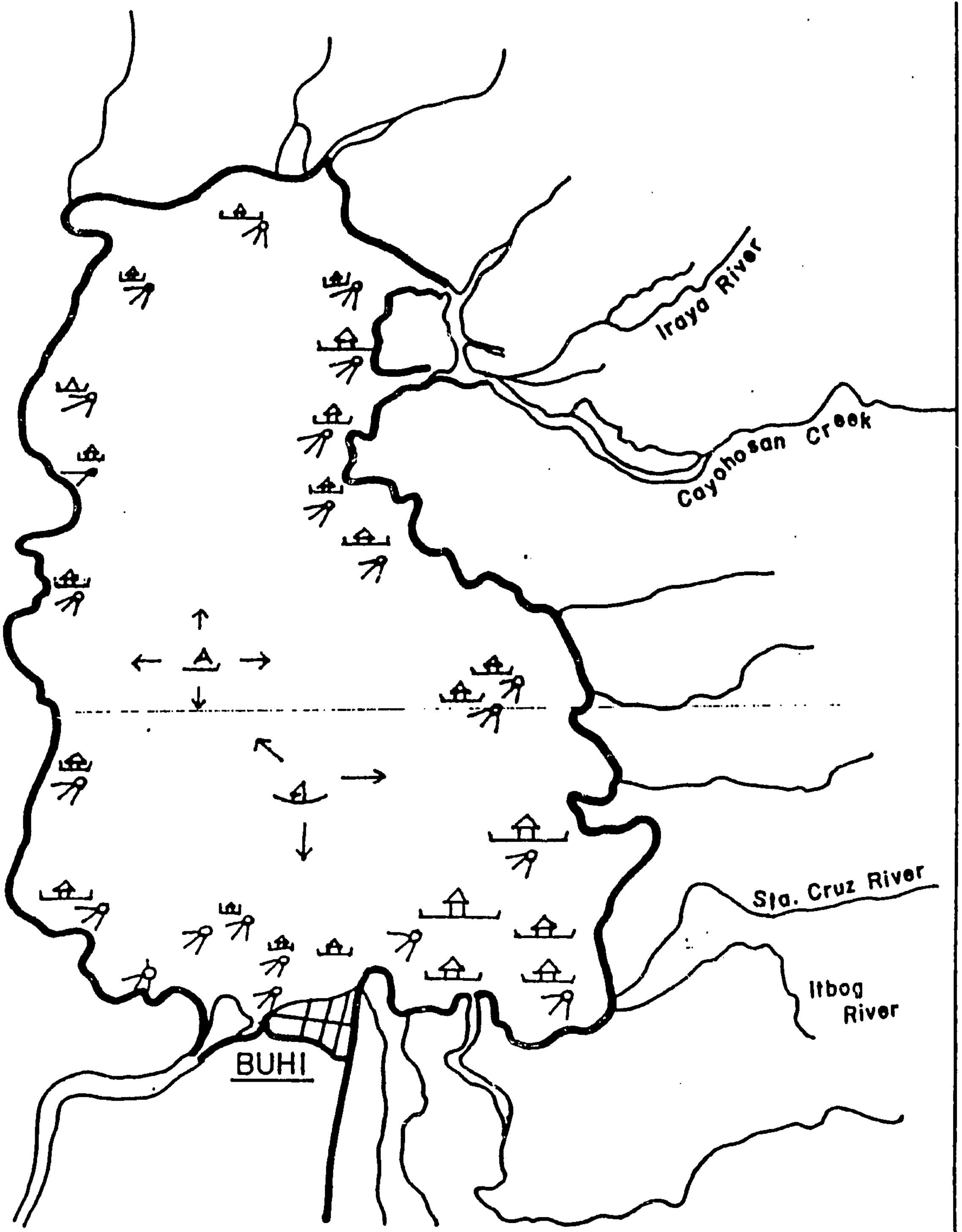


Figure 7. Location of Fish Cages and Fish Corrals

Table 5. Delineated fish sanctuary fish cage area and extent of fish cage culture operation in Lake Buhi, Camarines Sur as of October 1985.1/

Particulars	Statistics
Average surface area	1,800 has.
Average depth	6 - 12 m
Lake area delineated as fish sanctuary	86 has.
Lake area delineated fish cage belt	195 has.
Lake area presently covered by fish cages	15.12 has.
a. KKK-financed fish cages	2.40 has.
- No. of units	800 units
- No. of beneficiaries	400
b. Privately-owned/financed fish cages	12.72 has.
- No of units (registered)	3,180 units
- No of operators	156
Lake area still available for fish cage operation	179.88 has.
- Total fish cage units that could still be established	44,970 units
- Total number of families that could be benefited (at 28 families/ha.)	5,036

1/ BFAR Regional Office (Region V) Naga City, Camarines Sur, Philippines.

Table 6. Reported/registered number of operators and units of fish corrals and fish cage operators, Lake Buhi, Bicol Region as of October 1985.

Zone/Barangay		Fish Corral Operators	Fish Cages Units	Fish Cages Operators
I	San Buena/Sta. Cruz	25	37	30
II	Ipil	17	26	14
III	Iraya	31	50	26
IV	Ibayugan	18	31	18
V	Tambo	12	15	13
VI	Cabatuan	15	20	15
VII	Salvacion	24	43	24
Poblacion		13	16	16

1/ Office of the Municipal Fishery Inspector, Muncipality of Buhi, Camarines Sur.

Fish Cage Belt and Fish Sanctuary Area

The number of fish cages and the extent of capture fishing efforts has tended to increase. If left unchecked, they will ultimately impose a severe stress on the lake system, and consequently lead to fishery depletion. It is for this reason that only 10 percent of the lake's surface area has been proposed for fish culture and that at least 5 percent of the surface area has been designated as a fish sanctuary area.

The proposed fish cage belt and fish sanctuary area are indicated in Figure 8, based on the fishery development plan for Lake Buhi (BRBDP, 1979). The fish sanctuary area was selected considering its good water quality and the observation that it may be the spawning ground of most fish species. However, the criteria are not supported by a comprehensive limnological data to show whether or not the proposed location is the most appropriate fish sanctuary area.

That the proposed fishery development plant was not strictly adopted is indicated in Figure 7. This shows that only a limited number of cages are established in the proposed fish cage belt and that a significant number are in the eastern side which is the shallower portion of the lake. The high intensity of fishing activities (fish cages and fish corrals operation) in the south eastern side is evidence that the fish sanctuary area was not really formally estalished for Lake Buhi.

If the proposed fish sanctuary area is now formalized or officially pursued, it will create social problems for fish cage/corral operators who will be dislocated from the area. Furthermore it would appear that the area was selected without the support of comprehensive limnological data and that it is also a high potential pollution area.

Drawdown Farming Activities

It is estimated that along the lake shoreline are about 142 has of lowland areas. These areas are generally used for rice production. In addition, a sizeable amount of land is exposed from the lake shoreline when the water level is low, which normally happens during the dry months of the year. The location of the low ricelands and the extent of drawdown lands (lands which are exposed from lake) are roughly indicated by Figure 9. The water level in the eastern portion of the lake is shallower than in the western side and, thus, drawdown land areas in the western side are narrower.

The drawdown land areas are generally fertile and hence, could be productively used for crop production. The lands which are basically part of the lake are public lands. Owing to the limited agricultural land in the area there is the tendency among the people to compete for occupancy of the drawdown land areas. Potential conflict among the people (fish cage operators, farmers and fishermen) over the drawdown land areas exists and, thus, there is a need to promulgate priority in the use of these land by concerned government agencies.

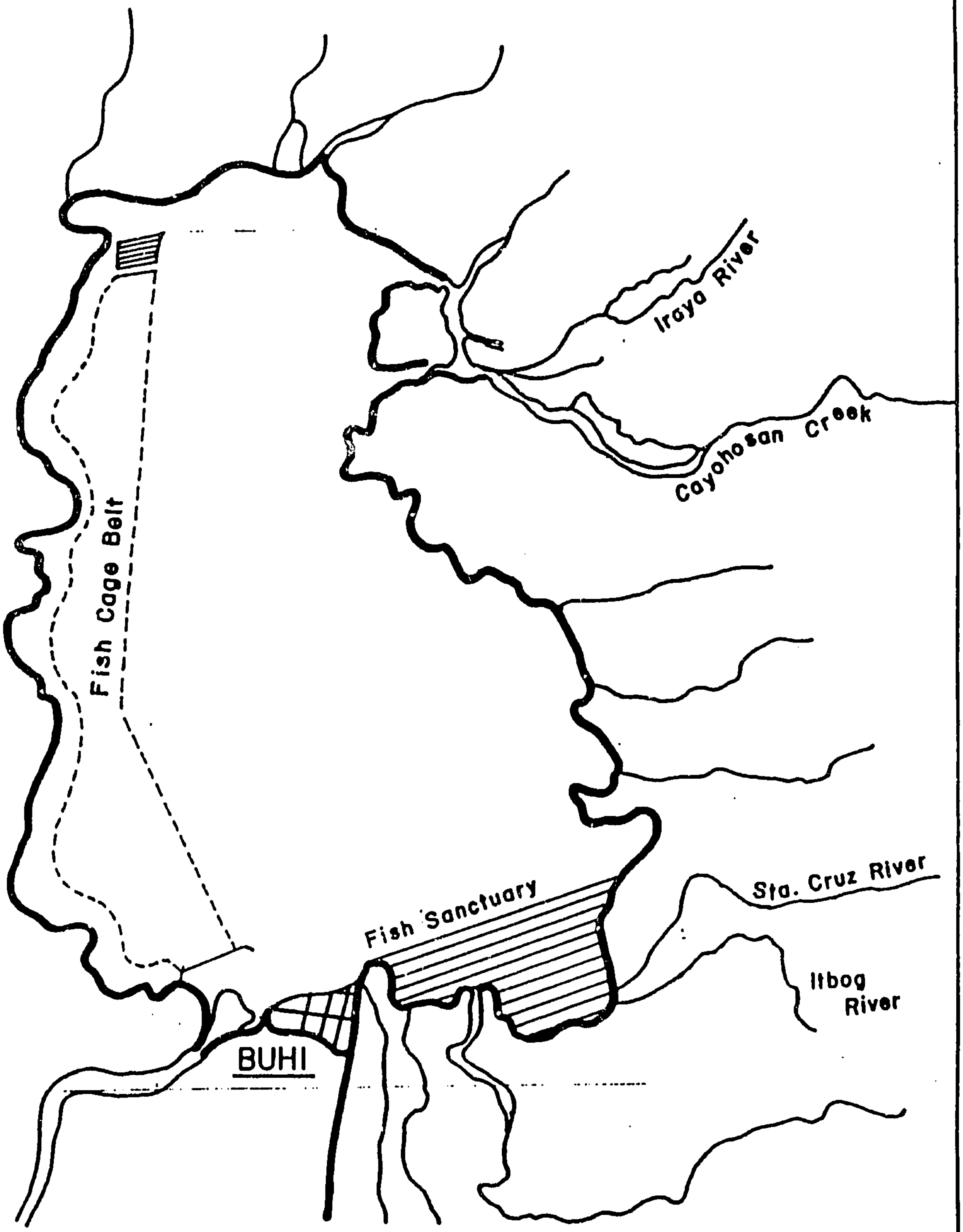


Figure 8. Proposed fish Sanctuary & Fish Cage Belt.

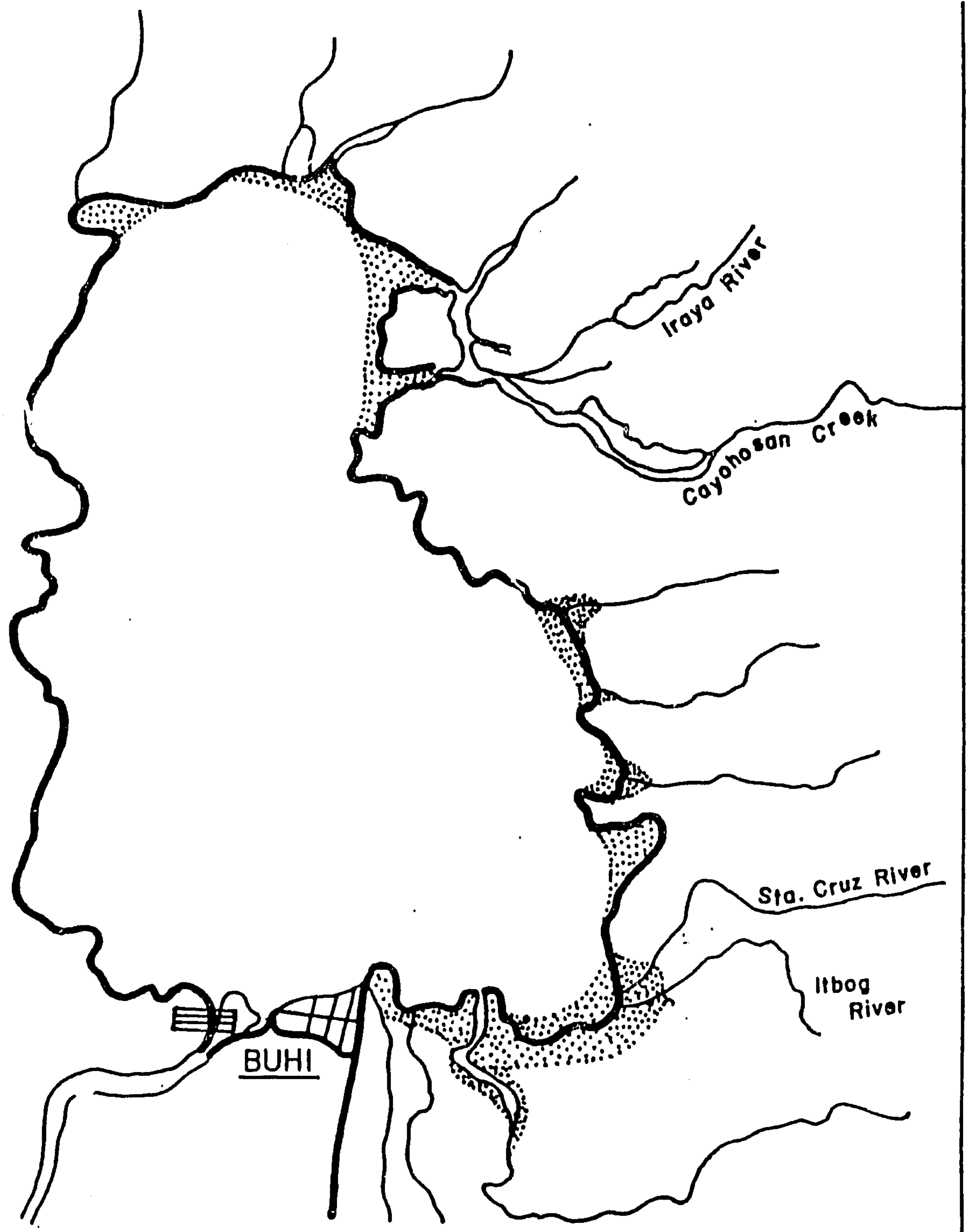


Figure 9 Profile of Lake Buhi drawdown lands and lakeside rice production areas.

While the extent of drawdown land in the western side is narrower severe, the effects of lowering the water level there has asevere effect on fish cage operation. At the minimum low water level of 79.0, fish cages will be drained i.e., will be hanging, and fish production in this part of the lake will be generally affected.

Cross-sectional profiles of the Coastal Zone

Figures 10 to 13 are transects indicating the key features or characteristics of the lake with respect to the gradient, i.e., the slope of the coastal zone, as well as with respect to the depth of coastal water. The lake water level in this cross-sectional profile is assumed to be at its normal level somewhere from 81 to 88 m.a.s.1. Thus, the drawdown land areas which are exposed during the dry season months are not shown in the figures.

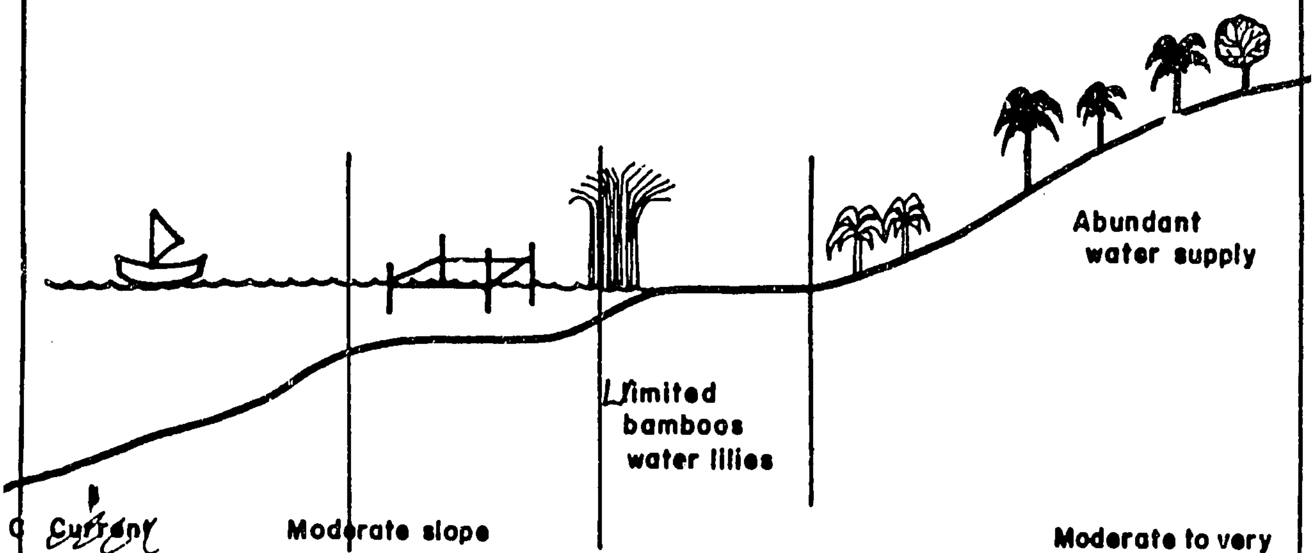
Based on the different transects shown in Figure 10 a to 13, the type of human activities (i.e., the production system) in the coastal zone is also dependent upon the physical profile, i.e., gradient of the land. For instance, agricultural production (i. e., rice farming) is more significant in the eastern side (Figure 10) than in the western side of the lake (Figure 12). This could be explained by significant differences in the topographic characteristics i.e., the western side has a steeper slope (higher gradient) than the eastern side of the lake and thus, obviously agricultural activities are not well suited in the western side. This is also true with respect to fishing activities. Fish cage operation in the western side are comparatively limited compared with the eastern side. This could be associated with the differences in lake water level. The western side has deeper water which makes it more costly to establish fish cages.

The nature and extent of problems vary with respect to the differences in topographic (slope) characteristics, along with other physical properties of the different coastal zones. A variety of problems which are generally natural (i.e., technical) and socio-economic in nature were identified affecting production activities in the different coastal zones. As in indicated in Figure 10 to 13 the different problems in the coastal zones are grouped into the land based and water based problems. If no solutions are adopted to correct these problems, there will be severe effects on the different properties of the lake system. Some of the possible solutions that may positively contribute to Lake Buhi agroecosystem productivity, stability, sustainability and equitability are discussed in a later section of this report.

Pattern of Disturbances

Lake Buhi agroecosystem is severely affected by various factors and stress which cause disturbances to the system. These factors, which are natural and man-made in nature, include: sulfur water inflows (Kanuba or sulfur upswellings), domestic sewage, water hyacinth proliferation and decay, sand and silt, agricultural chemicals, and illegal elements in catching fish.

Figure 10. Transect of Eastern side of Lake Buhi, Sta. Cruz, Ipil and Iraya areas.



Fishery

Capture

Cages
Fish corrals
Intensive medium to large fish cage operation

Agriculture

Rice farming fairly significant

Upland crops

Banana

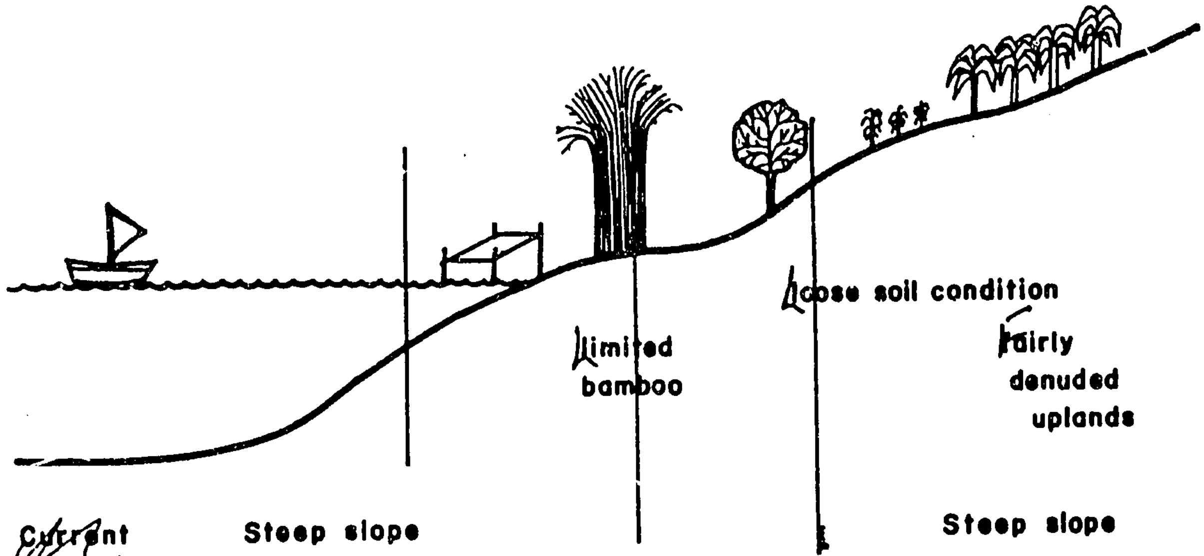
Coconut

Problems :

- increasing number of fish cages operations
- fish activities in fishery sanctuary areas
- fish cages operation excludes capture fishermen
- high competition in occupying fish cage areas

- crop damage due to coastal flooding
- upland farmer is confronted with high cost of marketing their upland product
- soil erosion product is becoming significant

Figure 11. Transect of Northern side of Lake Buhi, Ibayugan and Pascang areas.



Current

Steep slope

Deep water

Fishing

Capture

Moderate number of fish corrals

Small to medium scale fish cages

Dense water lilies in certain areas

Limited lowland farming

Small rice farm

Steep slope

Very significant upland activities

Corn, bananas

Coconuts

Root crops

Problems :

increasing number of fish cages

conflict between capture fishermen and fish cage operators

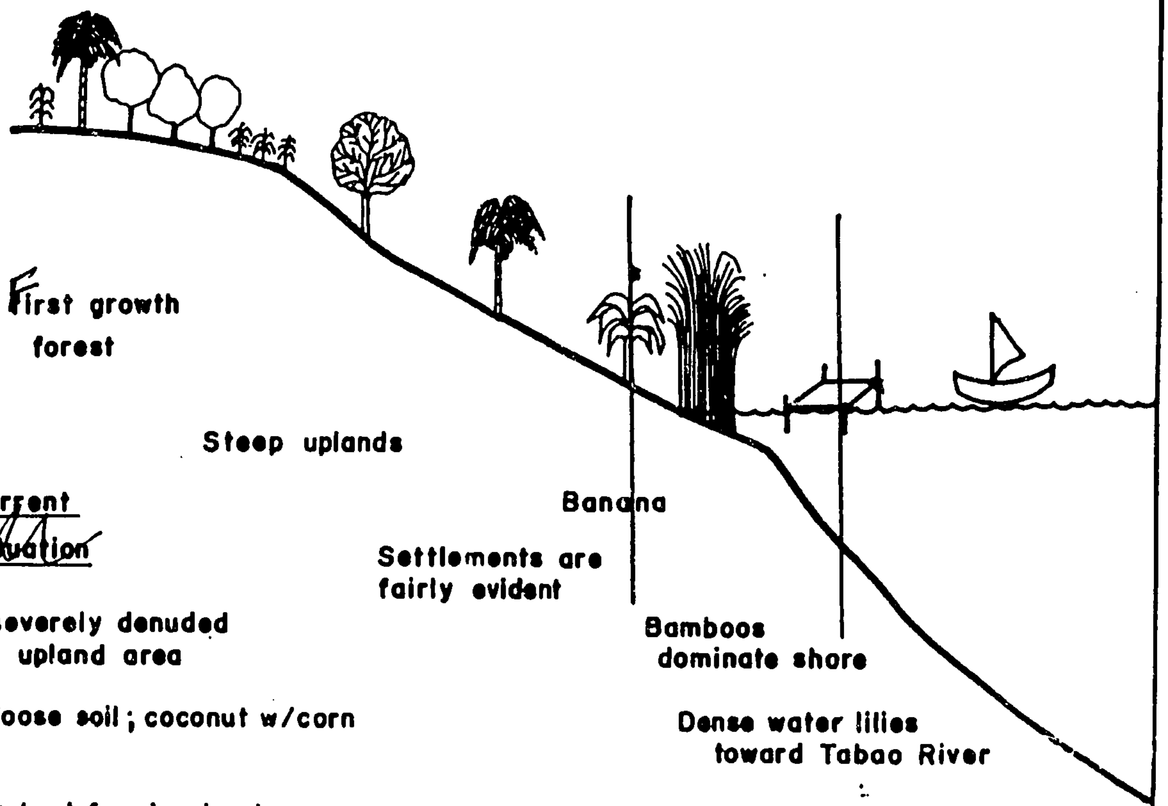
draining out of fish cages

land tenure

soil erosion

lack of access road. High cost of marketing agricultural products

Figure 12. Transect of Western side of Lake Buhi, Tambo and Cabatuan areas.



Current Situation

Severely denuded upland area

Loose soil; coconut w/corn

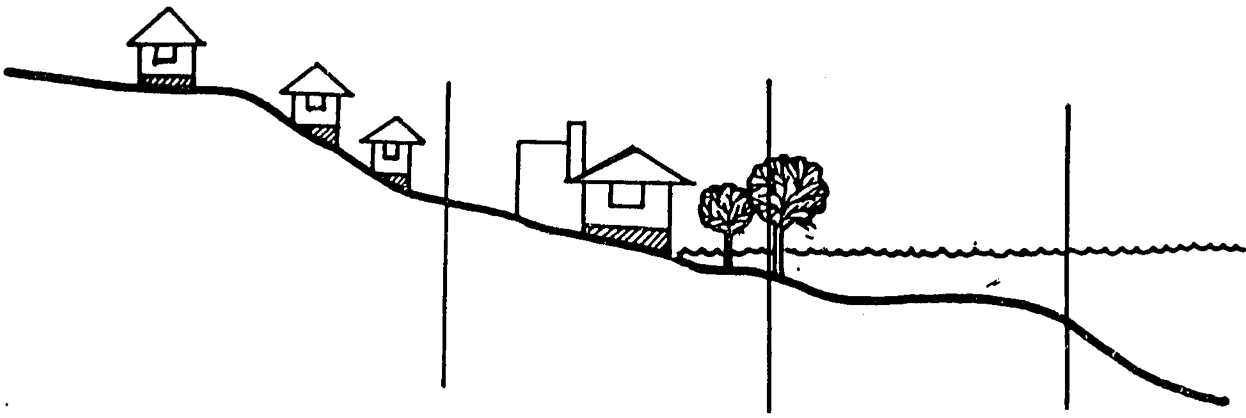
Upland farming involves corn, other crops & intercrop w/ coconut

Rough roads exist

Problems:

- Soil erosion is high
- Land tenure problem
- Siltation of lake
- Cages dry up w/low water level
- High cost of fish cage /or fishp[illegible] construction
- High density of water lilies affect fish cage

Figure 13. Transect of Southern side of Lake Buhi, Buhi Poblacion and Salvacion areas.



Current Siltation

Urbanized areas

Moderate slope
Shallow water depth

Rice farming is major part of coastal areas

Very dense water lilies

Significant number of fish corrals

Problems

- poor/or no proper waste/ disposal / sewerage
- road network still ne-- to be improve

- competition in occupying fish cage areas
- crowded fish cages
- high number of fish corrals
- encroachment
- quarrying

Unless influx of these factors are minimized, if not abated, the life of Lake Buhi will be at stake.

The potential point sources of pollution are indicated in Figure 14. The soils of the northwestern side are highly erodable (i.e., loose soil) and we would suspect the adjoining water to be prone to siltation. However, this is not the case. Instead siltation is severe in the eastern side of the lake (Figure 15) and can be attributed to the greater number of creeks and rivers.the high siltation rate is the reason why this side is shallower.

There is a higher degree of agricultural activities (rice production) on the eastern side of the lake, and thus agricultural (fertilizer and pesticides) pollution comes from this area. The type and rate of agricultural chemical used in production and the extent of water outflows from the agricultural land, as well as the incidence of inundation of the lands, are the primary determinants of agricultural chemical pollution inflow into the lake.

Domestic sewage pollution obviously originates from the southern urbanised portion of the lake. The degree of domestic pollution can be associated with the absence of a good sewage system in the urbanized zone and a lack of appreciation of the effects of domestic pollution on the lake system.

Use of illegal compounds such as thiodan and <u>tuble</u> in catching wild fish is another factor affecting the lake system. Thiodan fishing practice is more prevalent in the north western side and at the mouth of the Iraya and Cayohosan practiced by fishermen in the Cabatuan area on the western side of the lake.

Lake water quality is also affected by a natural water spring, a sulfur water spring connected with the Iraya river system located in the upland areas of Iraya. Sulfur water from this spring continuously flows into the lake.

Fisheries have been significantly adversely affected by the Kanuba or sulfur upwelling phenomenon. However, people in the area noted that Kanuba has lesser effects on wild fishes since these have a chance to escape. Figure 16 shows the prevalence of kanuba in various parts of the lake. Much more knowledge of the phenomenon is required.

Water hyacinth proliferation and decay is a potential threat to the lake system. Profileration is generally more dense in the southwestern side and in the shoreline areas. Since these plants are of a floating form they move to and from various parts of the lake. The general pattern of water hyacinth movements, influenced by wind directional pattern and water flows, is shown in Figure 17.

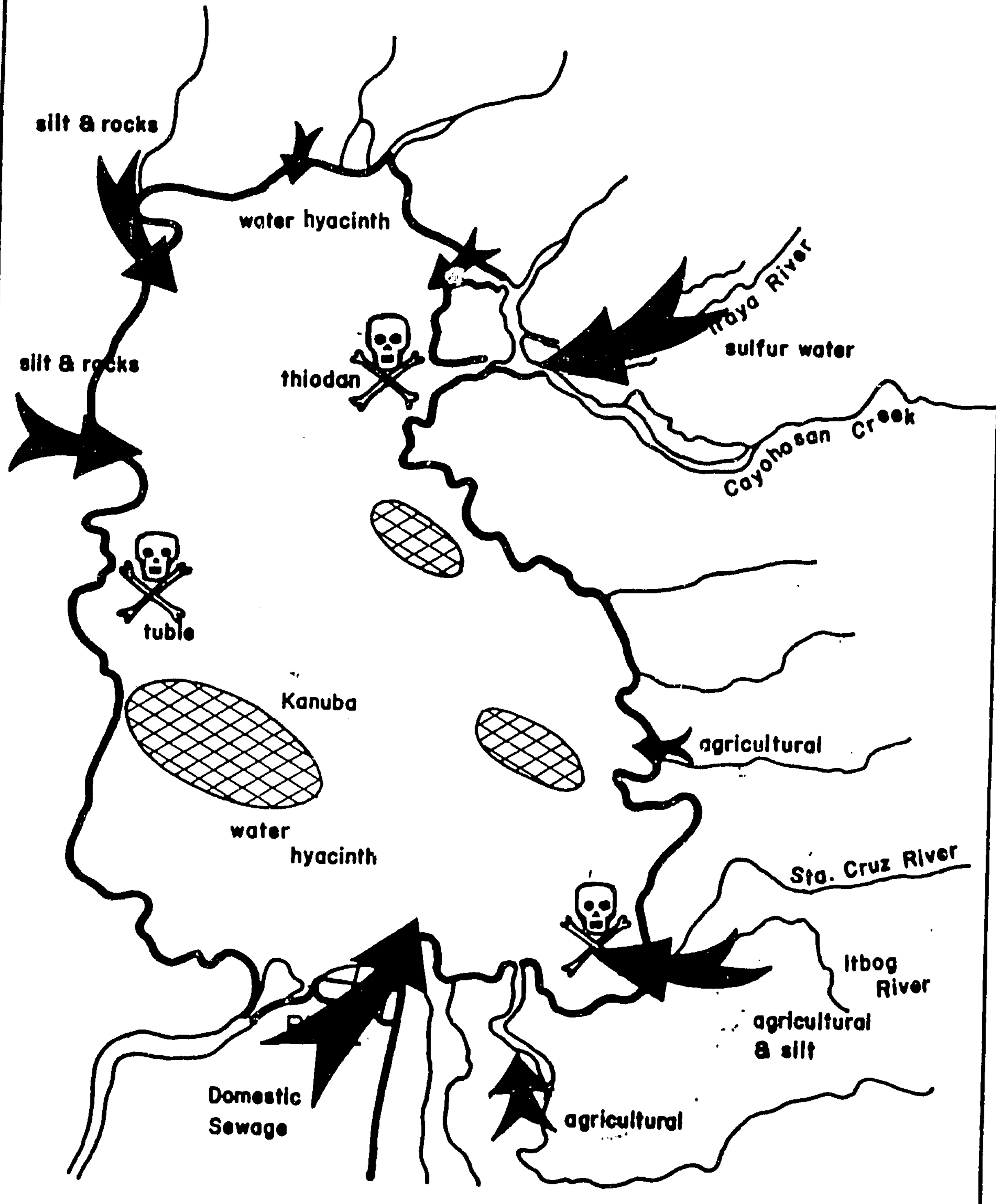


Figure ~~8~~. Point sources of pollution ~~in use of poisonous elements~~ compounds
~~& in catching fish~~.
14

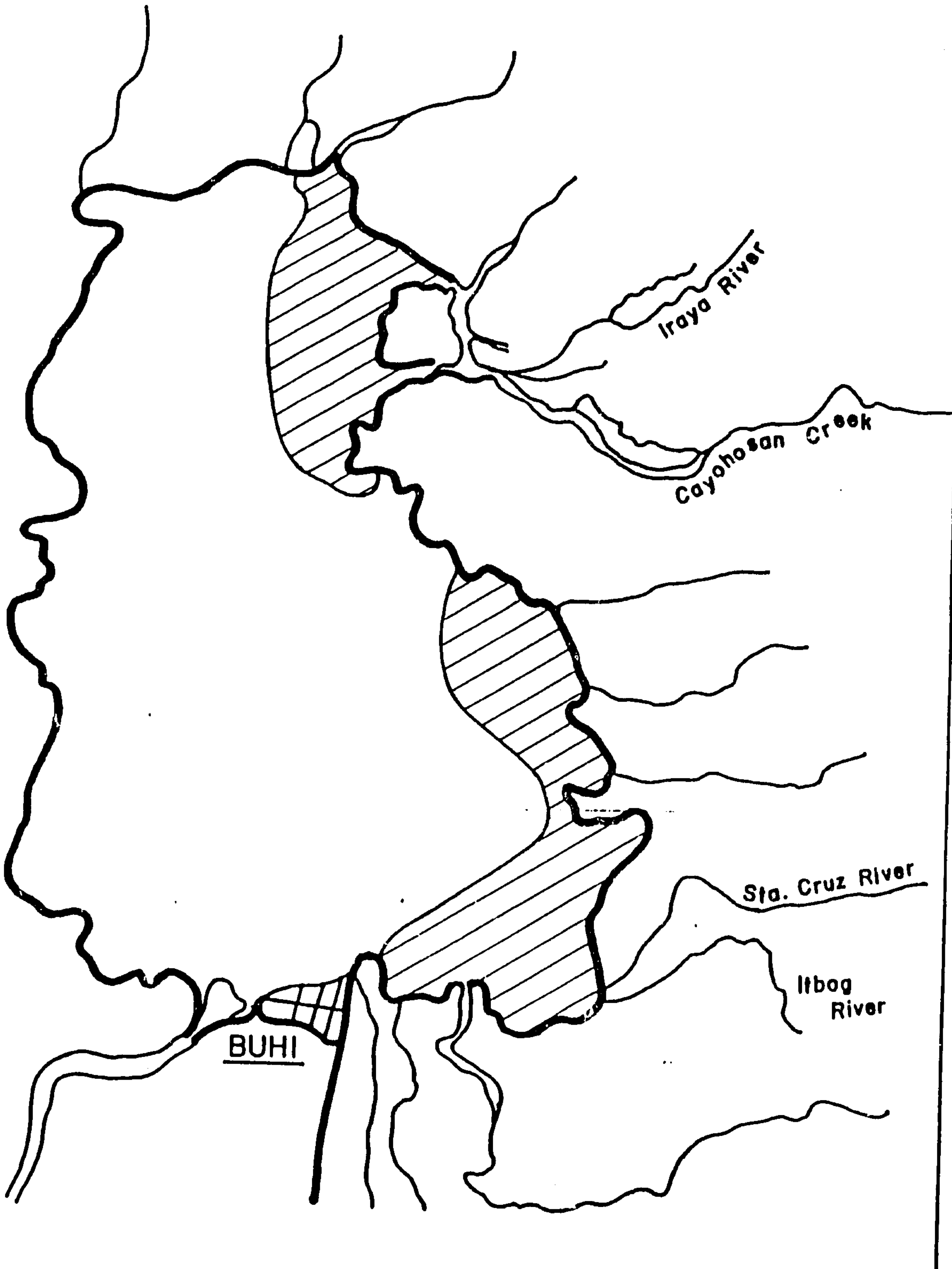


Figure ~~8~~ General profile of siltation areas.
15

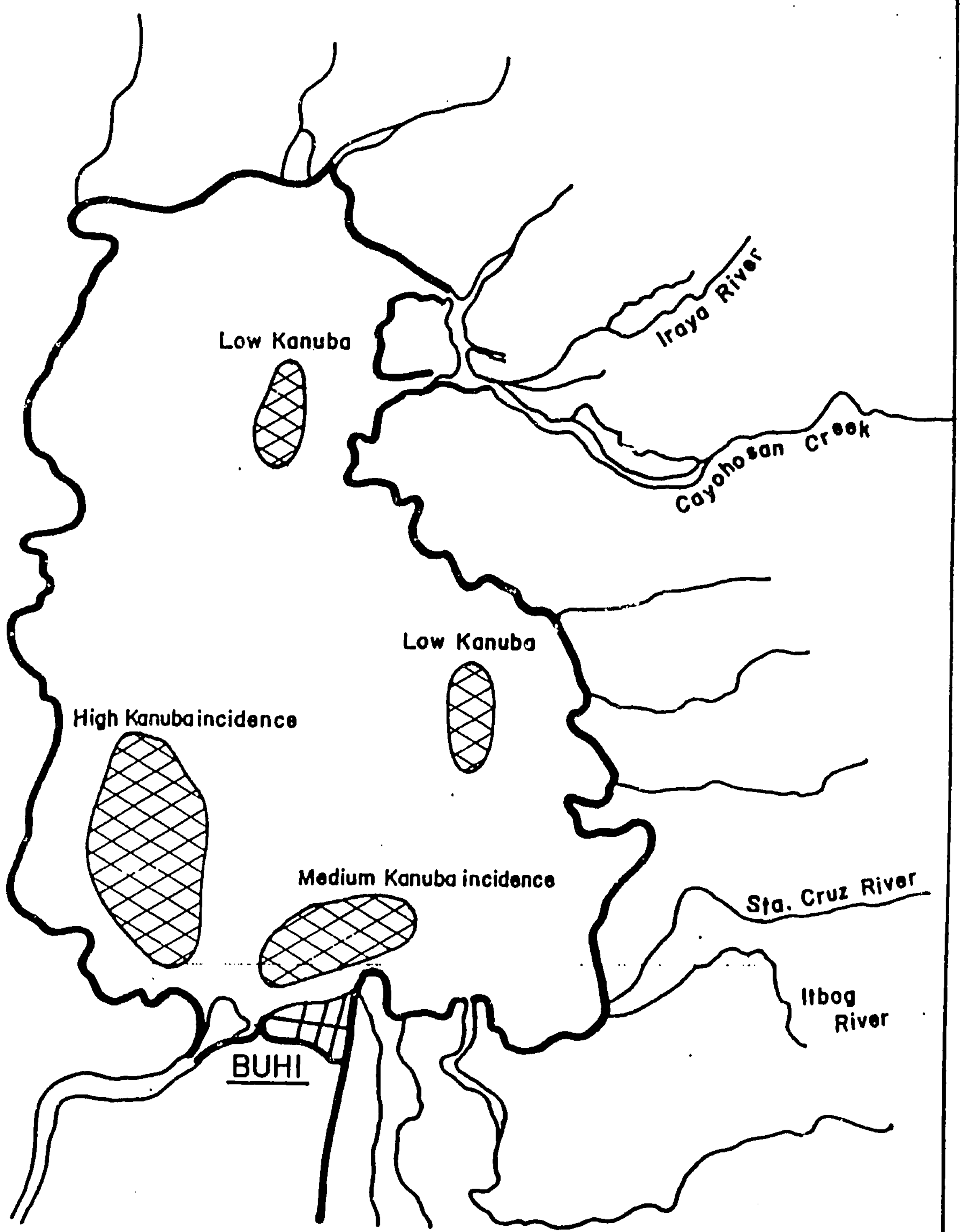


Figure 16: Kanuba (sulfur upwelling) incidence and occurrence

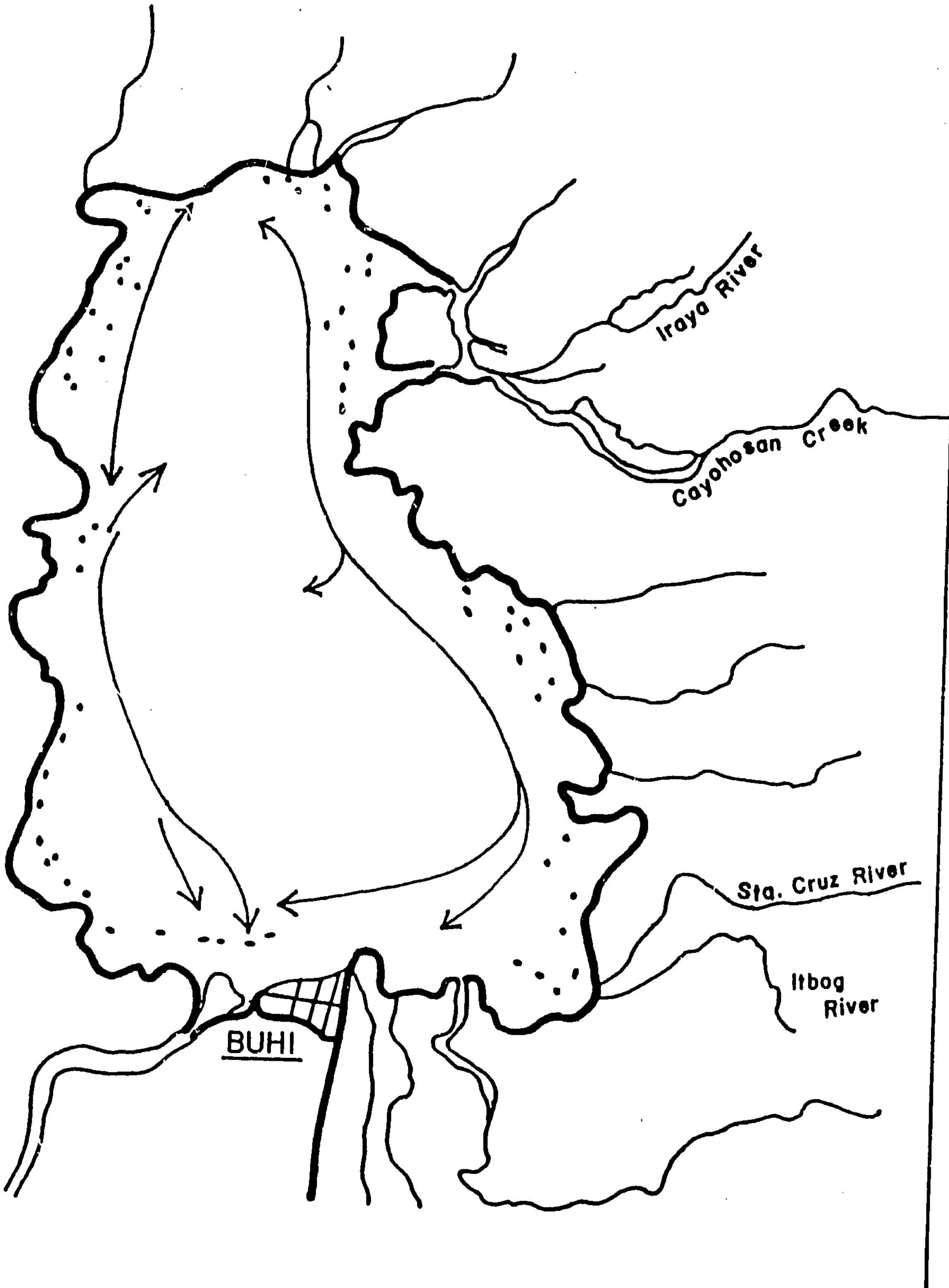


Figure ~~4~~. General profile of water hyacinth movements
17

Temporal Patterns

Seasonal Variation of Natural Factors

Analyses of the agroclimate factors are obviously necessary to obtain a better understanding of the behavior of bio-physico-chemical properties and to help in explaining variability of lake productivity, planning production activities and examining seasonality of demand for production inputs such as labor, fingerlings, etc. The seasonal variation of the agroclimatic factors (rainfall, typhoons, solar radiation and wind patterns), along with the behaviour of the bio-physico-chemical properties of are shown in Figure 18.

Because the lake is relatively deep, it is capable of undergoing thermal stratification. The lake water temperature ranges from 28.8 to 31.4 oC with minimum temperature in January and maximum in June.

The lake water pH was reported to have had a range of 7.6 to 8.7 in 1977-1978 and was observed to have had a range of 5.5 to 8.9 in 1982 (Zafaralla, et. al. 1984). Lake water transparency varies from 60 cm to 220 cm. and Zafaralla et. al. (1983) reported that water transparency has changed considerably in time. The decline in water transparency quality was associated with increased growth of autotrophic algae, brought about by the increased number of fish cages the occurrence of prolonged dry season and the increased agricultural activities in the shoreline areas of the lake.

Changes in lake water levels are directly influenced by rainfall intensity, but the influence only takes effect after a month or two. The construction and operation of the Hydraulic Control Structure (HCS) will certainly affect lake water levels. At this point in time, there is no way of determining lake water level changes since the HCS and the irrigation system are not yet fully operational. The 1983-84 data suggest, however, that lake water level is declining during the months of February and July, with the lowest level during the months of May and June.

Algal growth begins in the month of March and April, during which the lake water level has begun to subside. The *Microcystis* blooms occur in the months of April and May, just before the *kanuba* or sulfur upswelling months. The *Microcystis* bloom may be promoted by high solarradiation which normally starts in January and ends in July.

Kanuba predominantly occur in late May to September and sometimes up to November. The spatial pattern of *kanuba* occurrence in the lake is affected by the wind direction and water flow.

Lake primary productivity is highest during the months of May and June. It tends to decline during the succeeding months, up to September or sometimes October. The primary productivity trend is inversely related to rainfall intensity. The increase in the lake's primary productivity is preceded by high nutrient (N and P) content of the lake water.

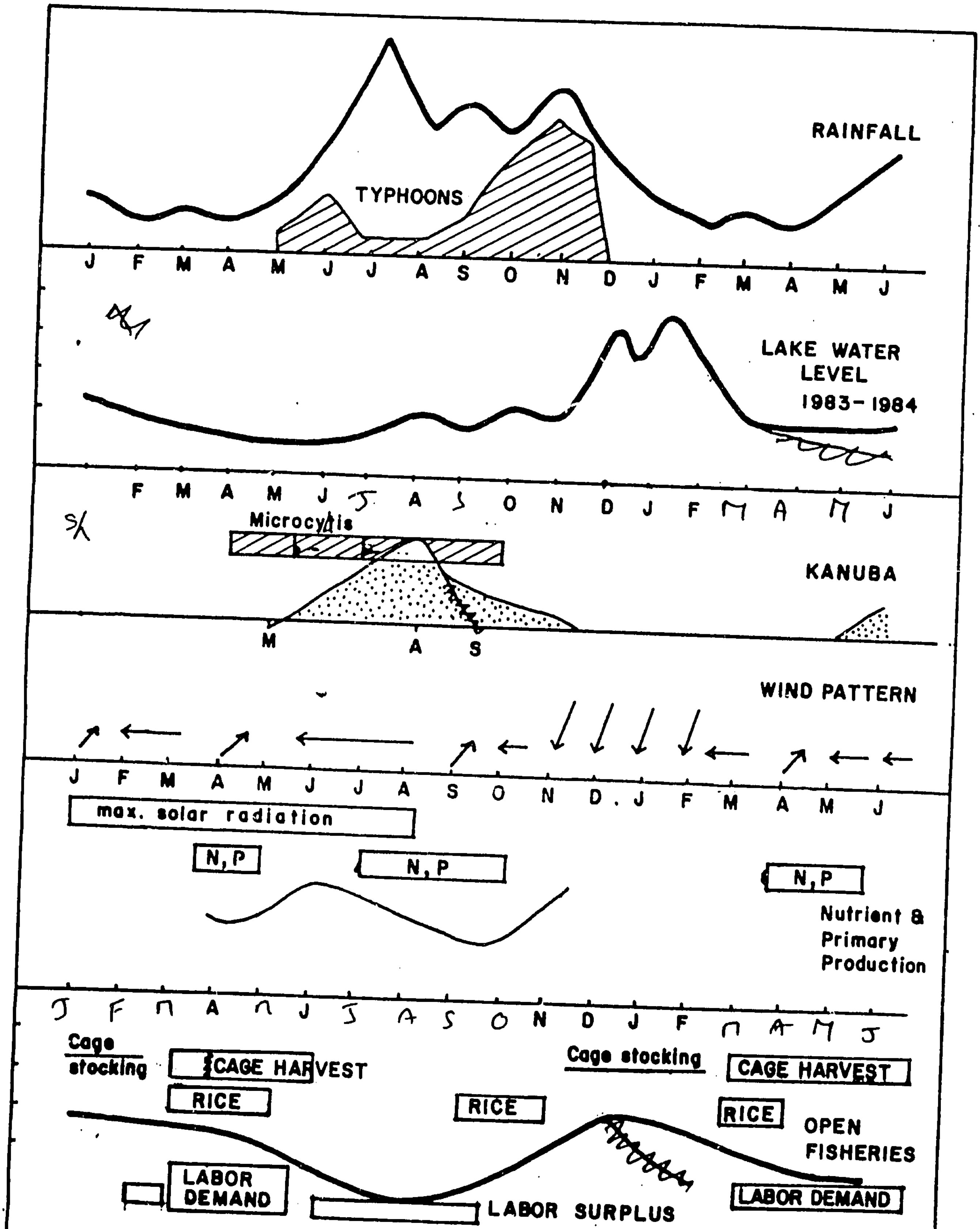


Figure 18. Seasonal variation of agroclimatic factors bio-physical-chemical properties & productivity of Lake Buhi, & labor demand & supply months.

An attempt was also made to determine the seasonal variability of fishery production. In the absence of monthly fishery production statistics we used a production level indicator, i.e., the percent of total survey sample fishermen indicating the months of their peak harvest in the open fishery (Tagarino, et al., 1985). Very few of the fishermen indicated the months of June up to October as their peak harvest months. In other words, open fishery production is low during the months of June to October. The seasonal variability in fishery production can be associated with the variability of the natural factors presented earlier. Hence, there is a declining trend in open fishery production with increasing rainfall intensity, when typhoon occurrence is more frequent. High rainfall intensity and typhoons make open fishing activities risky. The kanuba and sulfur upwellings disperse the schools of fish in the open fishing grounds, leading to low fishery production.

The seasonality of labor demand was determined by examining the pattern of production activities in the area. Levels of production, i.e., catch per fishing trip, are generally high during the months of November to January, and hence, fishermen in the area may be preoccupied in capture fishing during these months. The stocking and harvesting of fish cage are from November to later part of January, and months of April to later part of May, respectively. Similarly, planting and harvesting operations in crop production of the nearby lowland farms are just about the same as those of fish cages farming. Given this information it can b e concluded that labor demand is relatively high during the months of November to January, and April to May. And, finally, the labor surplus months are generally during the typhoon months, June to October.

Flows

Proper development and management are necessary in maintaining the beneficial uses of the Lake Buhi agroecosystem. Current major uses of the lake include navigation, hydroelectric power, irrigation, fishery and agriculture. It is also used for domestic purposes by coastal residents. Furthermore, the lake has a high potential recreational value as tourism develops in the area.

Sources of Income

Based on interviews of key informants, it was learned that fishing (fish capture and fish culture), farming, employment in public office, labor services in local businesses and self employment are the major sources of livelihood of the people in Buhi. No manufacturing establishments are within nearby areas of Buhi municipality, and thus, employment opportunities for people are limited.

Figure 19 indicates a rough estimate of the proportion of income from various sources of high, medium and low income groups. Generally, low income groups are those who do not have the necessary resources, land and capital, to make a living. This includes full time capture fishermen (sustenance fishermen) and the part time fishermen - laborer group. The high income groups are those who are engaged in fish culture, employed in public office, or engaged in commercial business.

Fishery Resources

As a fishery resource, Lake Buhi can be characterized as multi-species fishery. Even though several species of migratory fish can no longer enter into the lake, thirteen different species of fish, including shrimps,can still be found (Tagarino, et. al., 1985. BRBDP, 1979). These include the indigenous species and species such as tilapia, catfish, and others that were either intentionally or unintentionally introduced in the lake. Because of differences in size and nature the fish in the lake are linked by complicated competitive and predator-prey relationships. One consequence is that it is likely that some of the fish species will become extinct in the long run. Based on the composition of harvested fish (Table 7), tilapia which is not indigenous to Lake Buhi, is the most dominant fish species at present.

The Lake Buhi fishery resources are being exploited by fish capture and fish culture.

Fish Capture

This type of fishery resources utilization involves using gear of various types in harvesting fish that are wild in the open water. The level of production through fish capture is generally dependent upon the type of fishing gear used, the status of fishery resource and the extent of fishing effort.

The number of fish capture operators in Lake Buhi declined significantly from 2,250 operators in 1977 to only 700 operators in 1985 (Table 8). The majority of these operators are not full-time and only undertake capture fishing to supplement their income from other sources. The significant decline of capture fishing activities in Lake Buhi can be attributed mainly to declining profitability. Hence, there is an evident decrase in open water fishery resources: the average catch per fishing trip in 1982-1983 of 9.23 kgs. (Tagarino, et. al. 1985) decreased about 2.5 kgs in 1985, (Key informants, 1985). Furthermore, the available open water fishing grounds have tended to decrease inarea, some of the more productive areas now being occupied by fish culture (cage) operations.

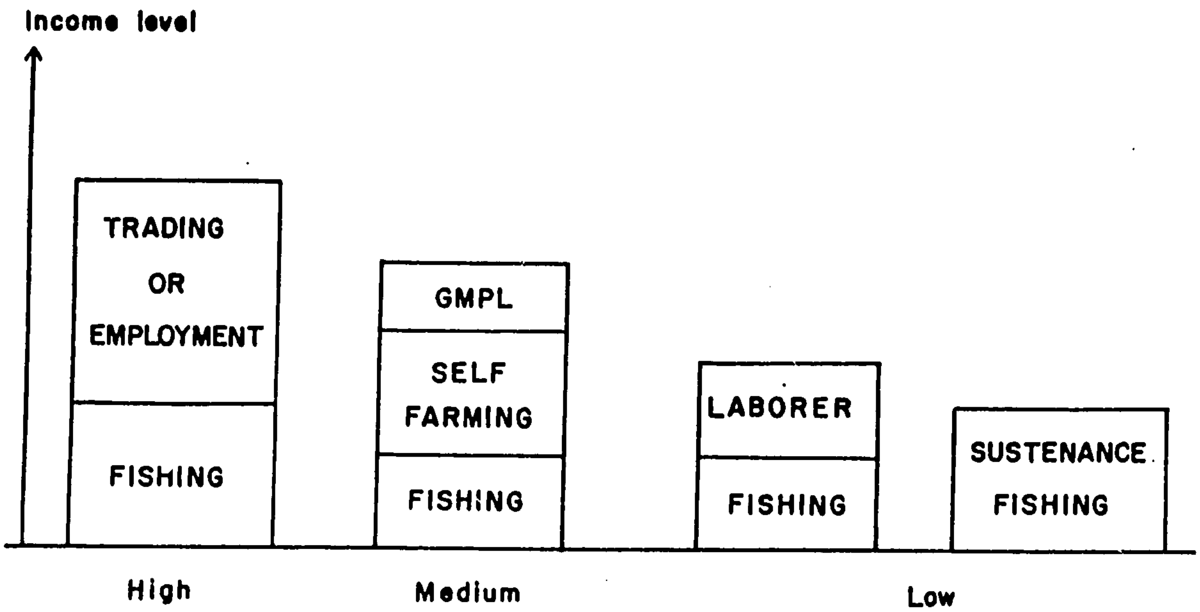


Figure 19. Bar diagram showing source of income by income groups.

Table 7. Percent composition and volume of harvested fish, Lake Buhi, Camarines Sur, 1983

Nature of Production and species	Total Catch (kgs)	% Composition
I Fish Culture (cages and fishpen)	35,865.00	65.01
a. Tilapia	35,833.50	64.95
b. Carp	32.00	0.06
II Fish Capture	19,303.50	34.99
a. Tilapia	9,053.15	16.42
b. Irin-irin	1,729.30	3.13
c. Dalag	5,618.90	10.18
d. Carp	2,037.85	3.70
e. Shrimps	447.45	0.81
f. Other minor species	416.85	0.75
Total	55,169.00	100.00

a/ BFAR Regional Office (Region V) Naga City, Camarines Sur, Phillipines.

Table 8. stimated number of fishermen, fishing boat-fishermen ratio and fishing equipment, Lake Buhi, Camarines Sur.

	Estimates	
	1977a/	1985b/
Number of fishermen	2,250	700
Full-time	250	100
Part-time	2,000	600

Boat-fishermen ratio

Fishing Equipment c/	No.	%
Fish cages	501	53.37
Fish shelter	55	5.92
Fish Corral	98	10.54
Gill net	177	19.03
Spear gun	28	3.01
Fish pot	2	0.21
Push net	29	3.11
Hand line	40	4.30

a/ BFAR, 1978

b/ Interviews of key informants, November 1985.

c/ Based on BFAR Resource Assessment of Lake Buhi (September 1983) involving 930 fishermen survey samples.

Fish Cage Culture

The statistics shown in Table 7 indicate that fish culture contributes a significant share to Lake Buhi's total fish production. Fish cage culture was inititially introduced onto the lake by BFAR in 1979 when the pilot testing of the feasibility of tilapia fish cage culture was undertaken. From the initial pilot scale, cage culture of tilapia has grown to a commercial scale. Improvements in fish cage technology, along with support (credit assistance) provided by the government, have encouraged the people to adopt this technology. No less than 500 operators are presently engaged in fish cage culture production.

Profitability of Fish Culture and Fish Capture

Economic analysis of fish culture and fish capture activities in 1982-1983 were made by E. Escober, et. al. (1984) and R. Tagarino, et. al. (1985) respectively. The production levels of various sizes of fish culture operation are indicated in Figure 20. In 1982-1983 the estimated annual level of fish catch of the average sample operator amounted to 614.00 kgs. for fish culture and 1489.44 kgs. for fish capture. These production data suggest that open fishery is not yet over exploited and also, fish culture technology is not yet fully developed. The development of fish cage technology has contributed to dramatic average fish cage operator in the area could produce as much as 6,300 kgs. of tilapia per year (Figure 21). While there is a dramatic increase in fish culture, the production level of fish capture has significantly decreased.

There is no significiant difference in the way fish catch is disposed of by fish culture and fish capture operators, (Figure 22). A significant portion of the harvested fish are sold, within and outside the municipality of Buhi.

Cost and return analyses of fish production 1982-1983 indicates that fish capture was more profitable than fish culture (Figure 23). In fact, fish culture (i.e., cage operations) was a losing business during that reference period. Recent cost and return estimates, however, suggest that fish culture production has improved and become a very productive source of livelihood for the people (Table 9).

The increased profitability of fish cage culture is one of the many reasons that have lead to the recent proliferation of fish cages in the lake.

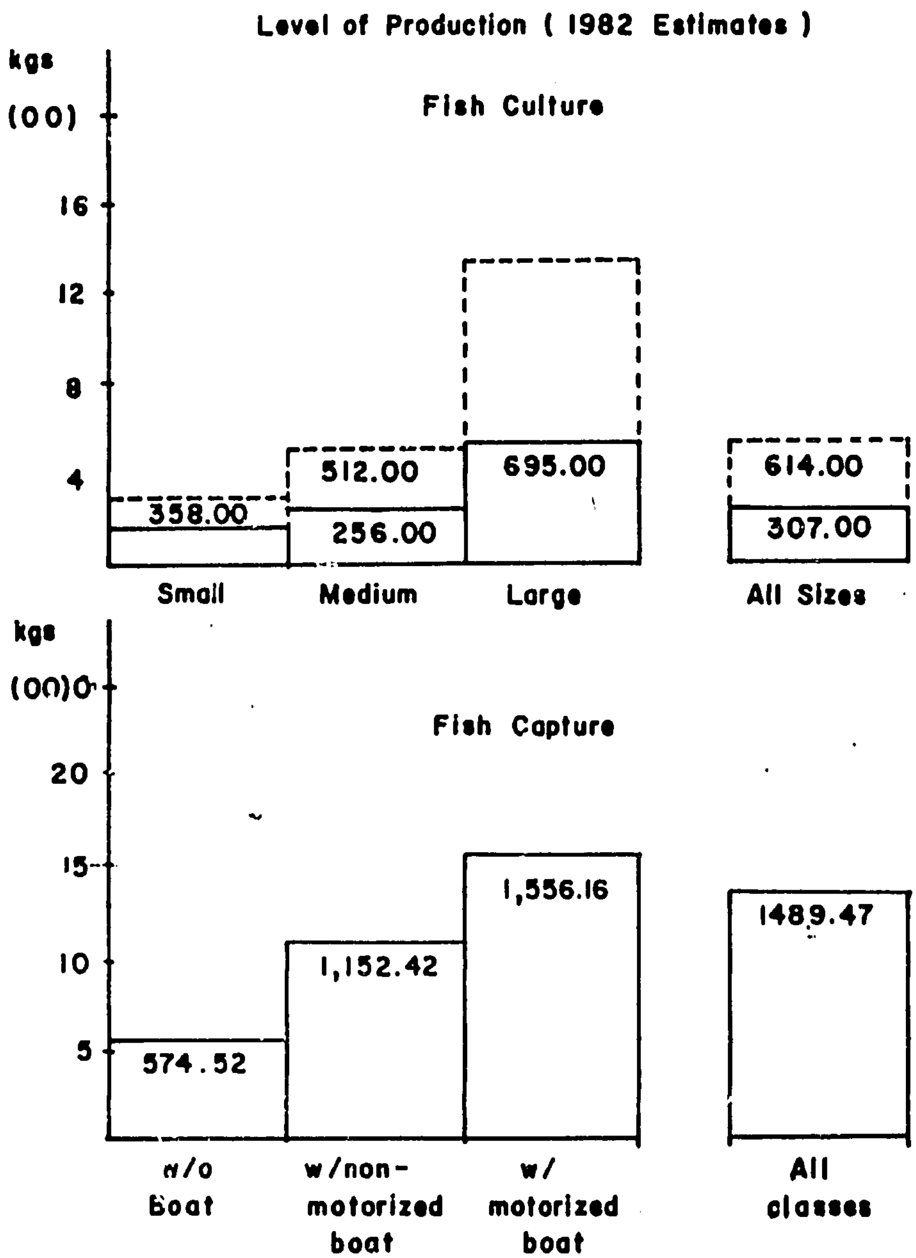


FIGURE 20. Level of production (1982 estimate) of fish culture (cage) and fish capture according to type of operation. (Source: Escover, et.al., 1984, and Tagarino, et. al., 1985)

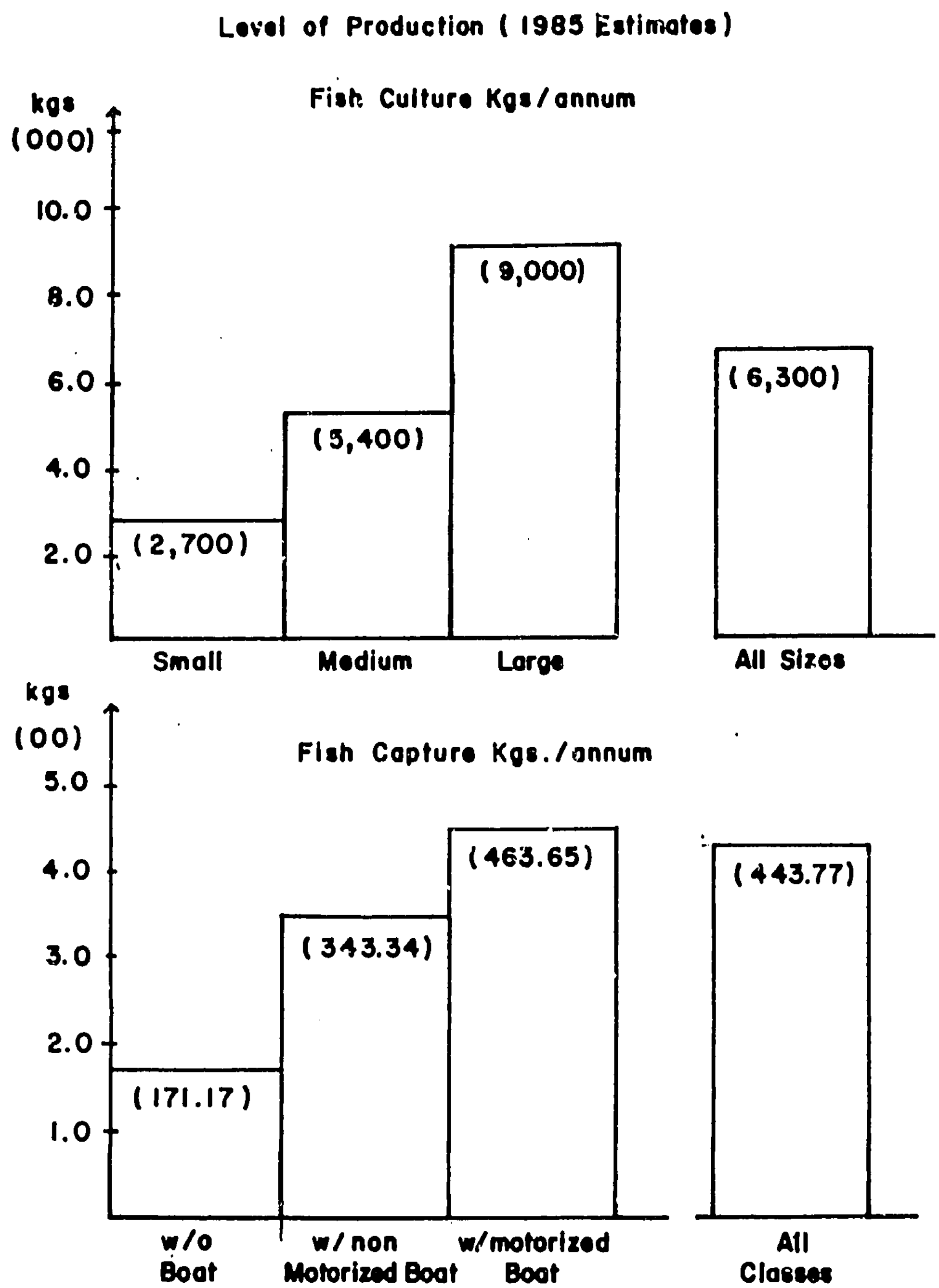


Figure ~~18~~. Comparison of expected level of production of fish culture ~~19~~ and fish capture according to scale of operation
21

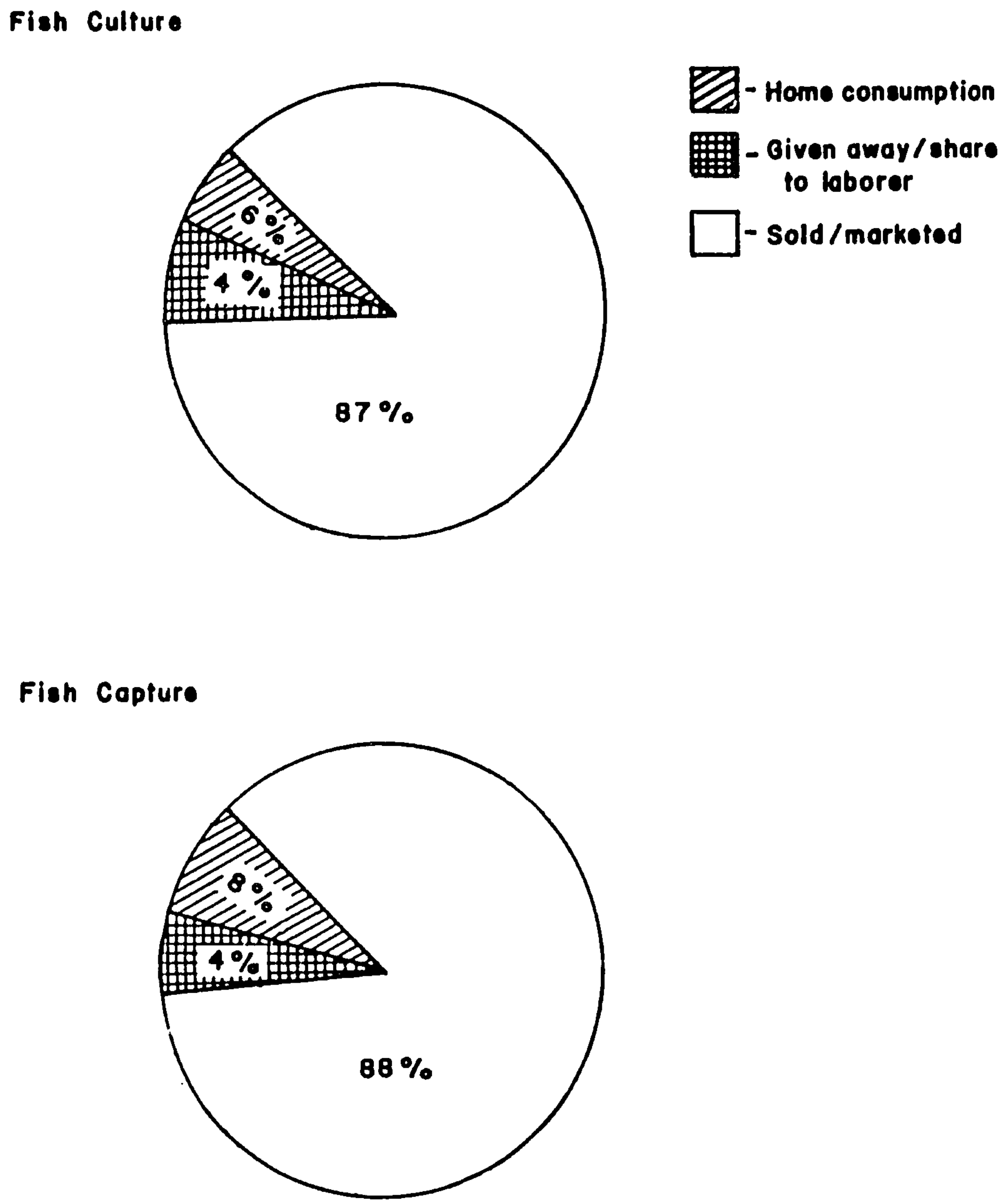


Figure ~~16~~. ~~Venn~~ Diagram of the distribution of production of ~~20~~ production of fish culture and fish capture activities 22 in lake Buhi.

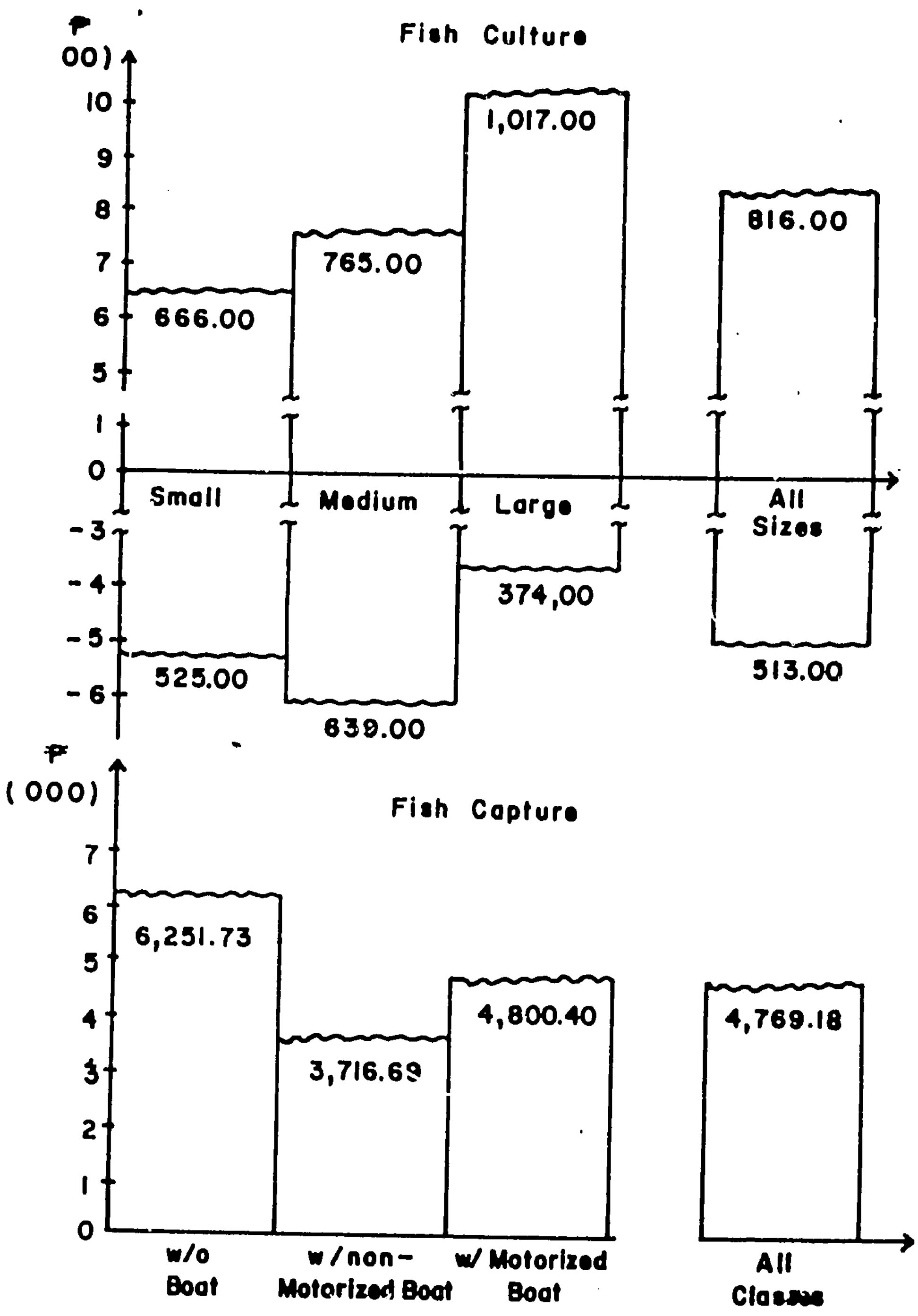


Figure 20. 23 Comparison of net returns between fish culture (cages) and fish capture operation 1702-83.
(Source: Escover, et.al 1984 and Tagarino, et.al. 1985)

Table 9 Cost and returns estimate for one unit fish cage per year

Production:	Range		Mean
a. Volume	500 kgs	1500 kgs	900 kgs
b. Value	₱8750	₱26250	₱15750
Cost Production			
1. Capital item			
8 bamboos	₱80.00		
Nets	500.00		
Thread	105.00		
Construction Cost	100.00		
	₱785.00 (50%)	₱392.50	
2. Fingerling ₱.20 per fingerling			
4,000 pcs. x 2 cropping period		1,600.00	
3. Labor ₱400/mo. for 10 mo.		4,000.00	
+ rice 3.65 cavans		912.50	
4. License		50.00	
5. Miscellaneous cost		1,000.00	
Total Cost		₱7,955.00	₱7,955.00
Net Return:	₱795.00	₱18,295.00	₱7,795.00

Opportunities for Cottage Industry

Cottage industry should be developed so as to provide alternative sources of livelihood for the people. This could be done through the assistance of both government and private institutions in the utilization of local resources for more productive uses. Some of the local resources which are of high export potential and commercial value include water hyacinths, tambo grasses and bamboos. In addition, fish processing, such as the drying of fish, is also an opportunity for those engaged in fishing.

External Linkages and Flows

The internal and external linkages and flows of the Lake Buhi system can be grouped into natural and the man-made linkages and flows. As indicated in Figure 24, the lake system is linked with outside systems in terms of the natural inflows of water supply through several rivers and creeks, the silt that is being carried by water inflows and the nitrogen and water that come from the atmosphere. It is also linked with the lower system (i.e., irrigation service area) in terms of the water supply outflows through HCS at the lead of the Tabao River.

The main influences include agricultural chemicals, domestic sewage, materials for fishing and fish fingerlings or stocking materials. An attempt was made by the local government to restock the lake with <u>sinarapan</u>. The most significant biological flows are inflows of fish fingerlings for fish cage culture and the outflows of marketable size fish.

The movements of hyacinth, fishes, boats, <u>kanuba</u> and the lake water itself establish the internal linkages and flows within the lake system. The hyacinth problem at most severe at the head of the Tabao River. The decaying hyacinth in that area causes deterioration of the lake water quality and release of obnoxious odor.

The fishermen in the study area have indicated that their fishing business is affected by their inability to control the input and output markets. The outflow of a large proportion of total fish harvest also contributes to the malnutrition problems in coastal barangay.

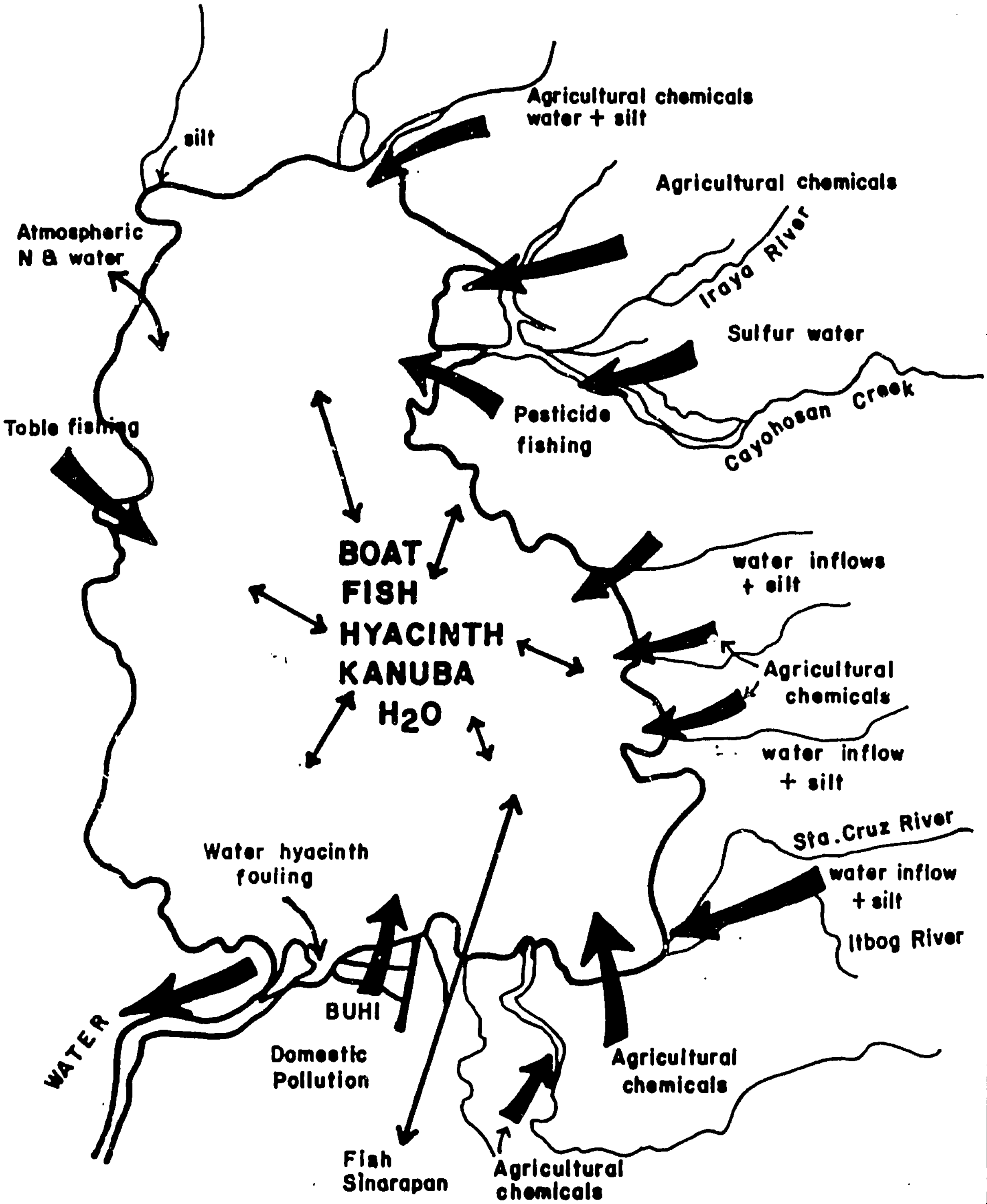


Figure 21. External linkages / flows of Lake Buhi System
24

External linkages/flows of fishing system

The flows and linkage of the fishing system with the input and output market is described by Figure 25. For the fish cage system a key informant indicated that fingerling production in Buhi was inadequate by as much as 60% of the total fingerling requirements of fish cages in the lake. This amount of fingerlings is being supplied by fingerling producers from outside the municipality of Buhi, particularly from Bato. Some of the construction materials for fish cages, such as poles or fish cage posts come from Buhi, but the nets are 100% imported into the area.

Except for the motors or engines and fuels, there are no other inputs that are imported for open fishery operation in the area. The operation of the fish cage system, while it may limit open fishery, may also contribute to open fishery production since fingerlings escape from the fish cages and the open fishery primary productivity is increased as a result of supplemental feeding of the cultured fish.

It was suggested by key informants that less than 50% of the harvested fish coming from the lake are consumed locally. Thirteen to fifteen percent of the total harvested fish are consumed by fishermen households themselves and their friends and relatives. More than 50% of the total fish production is sold in Buhi market and to fish traders. The fish marketing channels for the Bicol region are shown in Figure 26. The role of fish traders is important for both open fishery and fish cage operators in marketing their products outside Buhi.

There are significant differences in fish prices within and outside the muncipality of Buhi. The average prevailing price of fish during the field survey was ₱7.00/kg. in the Buhi market and as high as ₱25.00/kg. in nearby markets outside the municipality of Buhi.

Impact of the Kanuba

More comprehensive research has still to be undertaken in order to explain the real causes of kanuba or the sulfur upwelling phenomenon in Lake Buhi. One of the many theories about the kanuba phenomenon which may serve as research hypothesis for future work is illustrated by Figure 27.

Better understanding of the kanuba system is necessary in as much as it has significant adverse impacts on fisheries especially fish cage culture. Kanuba generally occurs during the months of May to October, when there are weather disturbances and a constant wind pattern. Furthermore, it is also known to occur prevalently in the south-western side of the lake, which is in the general direction of lake water flows.

Sulfur is a key element in the kanuba phenomenon. It can be postulated, therefore, that the kanuba process begins from the north-eastern side of the lake where there is a sulfur water inflow coming from a sulfur spring at the upland area of Iraya (see Figure 28). Since sulfur is heavier than the lake water it

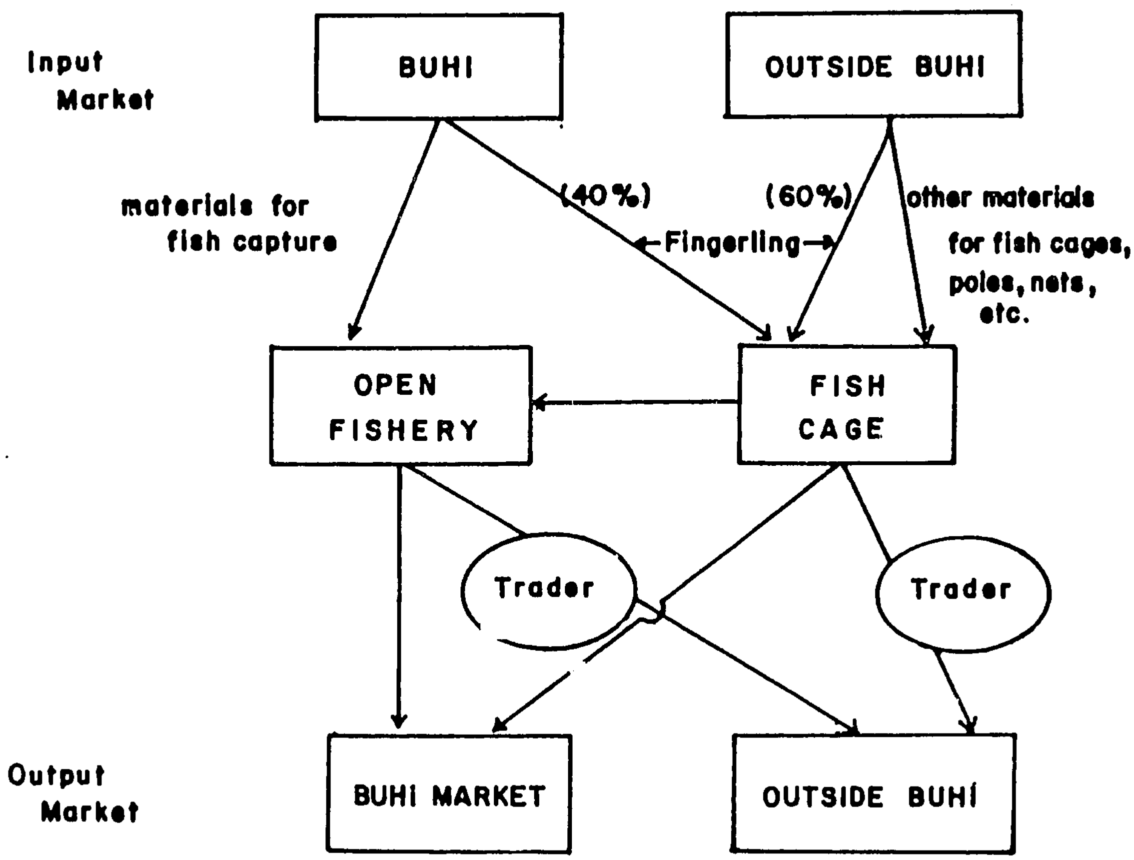


Figure ~~22~~ 25. Input and output flow diagram for Lake Buhi Fishery.

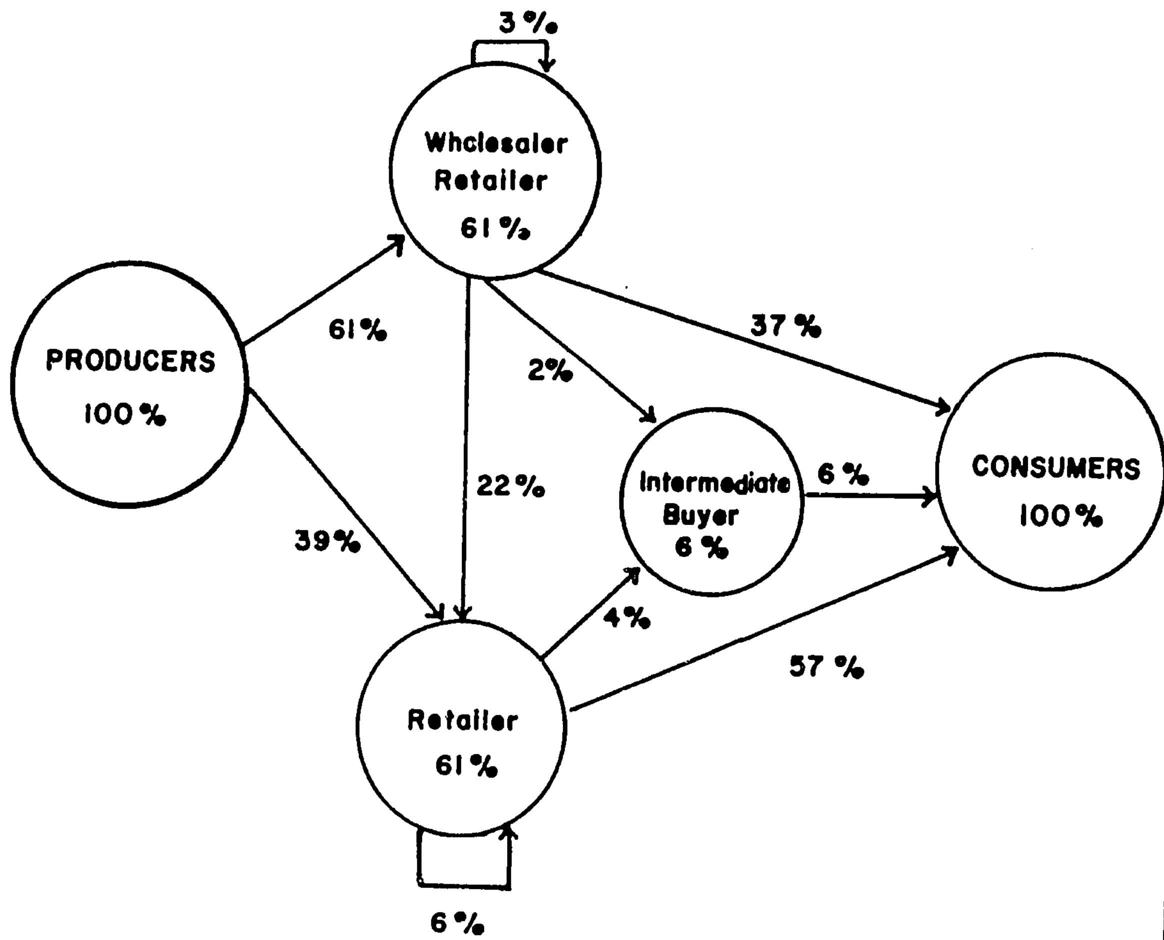


Figure 26. Fish marketing channels in Bicol
(Source : Escover, E. M., et. al. 1983)

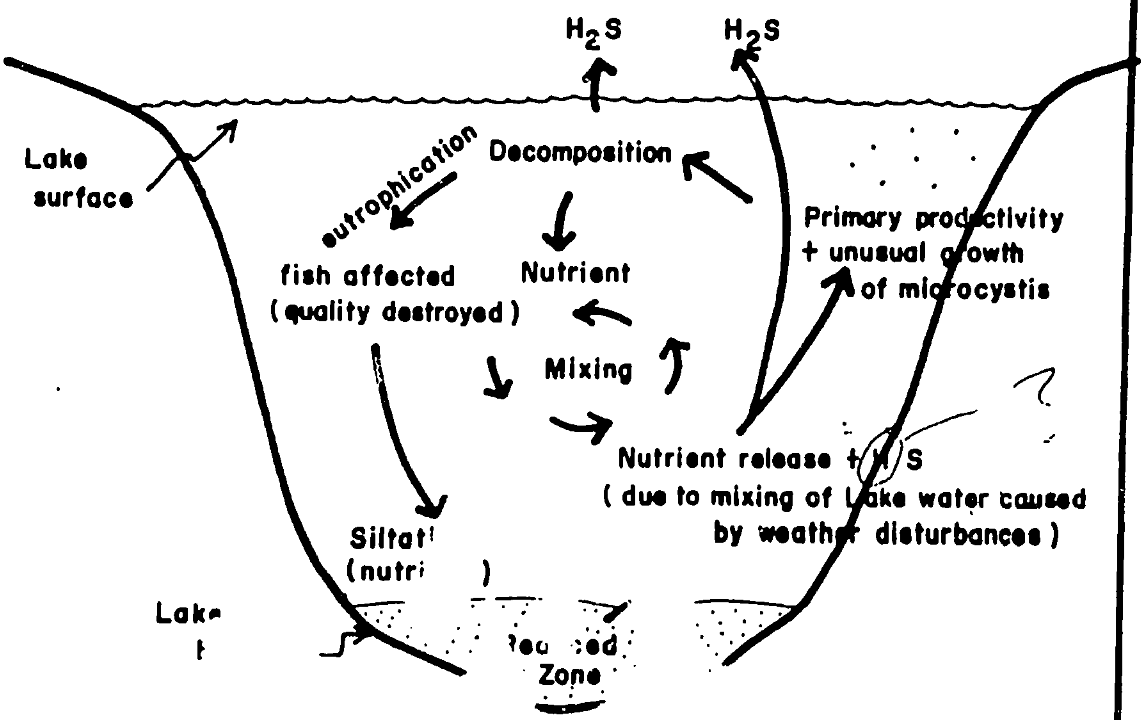


Figure 2 Theoretical K[illegible] System

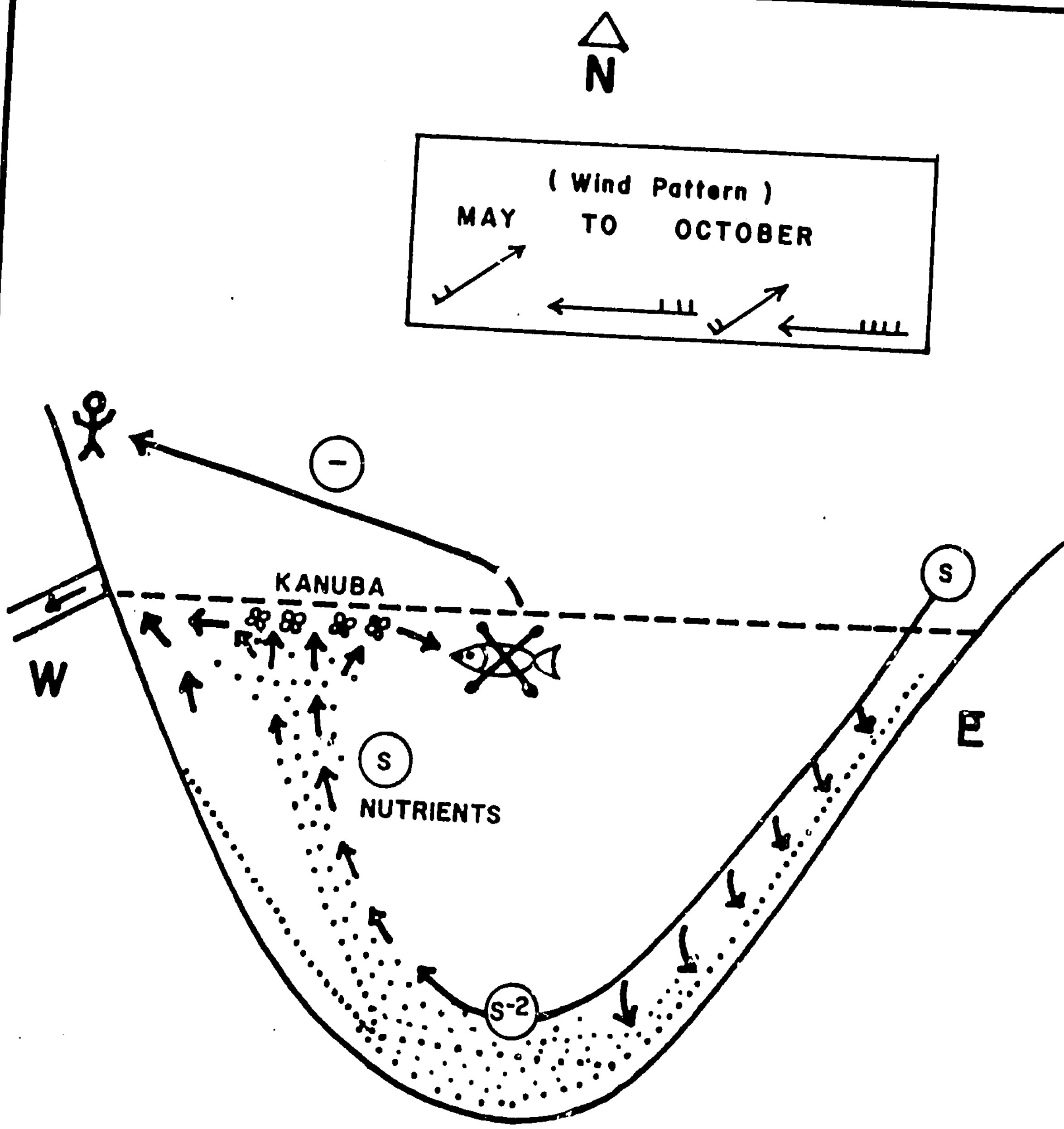


Figure ~~25~~ 28. Kanuba (Sulfur upswelling) impact flow.

precipitates and sinks to the lake bottom. It is distributed by bottom water current and mixed with organic matter in the reduced zone of the lake. When there is a weather disturbance, there is a tendency for the water to circulate. And hence, water circulation brings up the sediments which contain sulfur as well as organic matter which were deposited at the bottom of the lake. This usually occurs when there is a high nutrient content of lake water during an algal bloom. The combination of algal bloom and the upward movement of lake sediments, which contain sulfur as well as humus, produces toxic substances such as hydrogen sulfide. These cause the death of fishes in the area.

Decision Making

Decision Tree

The basic livelihood systems in Lake Buhi are shown in Figure 29. The principal factors affecting the choice of system are land, capital and skills.

Institutional Decisions on Lake Resources Allocation

As emphasized above, the Lake Buhi agroecosystem is being utilized for many purposes. Several government agencies/institutions and interest groups are directly or indirectly involved in the development and use of the lake, each of them having its own particular interest/objective in using the resource system. And since one particular use will have beneficial, adverse, or both effects on other uses of the lake resources system, it seems logical for them all to coordinate with one another in making policy decision concerning resource use allocation for maximum social benefit.

Figure 30 describes the interrelationships and institutional gaps between the different decision makers regarding allocation of fish cage areas, water supply and drawdown lands. Fishermen in the study area have, in one way or the other, established with the fishery authority and the local government linkages which are primarily in the form of fish cage licensing and Mayor's permits. A sizeable lake surface area could still be released for fish cage operations, and would be quickly occupied because of the dramatic increase in profitability of fish cage technology.

Increased profits from fish cage technology have attracted people from outside the municipality of Buhi. Hence, a high degree of competition and potential conflicts among fishermen and investors is not unlikely. This problem can be avoided if BFAR and the local government coordinate in the development and management of fishery resources.

As far as water use allocation is concerned, the local government and fishermen are tied up together. NPC and NIA are coordinating with each other and NIA with the Irrigators Associations. But again, the local government has so far not

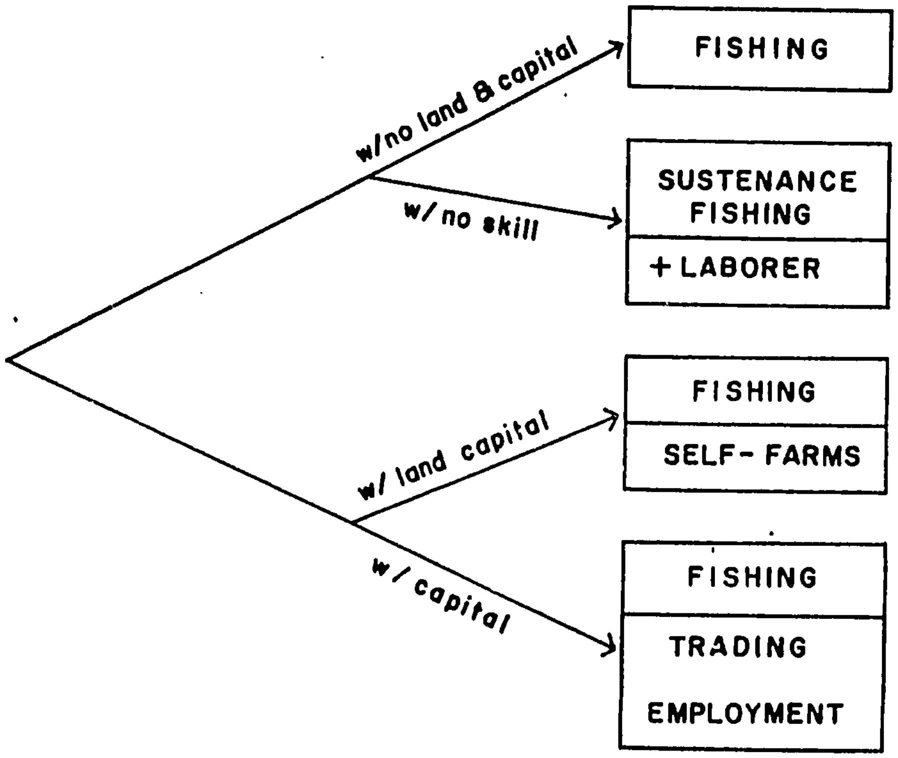


Figure ~~16~~ 29. Decision tree for livelihood system in Buhi, Camarines Sur.

Figure 30

MISSING

been a formal part of the decision making process concerning water use allocation and the operation of the hydraulic control structure, in particular.

Finally, who owns the lands which are exposed during low lake water level? Several government agencies may claim jurisdiction over the drawdown lands. It is part of the watershed so BFD could claim it; it is a public land so BFD still has the jurisdiction, which in turn goes under the responsibility of the Bureau of Lands. There is also the Ministry of Public Works and Highways which has the necessary permit to use these lands. NPC and NIA, on the other hand, may have the rightful claim over these lands, because these are parts of the water reservoir (i.e., lake system) and thus are needed to pursue the national public policy on power and irrigation. In terms of hereditary rights, people (fishermen, farmers, etc.) in the area have the rightful claim. Coastal people, the fishermen and coastal rice land owners seem to be poorly interlinked, but both groups are tied up with local government. Landless and cageless people in the area remain uncertain as to whether they may be included in municipal planning. The diagram of the drawdown land suggests that there is a need for a clear legal definition of water resource boundery, i.e., what is owned by the state, what part of it could be disposed as private land and so on. Moreover, the problem of the institutional decision making process becomes further complicated because of the establishment of the hydraulic control structure which will in turn make the natural drawdown land basically artificial.

System Properties

As presented earlier, Lake Buhi has numerous behavioral characteristics which can be summarized into four interconnected system properties: productivity, stability, sustainability, and equitability. Variables and processes which may positively or negatively affect the system properties have been identified and discussed in the earlier section of this report. The more relevant key variables and processes are summarized in Table 10.

Productivity

Comprehensive limnological data have yet to be generated for the formulation of appropriate conservation measures and effective management strategy for Lake Buhi. The significant gap in limnological data is a big constraint in making rational decisions concerning lake resources use and allocation. The data are particularly necessary in the determination of the lake's maximum carrying capacity.

An estimate of the lake's maximum carrying capacity must be well established so as to arrive at a rational decision as to how much lake area may be licensed for profitable fishing activities so as to maintain maximum productivity. Comprehensive limnological data are also vital in the selection of the appropriate location of the fish sanctuary. The big gaps in limnological data are a constraint not only achieving high sustainability of the lake system. The other factors limiting productivity include the natural and man-made pollution such as <u>kanuba</u>, agricultural chemicals, domestic sewage, silt, the crowding of increasing number of cages which affect fish capture operations, and the level of production and poor health condition of the people in the lakeside barangays.

Productivity of the lake agroecosystem can be improved substantially through: (a) the introduction of new and appropriate technology in fishery, farming, and cottage industry, so that the excess labor supply and the local indigenous resources like water hyacinth may be efficiently used in production; (b) the production of fingerlings, poles and other materials for fish cages in the lake or nearby area so that the availability of these production inputs will not be a constraint on fish culture operation and production; (c) the establishment of a fish sanctuary area which is supported by sound limnological data so that there will be a place for wild fish to reproduce naturally. Thus, the production level of capture fishing can be maintained if not improved; and (d) the provision of institutional support services such as credit, marketing facilities, and cooperatives.

<u>Stability</u>

The increasing number of fish cages and the construction of fishpens tends to exclude or limit the available fishing grounds for capture (sustenance) fishe[illegible]n. This situation seems to create social disharmony and, t[illegible], tends to impose destability of the lake system. The HCS ope[illegible]ation well above or below 82 m. asl would result the inundation [illegible]f lakeside agricultural lands and the d[illegible]ining-out (hanging [illegible] fish cages, thus affecting the stability of the lake syste[illegible]

The instability of the l[illegible]em can be minimized if not eliminated, if it is properly [illegible] and zoned according to its multiple uses. An increas[illegible] number of fish cages (and fishpens) operations must b[illegible]ted. Fish cage operation should also be limited to th[illegible]m carrying capacity of the lake. A high degree of co[illegible] in occupying the remaining fish cage areas will also [illegible] stability. Therefore, an appropriate mechanism by wh[illegible] available fish cage areas can be equitably allocated [illegible]ary to maintain an equilibrium for the lake system. [illegible]ion to this, new sources of livelihood such as prop[illegible] development, cottage industry, intensified delivery [illegible]rvices, etc. should be vigorously pursued. T[illegible]ove the standard of living of the people, which will ultimately promote the stability of the lake system.

Table 10. Key variables and processes affecting Lake Buhi Agroecosystem prcperties.

Positive	Negative
PRODUCTIVITY	
- New aquaculture technology - Fish sanctuary - Fingerling production - Production of poles and other materials for cages - Drawdown farming - Support services c. credit, marketing and cooperatives	- Pollution (kanuba, fertilizer, pesticides sewage garbage, silt, etc) - cage crowding - limnological data gaps - poor health of people
STABILITY	
- Lake zoning and management - HCS operation at 82 m asl - Proper tourism development - Social Services delivery	- Cage crowding - Fishpen culture - HCS operations well above or below 82 m asl
SUSTAINABILTY	
- Watershed management (protection & rehabilitation) - Popular control	- Tributary diversion outside lake basin - Proliferation of water hyacinth - Accelerated siltation
EQUITABILITY	
- Local participation in lake resource allocation and use (licensing) - Marketing/Production cooperatives	- No local partipation in lake resource allocation and use (licensing, etc.) - Dummy fish cage operation and crowding cage operation - Drawdown and flooding (shallow wells and inundation)

Sustainability

An effective watershed management, including the rehabilitation and protection of forest land, is very necessary to promote the sustainability of the lake system. However, even though there is such an effective watershed management, sustainability can not be assured or maintained if more tributaries of the lake are diverted outside, such as the proposed diversion of Itbog Falls for local water use in the Rinconada area. The other factors which may adversely affect sustainability of the lake system within the short-run and long-run perspectives are the increasing water hyacinth and the accelerated siltation rate. It is possible that the lake surface area may become covered by water hyacinths since the HCS is observed to have prevented their outflow. Should this happen, it could induce a sudden collapse of the lake system. The introduction of new technology which could use water hyacinth as input seems to be the logical approach in dealing with this problem. At the same time, it would enhance people's livelihood.

Equitability

The biggest issue which tends to make the distribution of lake resources inequitable is the lack of participation of local government in the allocation of the uses of the lake resources. The practice of dummy fish-cages ownership and the crowding of increasing numbers of fish cages will further enhance inequitability. Local participation in resource allocation in the form of licensing, and prevention of dummy fish cage ownership arrangements, should therefore be instituted so that there will be better equitability in the distributions of the benefits of the lake resources.

4.3 THE TABAO RIVER

FELINO P. LANSIGAN AND WILFREDO OLANO

Introduction

The Tabao River (also known as Buhi River or Barit River) is the only outlet of Lake Buhi and serves as an additional storage reservoir and hence contributes to power generation, irrigation, and flood control.

The System Boundary

For discussion purposes and in order to establish a common reference point in the analysis the system is defined as including the areas and structures of the lake Buhi Control Structure, the Tabao River channel, and the NPC Reservoir.

The system also includes the areas along the so-called old Tabao River. Figure 1 shows the schematic representation of the system boundaries relative to Lake Buhi and its tributaries, while Figure 2 shows the system components. The barangays of the muncipality of Buhi within the Tabao River subsystem are represented schematically in Figure 3.

The system boundary covers the hilly area and flood plain areas along the Tabao River channel, including some of the lowland and irrigated areas (slope 0-20%) on the east side of the channel. Along the channel near the old Tabao River area is about 40 has. of land owned by NPC. These were bought by the company from residents along the channel when the NPC reservoir was established.

In the following the original Tabao River will be referred to as the old Tabao River, or Tabao River, and that part of the river resulting from the channeling work will be referred to as the Tabao Channel.

System Hierarchy

Figure 4 shows the system hierarchies for the Tabao River ecosystem. The first-level in the hierarchy is based on the dominant land use while the second-level refers to the distinctly defined areas/structures in the Tabao River.

Hilly lands, flood plain areas, and irrigated areas are closely linked with each other, while the flow of energy (water) is the main link between the control structure, the channel and the forebay reservoir. The regulation and use of water at the upstream and downstream portions of the subsystem are also irrelated.

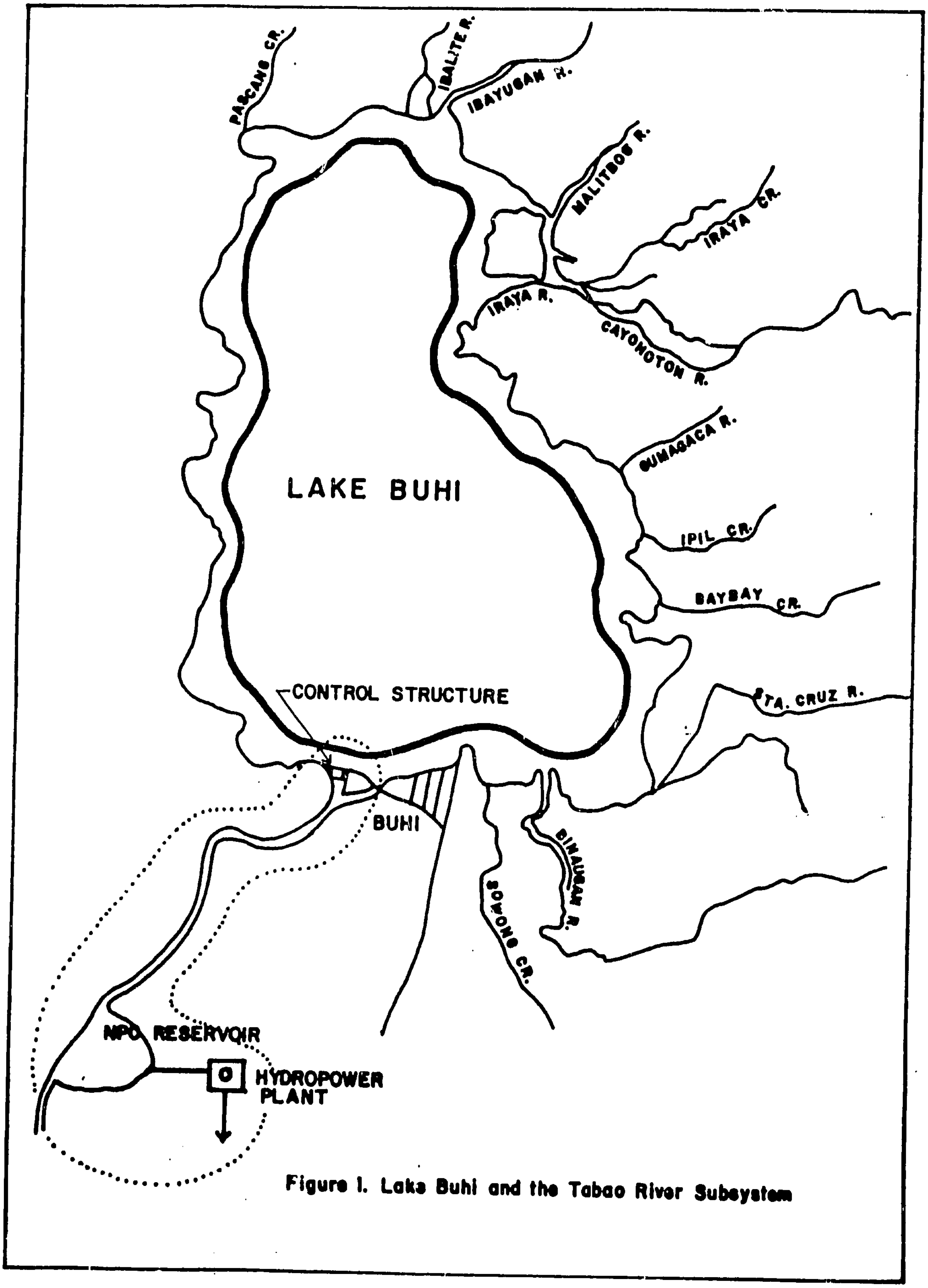


Figure 1. Lake Buhi and the Tabao River Subsystem

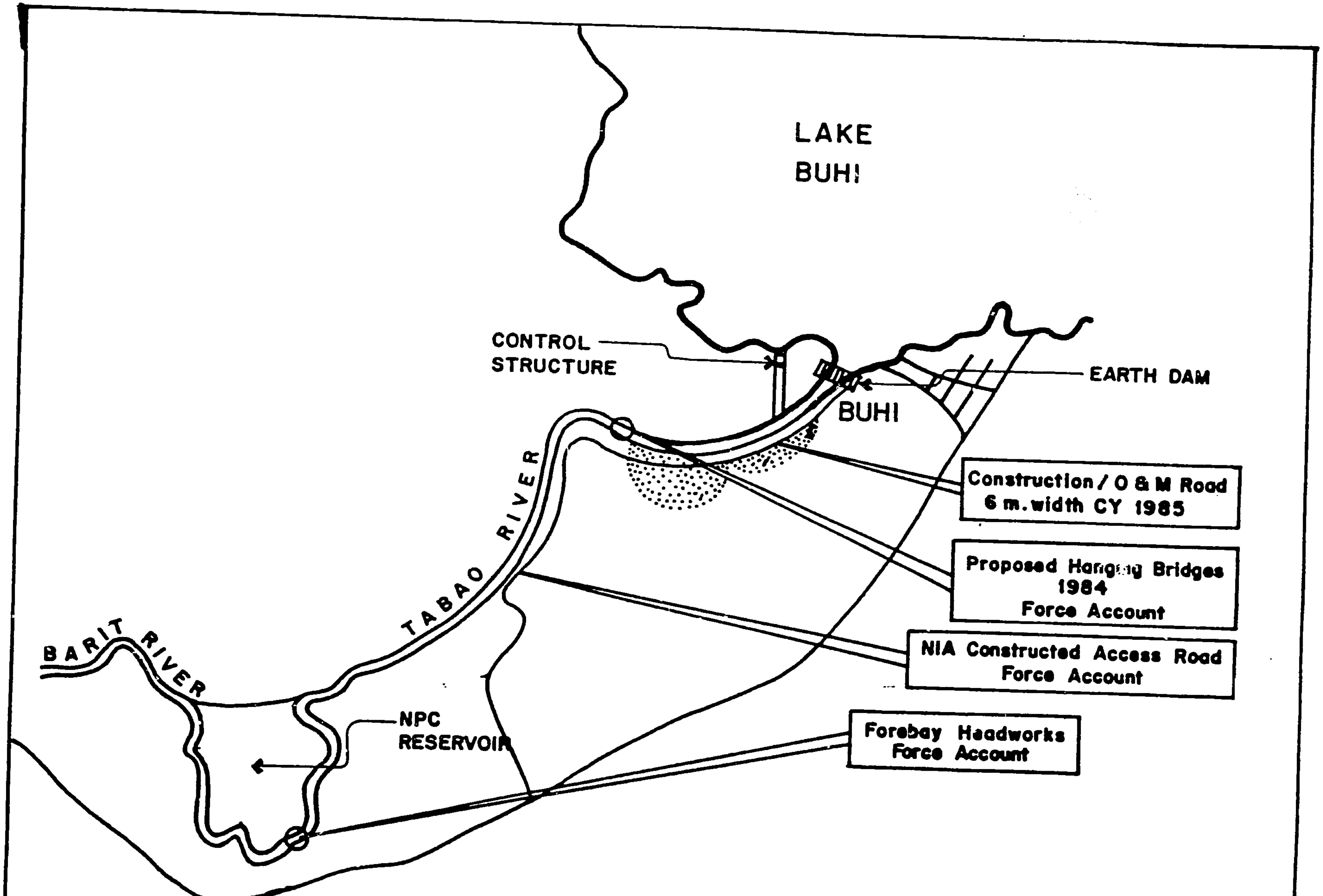


Figure 2. Tabao River Subsystem Components

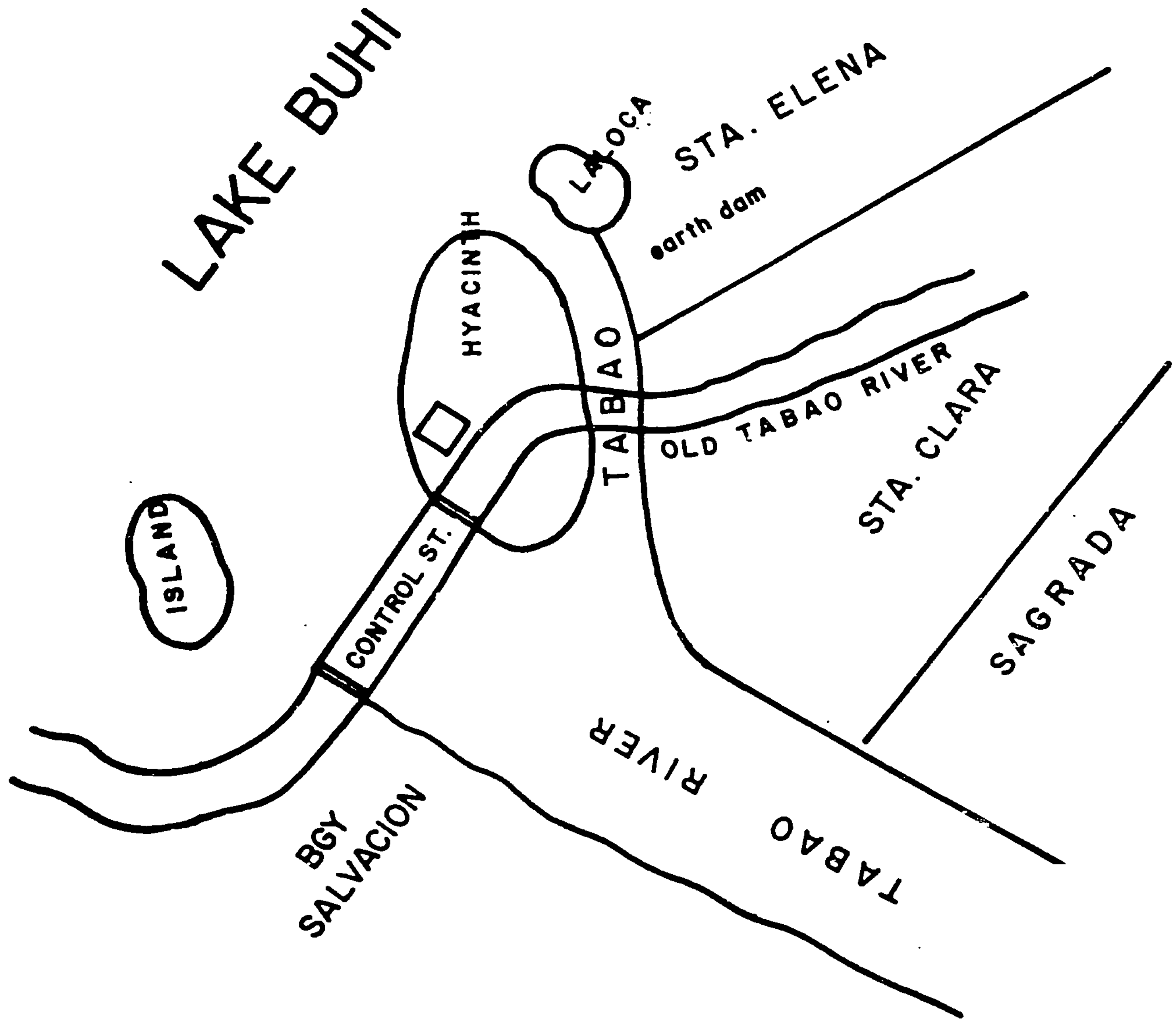


Figure 3. Schematic Representation of Old Tabao River Relative to Control Structure and Channel

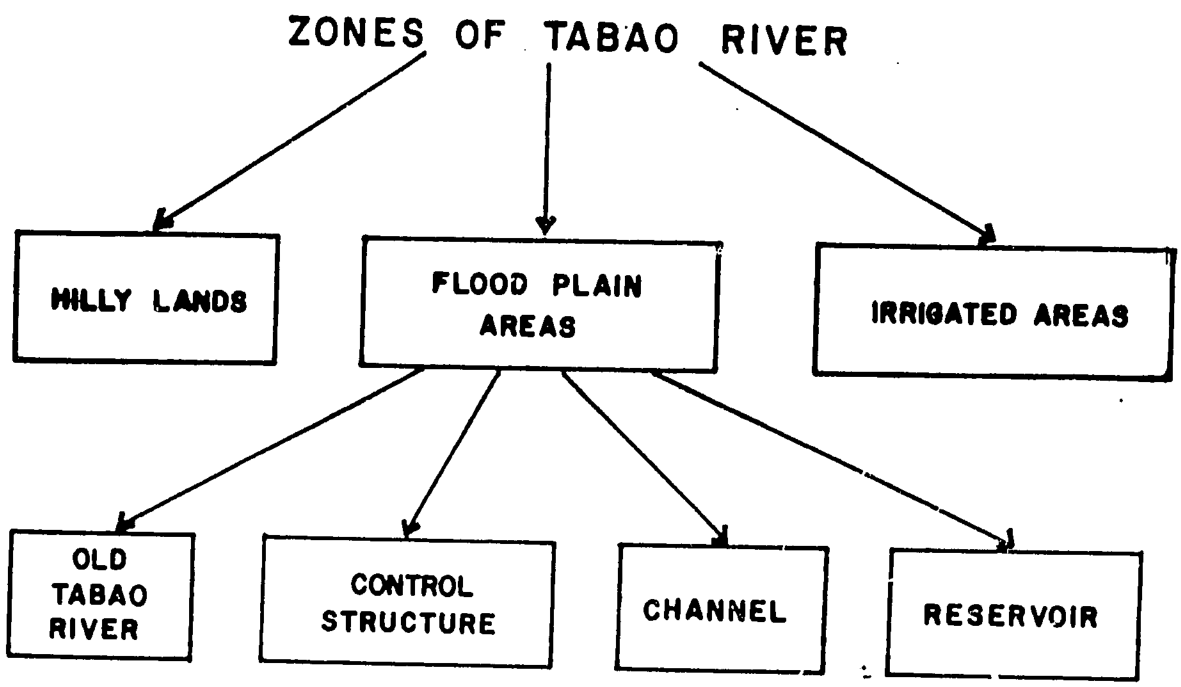


Figure 4. Systems Hierarchies

The so-called old Tabao River area has been identified as part of the subsystem inasmuch as the problems of the area are not isolated from the Tabao River itself.

Spatial Relationships

Table 1 summarizes the dominant physical features of the area along the Tabao River system. The soil characteristics and landuse differ considerably between the east side and west side of the river. The cropping system on each side is determined by the topography of the area, principally the slope.

Transect

A transect of Tabao River and vicinity is presented in Figure 5 (looking upstream). On the west side of the Tabao River channel are lakelets located in the hilly land area. These are currently designated as sanctuary areas for "sinarapan".

Among the problems identified are the inadequacy of irrigation water supply for the irrigated area and lowlands on the east side of Tabao River which are totally dependent on the small creeks for their water source. Farmers cannot draw water readily from the river since there is a need to pump up water to their fields.

Table 2 presents some of the problems and opportunities of the system. The more pressing problems in the old Tabao area are those that involve tenurial conflicts and human settlement activities. (e.g. squatting) and health and sanitation probems. Along the channel area, the more pressing problems involve the operation and displacement of fish cages which constitute one of the main sources of livelihood for the people living along the channel.

Temporal Patterns

Seasonal Calendar

Figure 6 shows the seasonal calendar of activities at Tabao River and vicinity. Rainfall distribution is bimodal with relatively high amounts during July and November. The figure also indicates that river flows are high from December to February. It appears that there is a lag time of about 2 to 3 months between the peak flow months and the peak-rainfall months.

Residents along Tabao River go fishing all year round, catching shrimps usually from September to March with an average catch of about 8:10 kg/ fisherman/week (three times a week). From March to late August, Tabao fishermen get about 2 kg of eels per day.

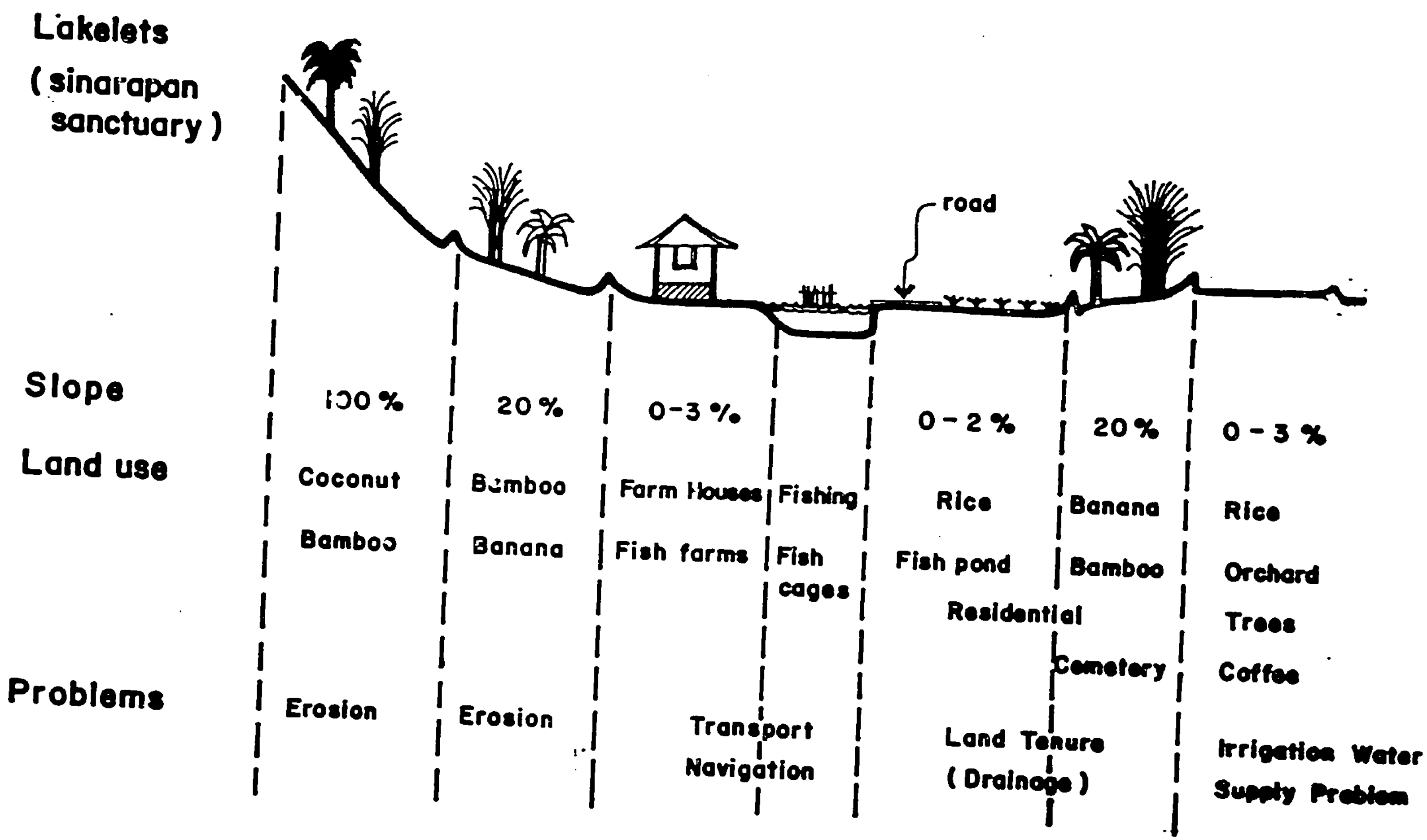


Figure 5. A transect of Tabao River and Vicinity (looking upstream)

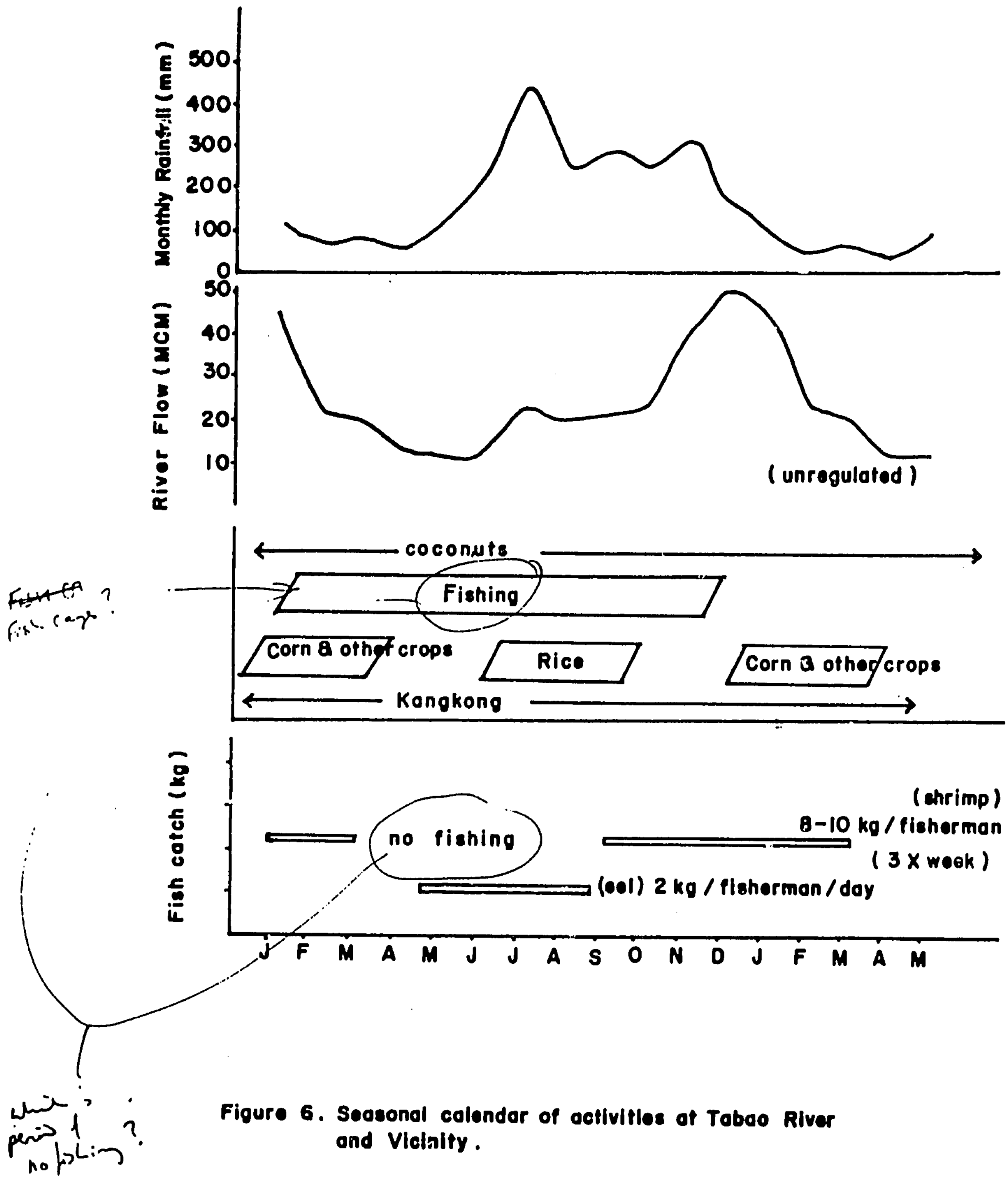
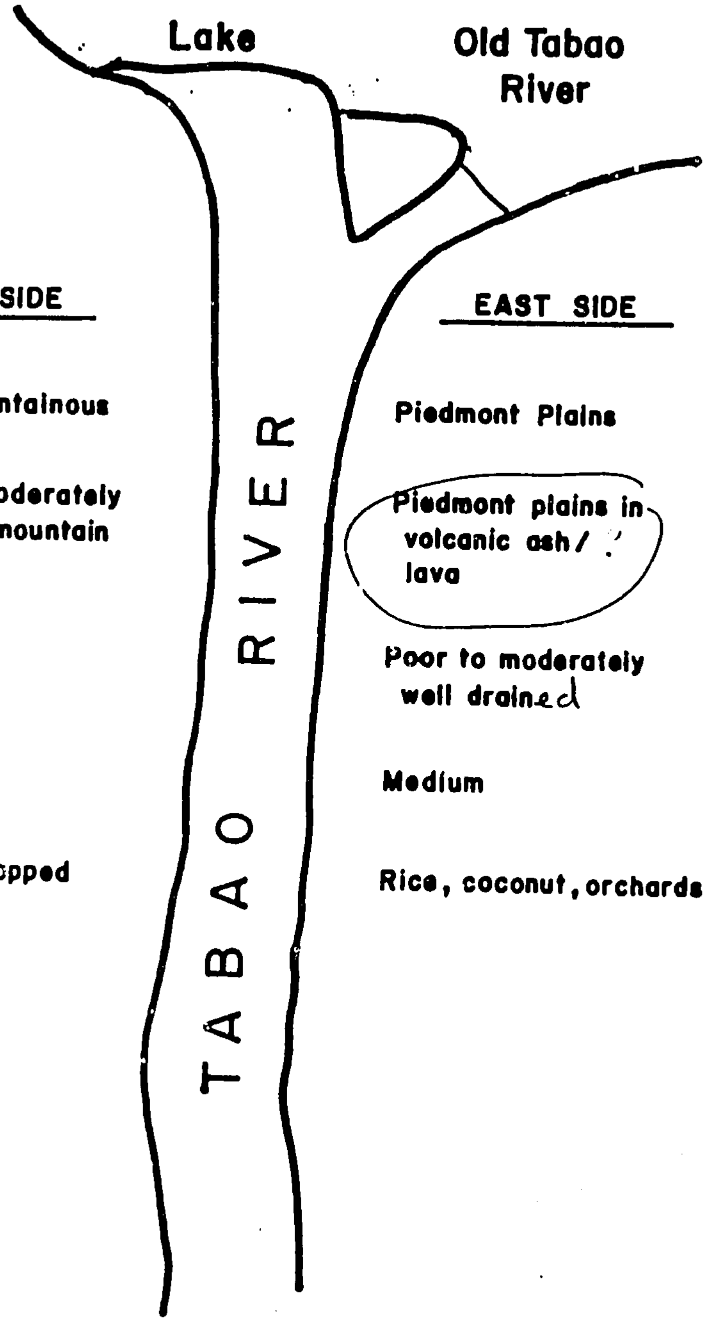


Figure 6. Seasonal calendar of activities at Tabao River and Vicinity.



	WEST SIDE	EAST SIDE
Main Land Type	Hilly to mountainous	Piedmont Plains
Physiographic Unit	Sloping to moderately steep hills / mountain	Piedmont plains in volcanic ash / lava ?
Soil drainage	Well drained	Poor to moderately well drained
Fertility	Medium - High	Medium
Vegetation / Main Present Land Use	Mainly intercropped coconut	Rice, coconut, orchards

Table 1. Physical Factors of Tabao River System

Table 2. Problems and Opportunities in the Tabao River System

Problems:

1. Old Tabao River

- Health and sanitation
- Land grabbing
- Viability of fish cages
- Squatting
- Water hyacinth
- Pollution
- Quarrying
- Claiming of accretion areas
- Danger of collapse of earth fill dam at Old Tabao

2. Tabao Channel

- Low plankton productivity
- Navigation to the market via the lake
- Decreased fishing income
- Drying up of fish ponds on both sides
- Unemployment due to displacement
- Viability of fish cages due to water fluctuations and poor water quality
- Boulders, excavated materials.

Opportunities:

- Settlements (playground, housing,)
- Alternate market site) URBAN EXPANSION
- Docking area)
- Development Training Center) URBAN EXPANSION
- Additional irrigated areas
- Fish cages (alternative to urban expansion)
- Intensified upland cropping (areas 20% slope)
- Bridges
- Cottage industries (for use of water hyacinth)
- Managing/regulating growth of water hyacinth through introduction of technology (Old Tabao)
- Tourist attraction (Control structure)
- Boulders to be used as filling materials
- Better access to Barangay Lourdes, etc.

The dominant cropping system includes rice from June to September, and corn and other crops during the other months. Kangkong is also grown providing source of food for the residents.

The calendar of labor and prices is plotted in Figure 7. Estimates of labor inputs for rice and other crops and price fluctuations are very inadequate or not available.

The income of farmers and fishermen from different sources is shown in Figure 8. Bamboo provides a significant additional source of income for residents along the river.

With the deepening and widening of Tabao River, the outflow from Lake Buhi will be regulated. Figure 9 shows the proposed operating policy for the Lake Buhi reservoir within the minimum and maximum water surface level of 79.3 m. and 82.15 m. MSL, respectively. Figure 10 plots the corresponding discharge curve while Figure 11 shows the storage-elevation curve for Lake Buhi.

Flows

Figure 12 shows the different uses of water from Lake Buhi. Power generation and irrigation of lowland areas are the main uses. Water in the Tabao channel is also used for fish cages. Figure 13 illustrates schematically the flow and regulation of water. Note that "wasted" water from the NPC Hydropower Plant empties into Daraga River abd is also used for irrigation downstream.

Impact of Closure of Old Tabao River

Figure 14 shows an impact flow analysis of the closure of the old Tabao River. On the positive side, are improvements on the productivity, stability, sustainability and capability characteristics of certain sectors of the Tabao River subsystem, with the reclamation of productive areas and a potential site for human settlement as well as the location of possible sanctuary for indigenous fish species. Apparent negative impacts occur on the socio-economic and political activities of the residents of the area, including health, sources of income and community people relationships.

Impact of Control Structure

The construction of the Lake Buhi control structure and its subsequent operationalization is considered by some sectors in the area as controversial, particularly with regard to water resource allocation (Figure 15).

The impact analysis however indicates that the structure could also serve as a tourist spot, and may provide/flood and drainage facilities, and transportation. With the regulated flow of water downstream and in the channel itself, the system properties of certain areas in the vicinity of the system and those of the users of the water resource may be enhanced.

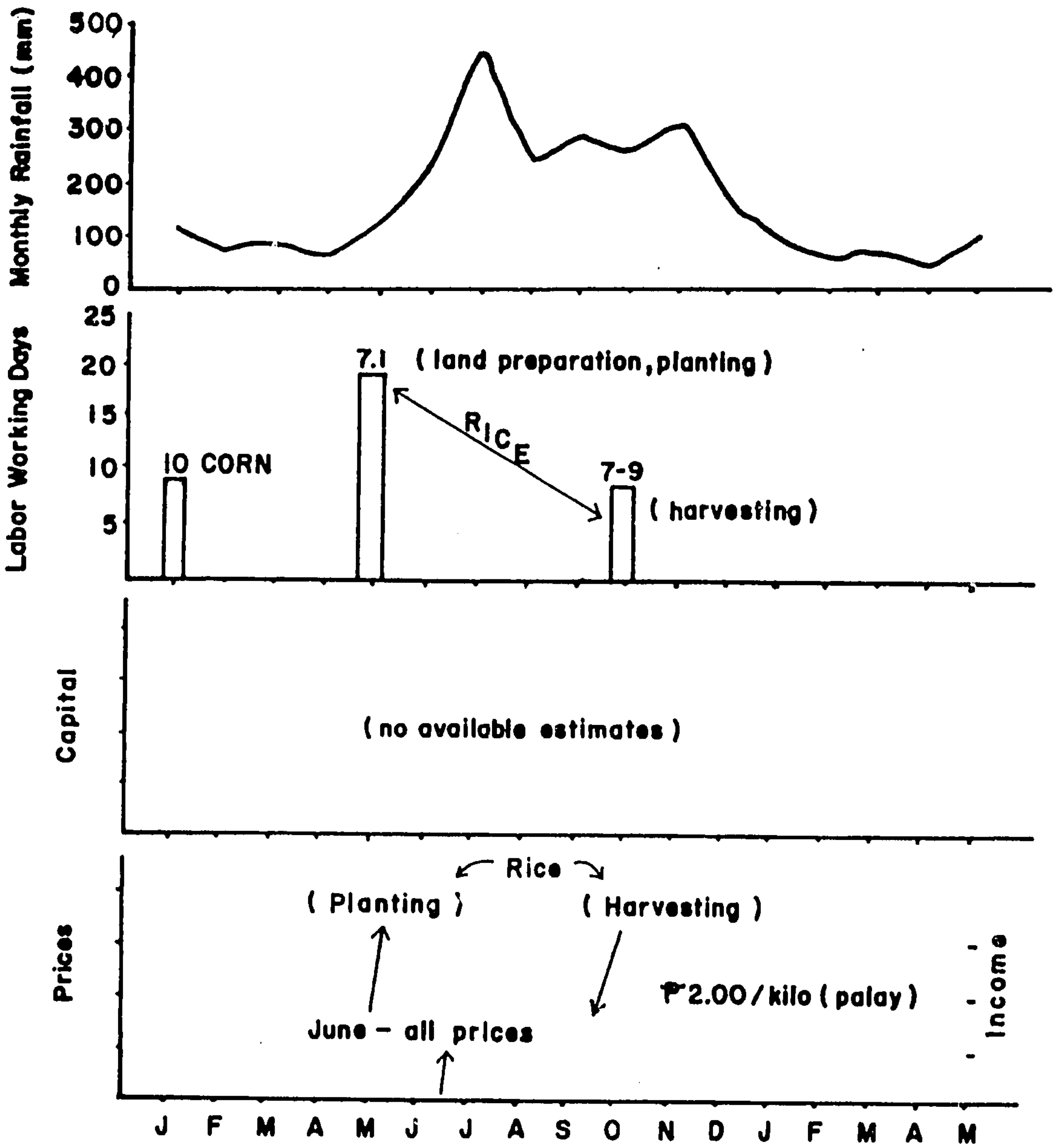


Figure 7. Seasonal Calendar of prices, income, labor and rainfall at Tabao river.

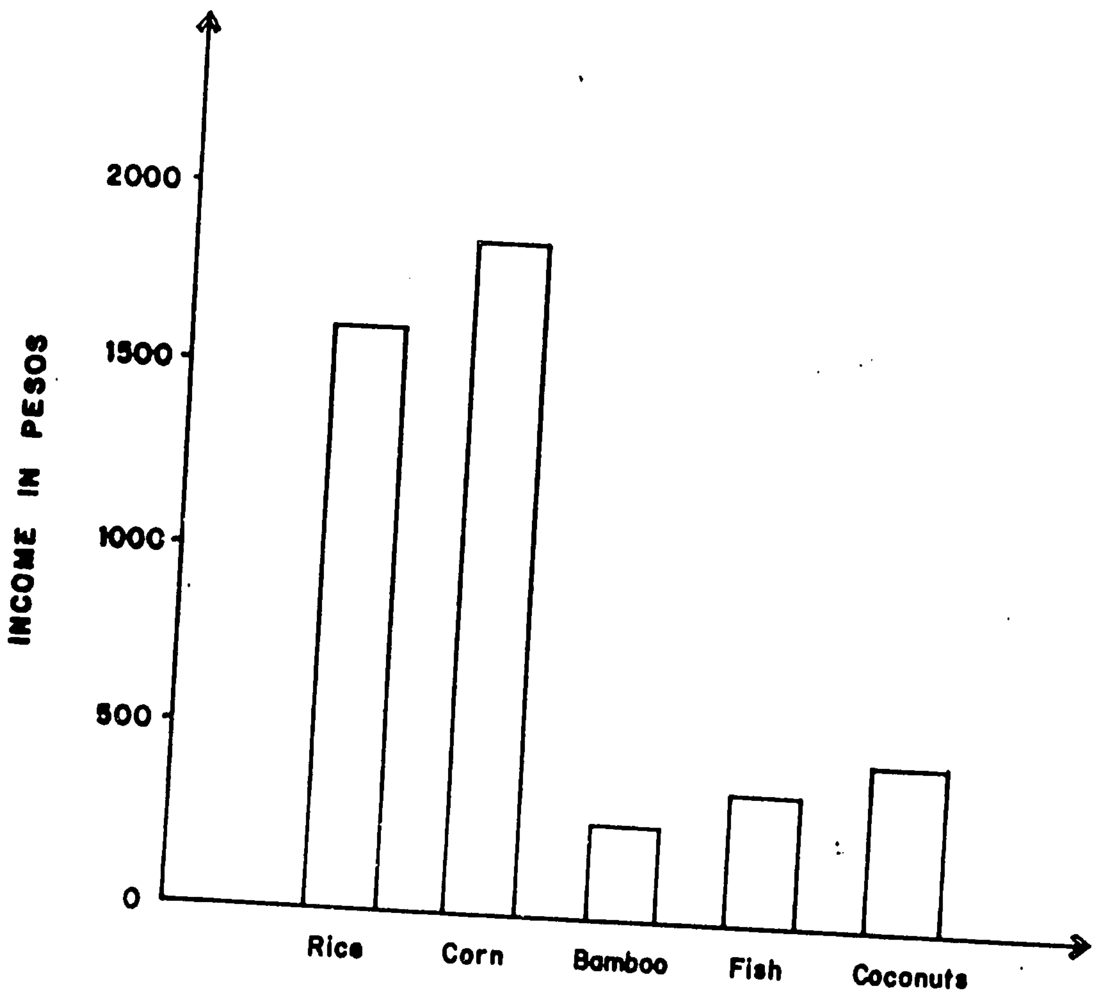


Figure 8. Sources of Income at Tabao River

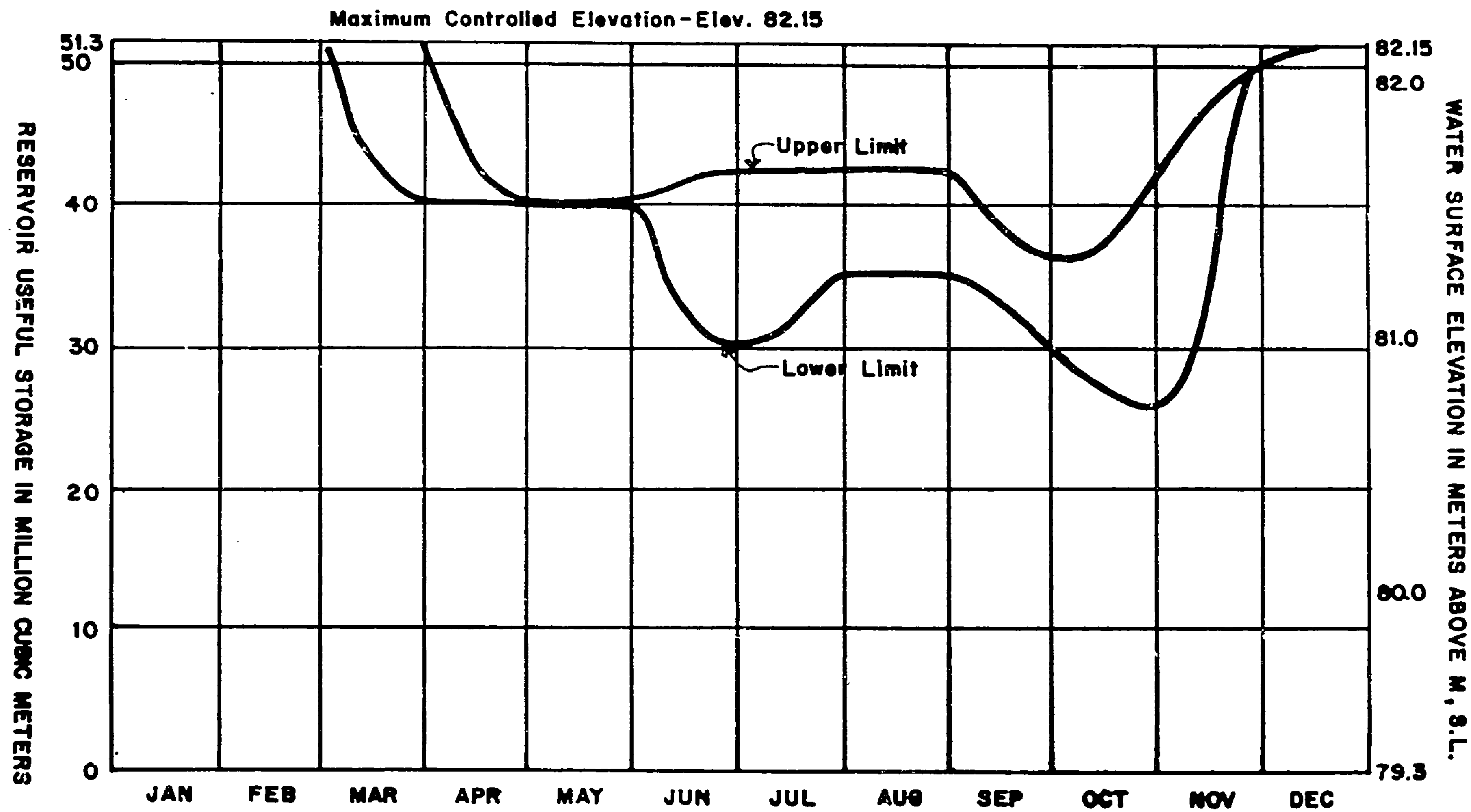


Figure 9. Proposed "Rule Curve" for the Operation of Lake Buhi Reservoir
(with Channelization Only) (Ref)

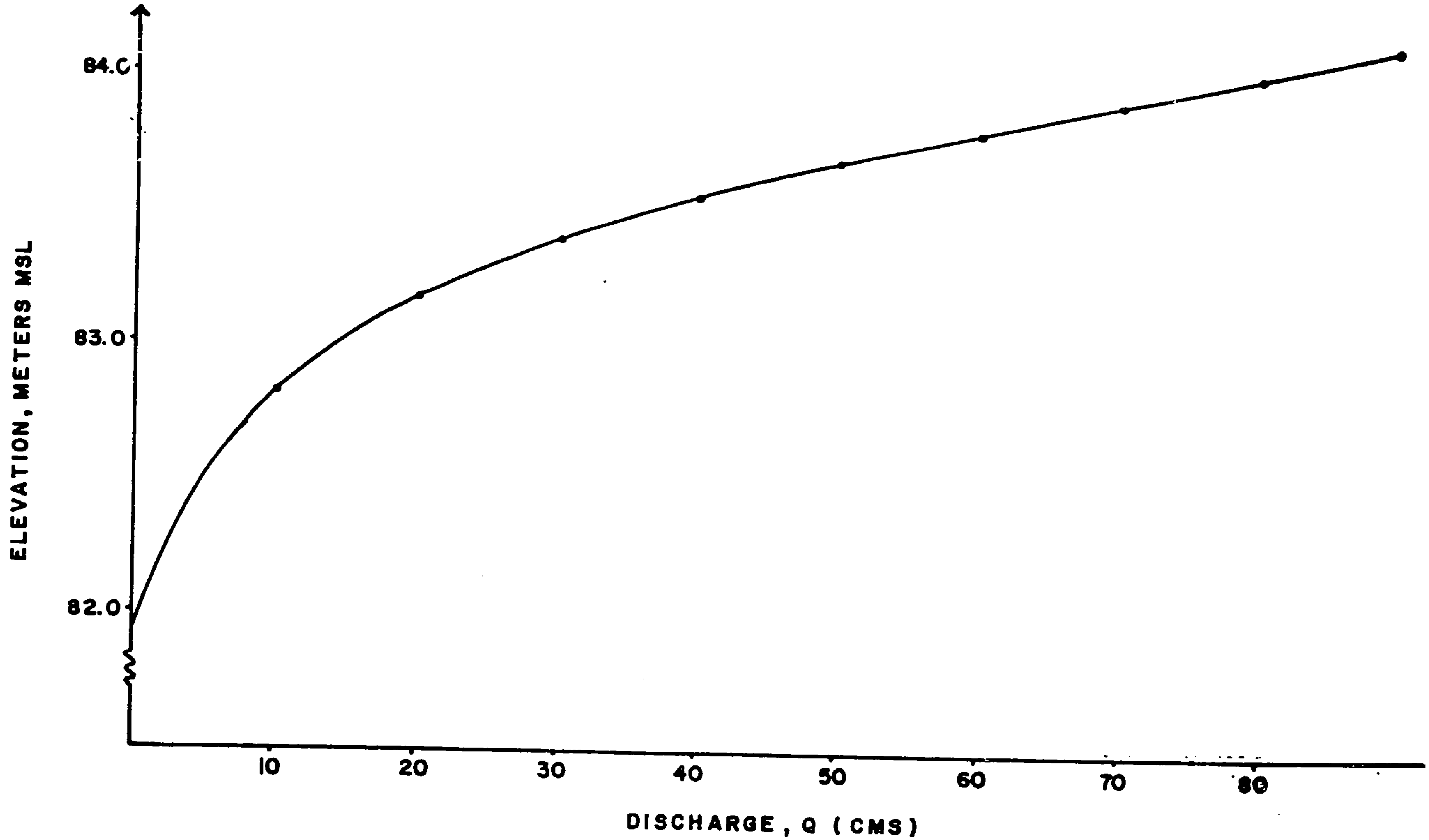


Figure 10. Rating Curve for Lake Buhi Outlet (Ref)

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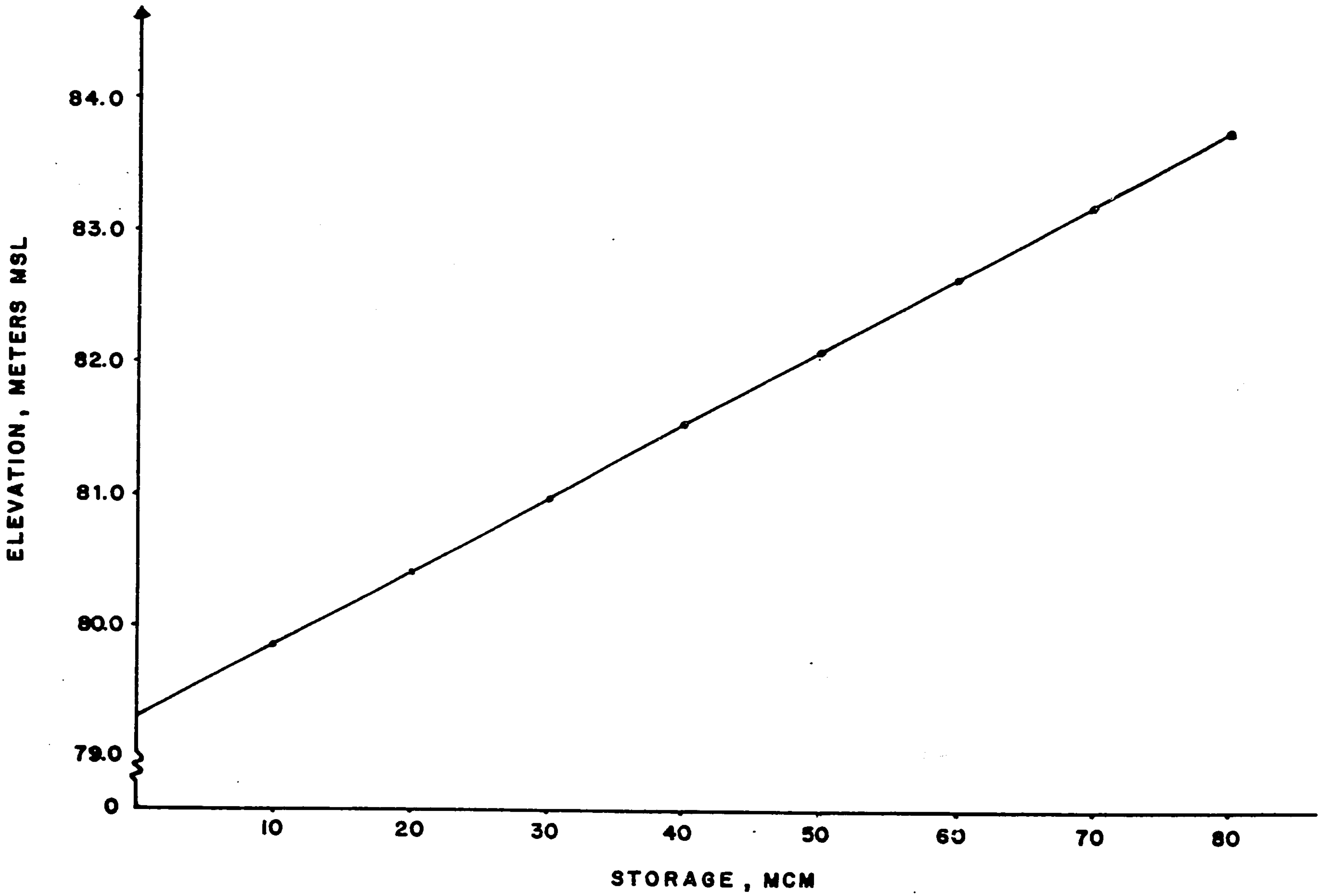


Figure 11. Control Storage Capacity – Elevation for Lake Buhi (Ref)

WATER USES

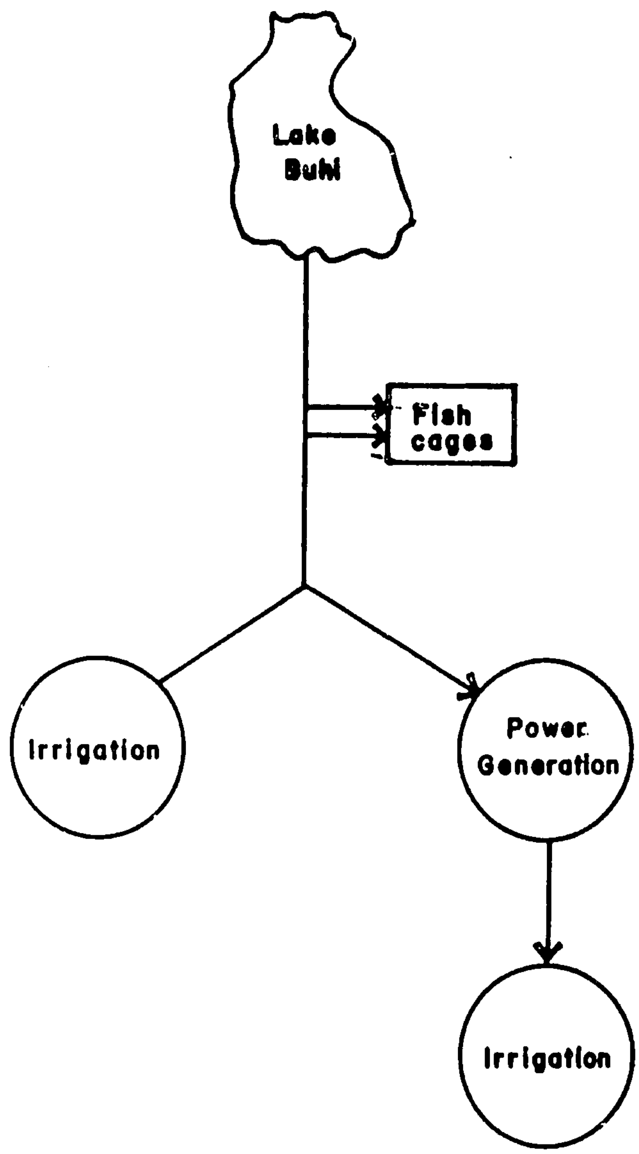


Figure 12. Flow Diagram

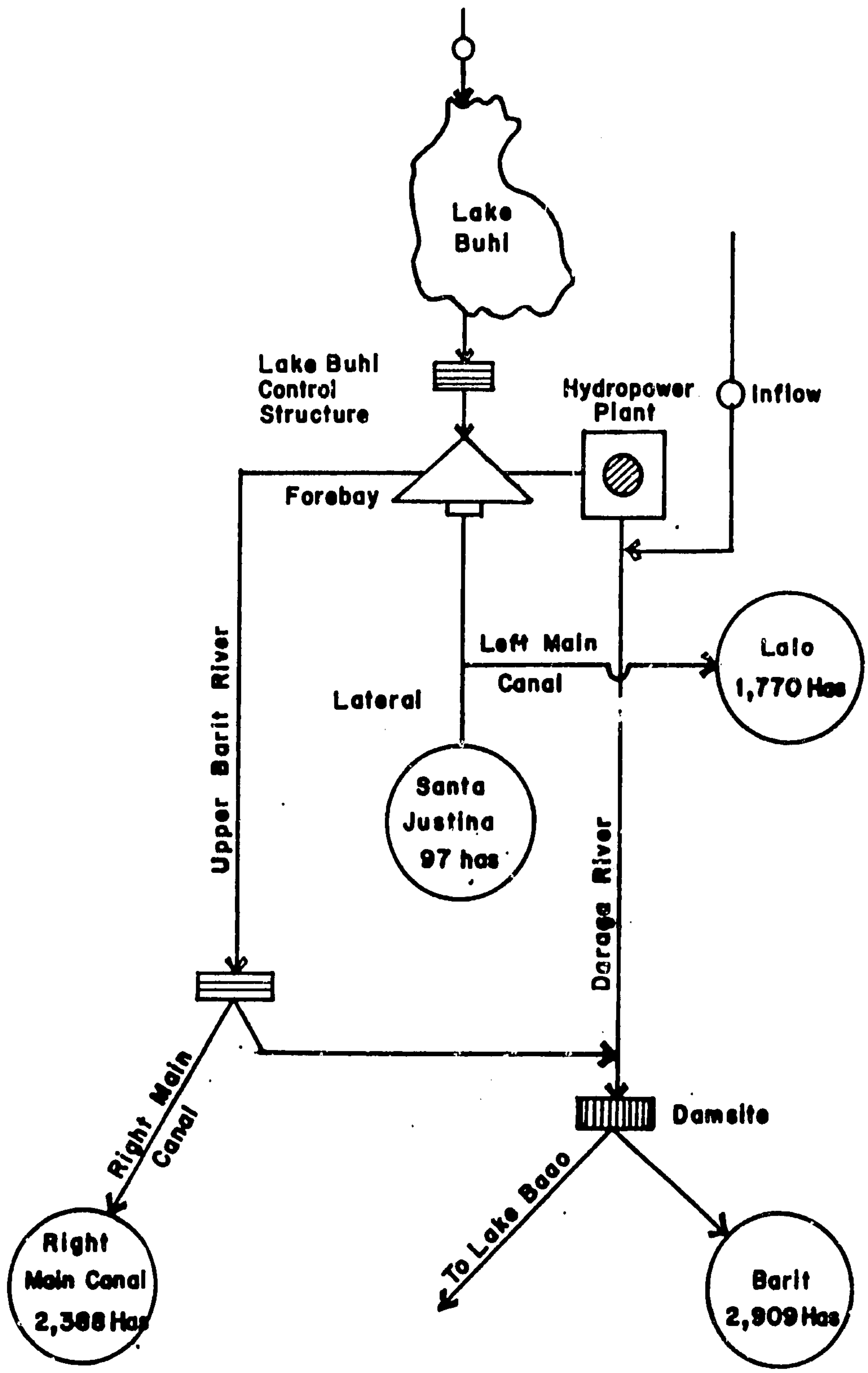


Figure 13. Lake Buhl Regulation Scheme (Ref)

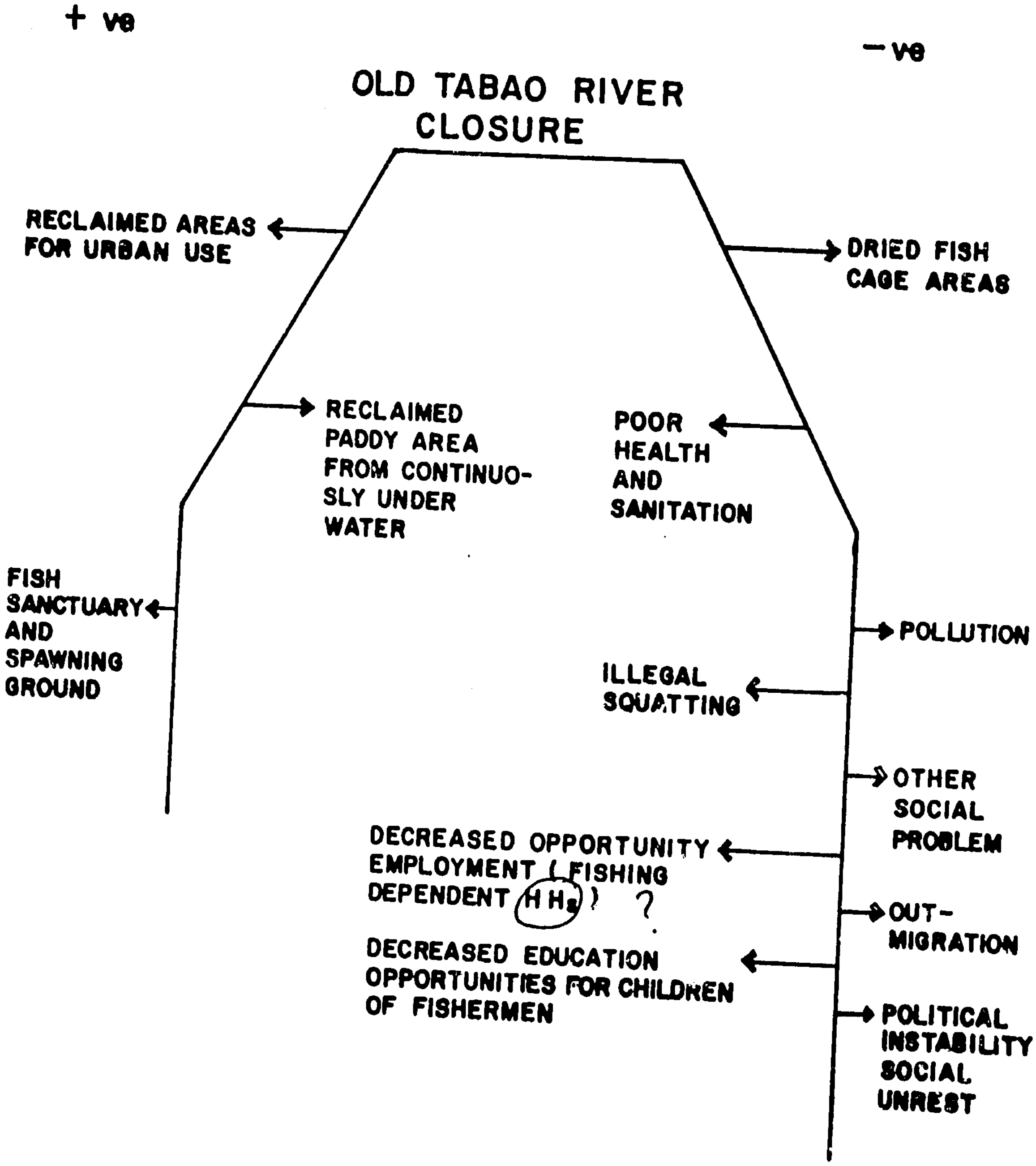


Figure 14. Impact Flow Diagram

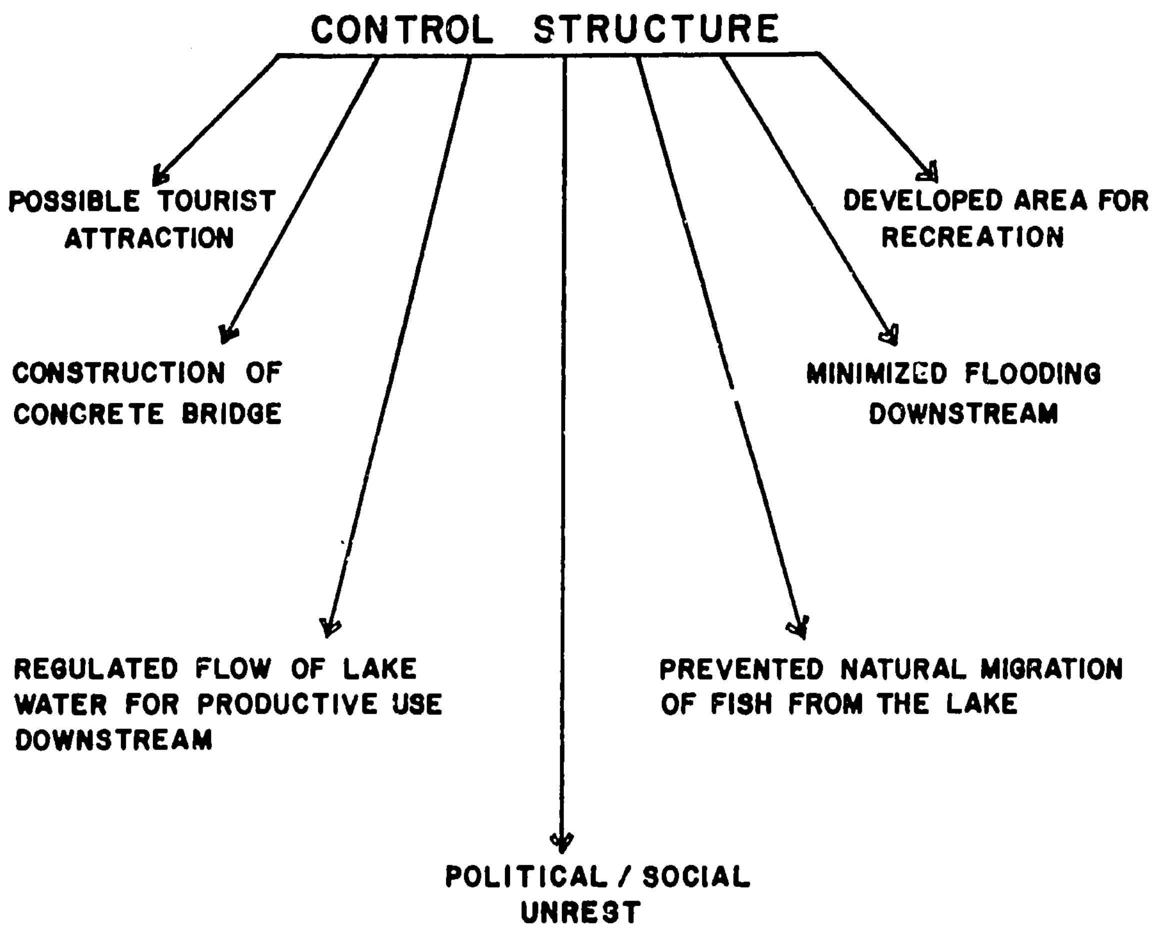


Figure 15. Impact Flow Diagram

Certain livelihood schemes currently existing in the area, as shown in the impact flow analysis, may remain operationally viable. Traditional fishing may still continue downstream, with fish caging in some portions of the channel, and rice farming activities on both sides of the channel.

The more negative impact of the operationalization of the control structure and its other sub-systems is more felt among the rural households in their vicinity whose other major sources of income are traditional fishing and the newly introduced fishcaging activities (Figure 16). This is indicated by the decreased opportunity for viable fishing and fish caging operations in the system brought about by the decrease in water level of the lake resulting to low flows in the river.

Impact of Tabao River Channeling

Figure 17 illustrates the impact flow of the Tabao River channeling which involves the deepening and widening of about 3 kilometers from the control structure at the lake outlet.

The Tabao River channel and channeling activity have certain positive impacts, including among others the benefits of water resource users downstream and from both sides of the channel.

There, are however, certain portions along the Tabao River channel whose system properties are negatively affected. As shown in Figure 18, some areas may not be easily accessible as a result of the deepening of the channel. The lowering of the water level in the deepened portions of the channel may also result in draining of some fish ponds located along side the channel and decreased water for irrigation use by some farmers. The channelization of Tabao River must have also disturbed fish food production and movement of indigenous species in the channel.

Decision Making

Figure 19 shows the decision tree for the existing livelihood systems. The figure indicates the probable outcomes when the farmer/fishermen have varying degrees of accessibility to water supply.

Figure 20a shows the existing institutional linkages concerning the Tabao River management between NPC and NIA following a memorandum of agreement signed in August 1980. On the other hand, Figure 20b illustrates proposed institutional decision-making set-up whereby the Buhi Local Government (BLG) becomes a partner in the regulation and management of the river.

System Properties

Figure 21 summarizes the factors affecting the system properties of productivity, stability, sustainability and equitability.

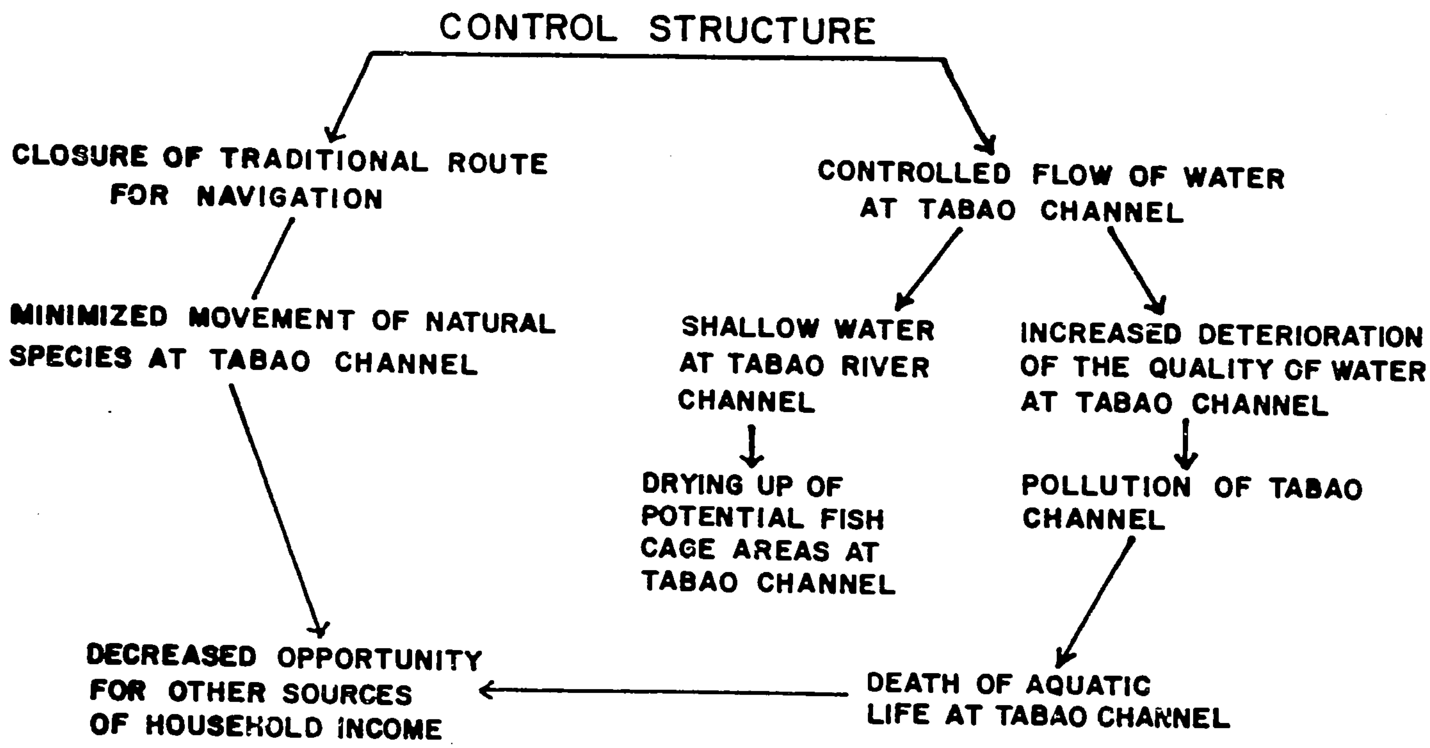


Figure 16 Impact Flow Diagram

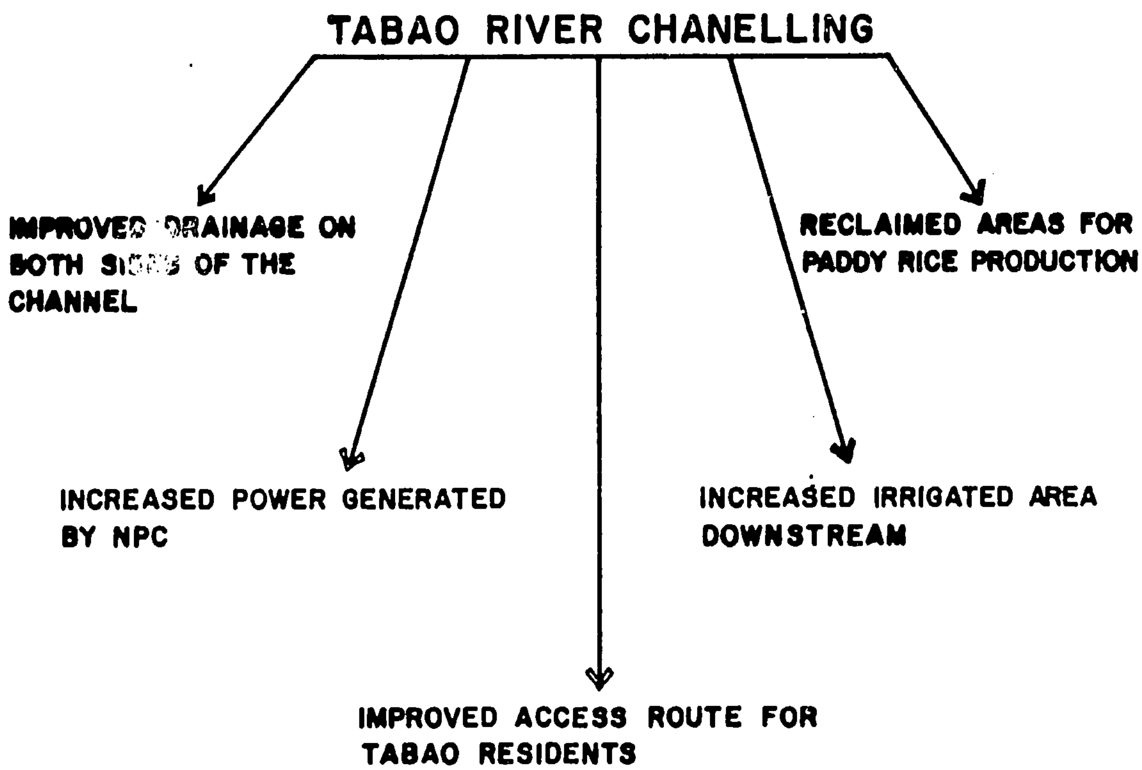


Figure 17. Impact Flow Diagram

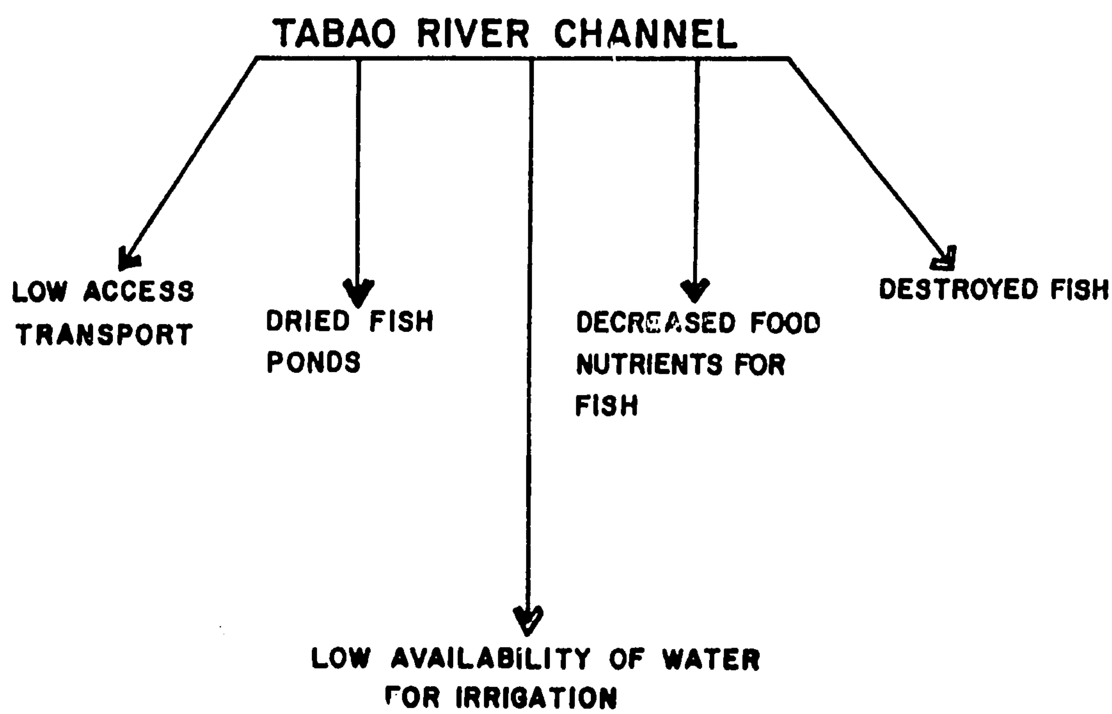


Figure 18. Impact Flow Diagram

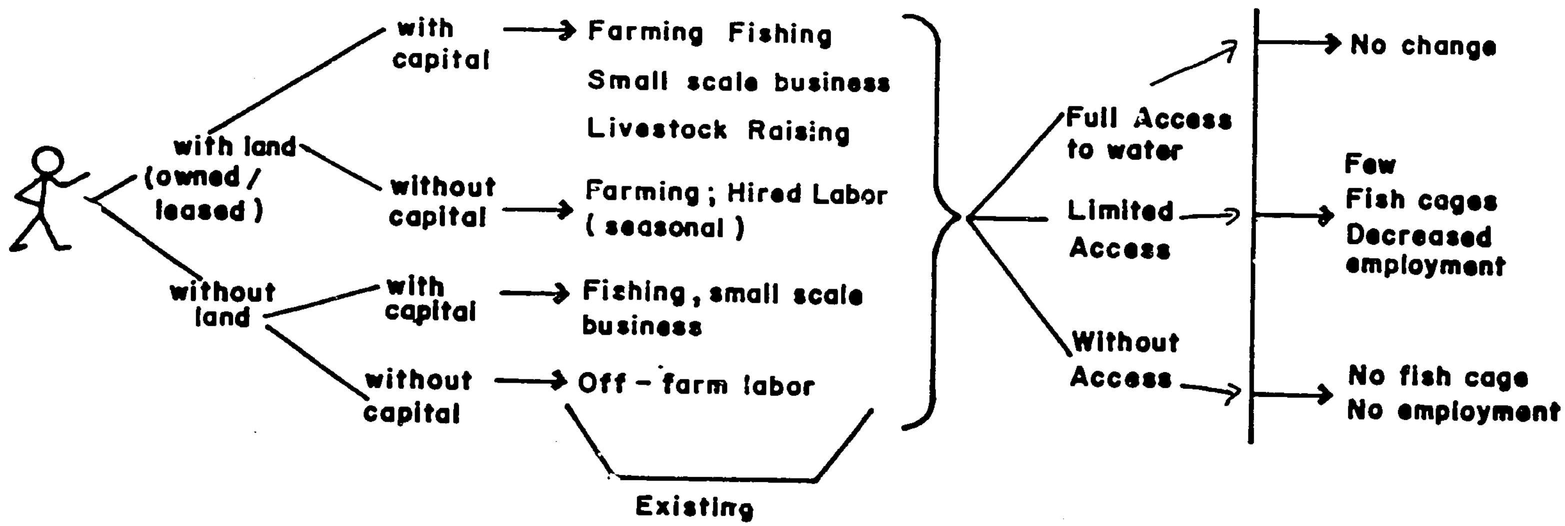


Figure 19. Livelihood Systems

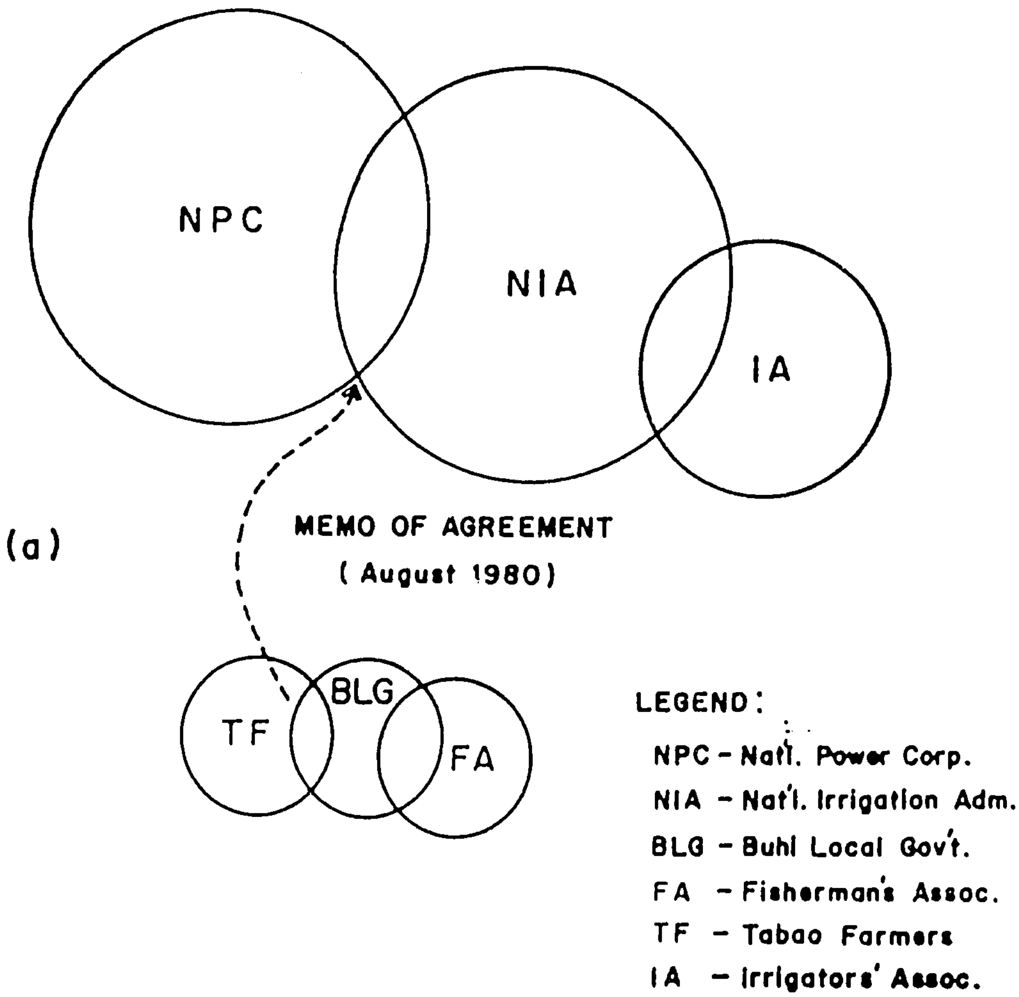
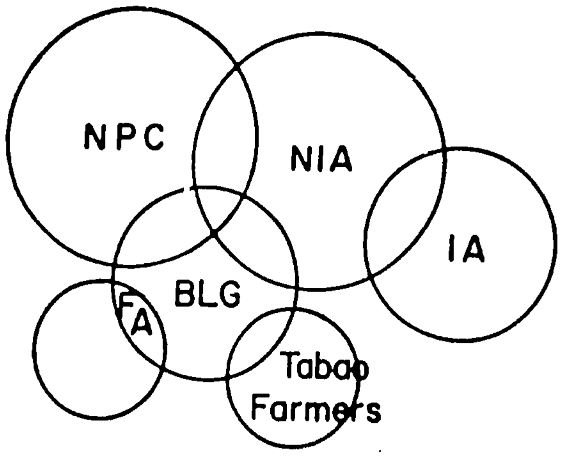


Figure 20. Tabao River Management

(b)



LEGEND:

- NPC – Nat'l. Power Corp.
- NIA – Nat'l. Irrigation Adm.
- BLG – Buhi Local Gov't.
- FA – Fisherman's Assoc.
- TF – Tabao Farmers
- IA – Irrigators' Assoc.

Figure 20. Tabao River Management

4.4 IRRIGATION SERVICE AREA

CORAZON B. LAMUG AND ENRIQUE P. PACARDO

Introduction

Hierarchy

The irrigation service area for water coming from Lake Buhi comprises four zones: Upper Lalo, Lower Lalo, Barit, and the New Area. These areas in turn consist of smaller systems which straddle several towns. The hierarchy of these agroecosystems can be seen in Figure 1. Due to a time constraint, the unit of analysis only covers the Lower Lalo service area hoping that this can be extrapolated to the rest of the Service Area. The map of Lower Lalo is shown in Figure 2 in which the dominant soil types are Iriga clay and Salvacion clay (Figure 3).

Spatial Relationships

Transect

From a transect of the system, four interacting systems can be delineated (Figure 4). Of the four agricultural systems, the productivity of irrigated crops is highest followed by rainfed and upland crops. As to the stability, irrigated areas maybe considered low to medium due to the strong dependence on inputs such as fertilizer and pesticides, the prices of which are increasing. The stability of rainfed farming in Bicol region may also be considered low to medium. The upland agroecosystem, on the other hand, may have medium stability due to the diversity of crops raised.

Temporal Patterns

Seasonal Calendar

The important seasonal factors which strongly influence the performance of the crop are rainfall and sunshine (Figures 5 and 6). Although some deficit is observed in February, March, and April, the Bicol climate as a whole is characterized by the absence of distinct dry season. The mean annual rainfall recorded at Pili, Camarines Sur is 2,500 mm. However, the standard deviation of monthly mean is very high in July and November. A problem may develop when rainfall for these months exceeds the average. Then the wet season rice crop (Figure 7) may be destroyed by flooding.

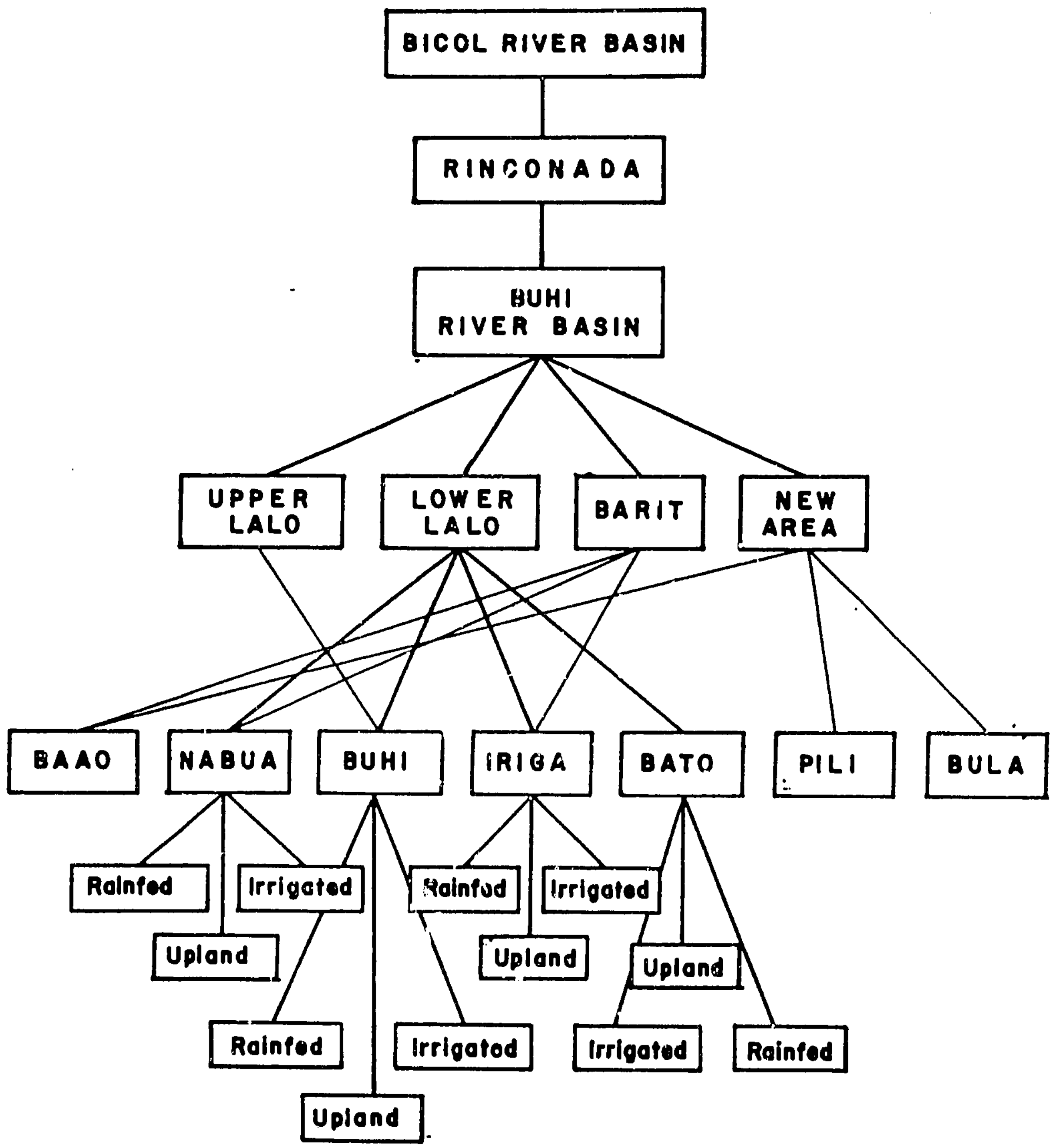


Figure 1. Systems Hierarchy

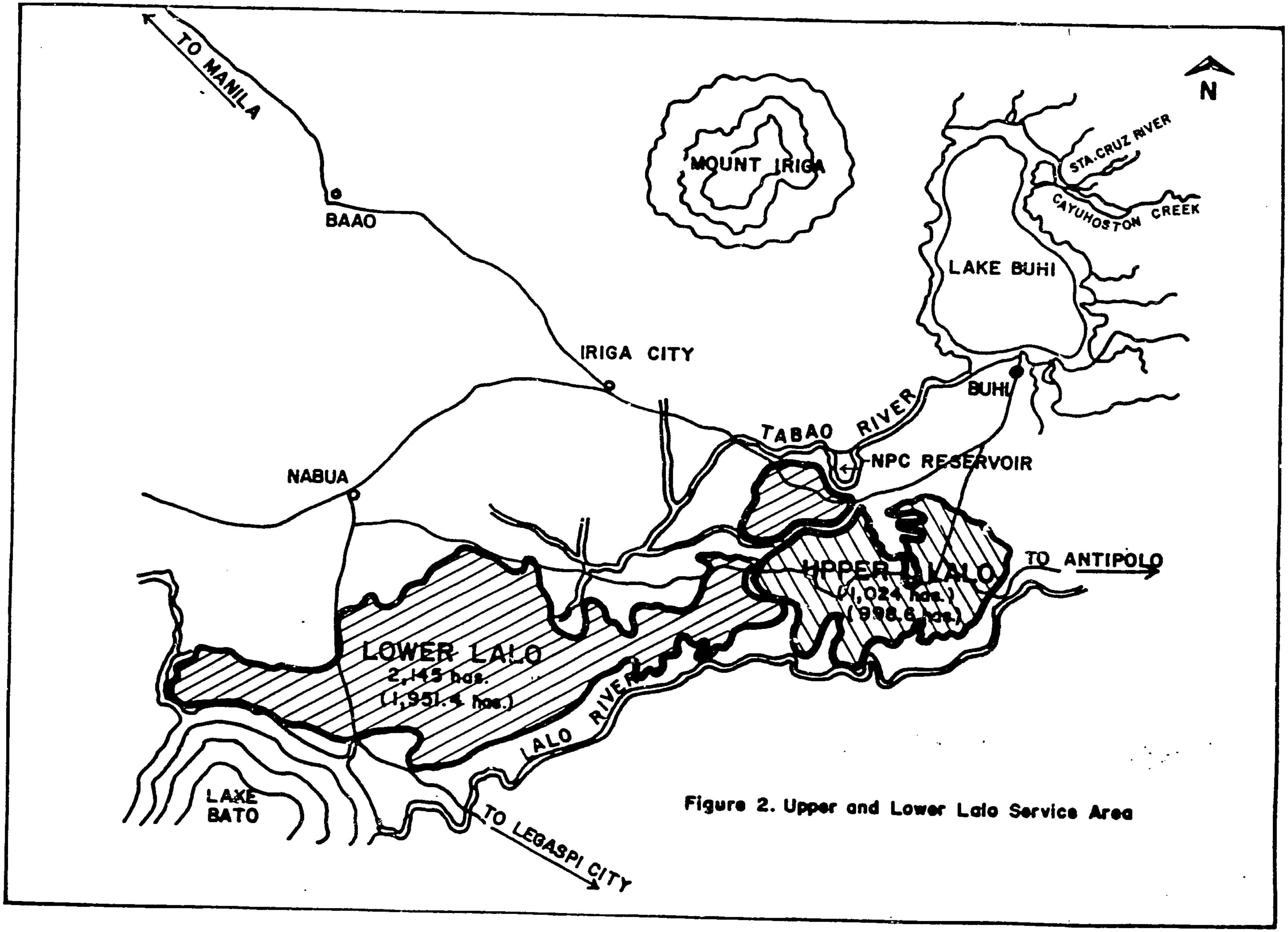


Figure 2. Upper and Lower Lalo Service Area

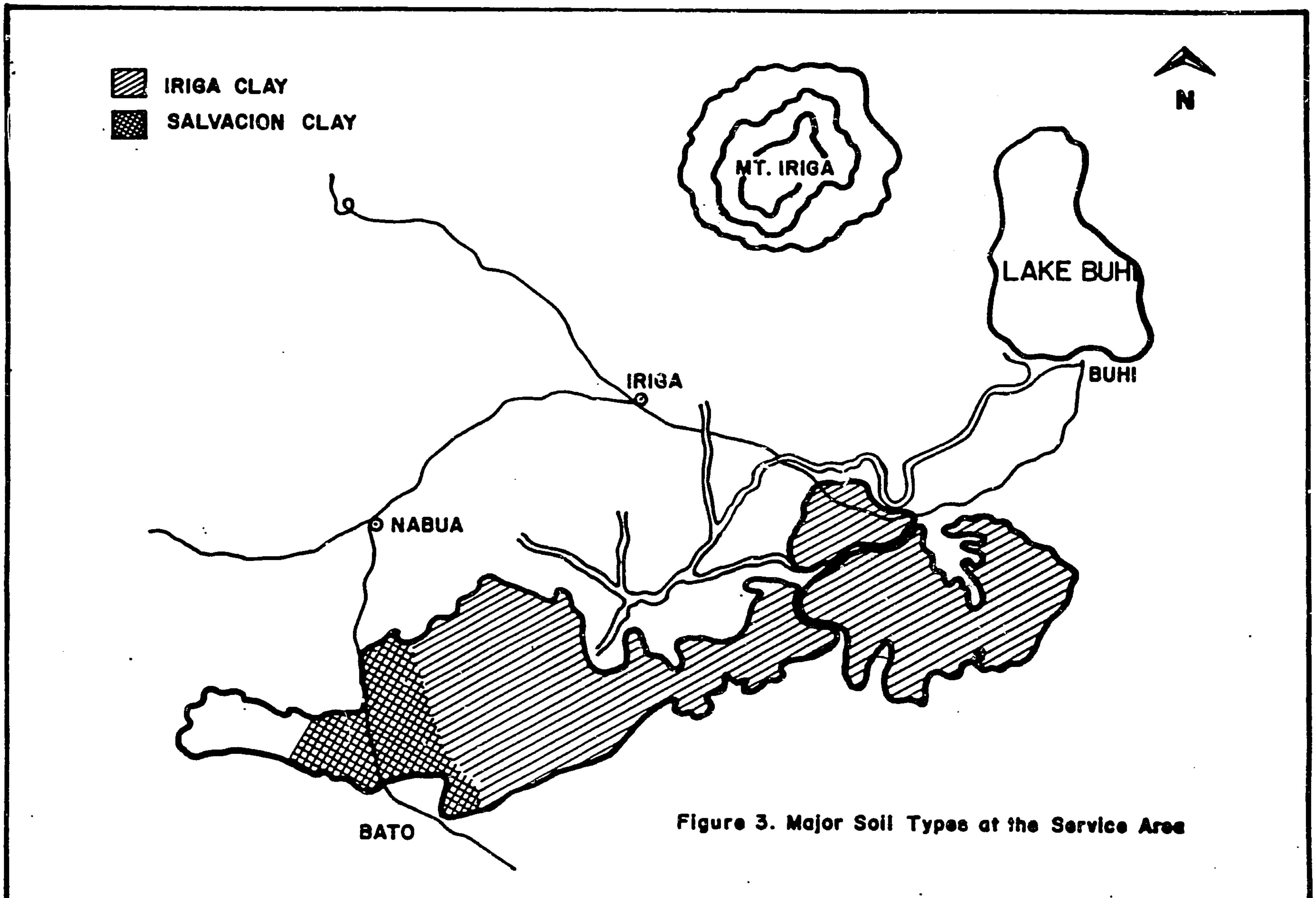
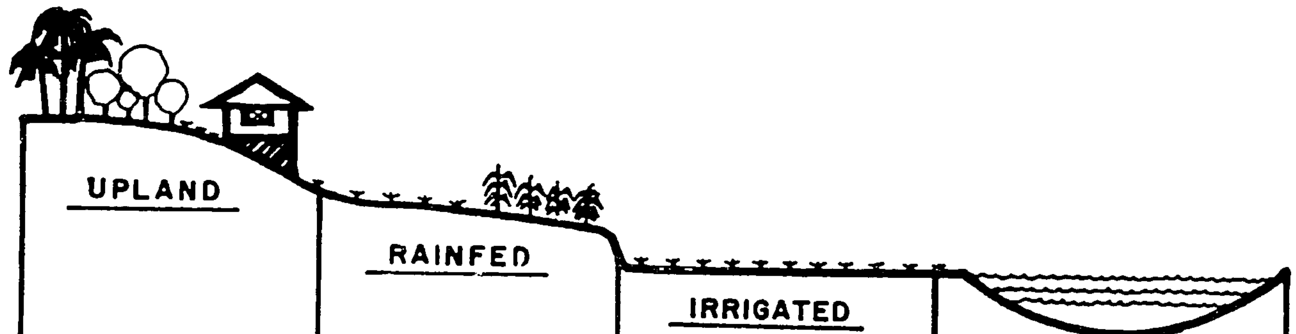


Figure 3. Major Soil Types at the Service Area



	UPLAND	RAINFED	IRRIGATED	LAKE BATO
Slope	1–3 %	0–2 %	0–1 %	
Land/Water	Crops (corn, rice, banana, coconut) Farmhouse Livestock/poultry	Crops (rice, corn) Vegetables ~~Vegetables~~	Crop (rice) Fishing	Fishing Irrigation
Problems	Low rice yield Low coconut price Peace & order	Low yield Pests, weeds diseases High input cost Water stress & order	Flooding Pests, diseases High input cost Drainage Peace & order Water distribution	
Opportunities		Improved cultural management of crops	Water management Organic fertilizer Fishing in inundated areas	

Figure 4. Transect of Service Area

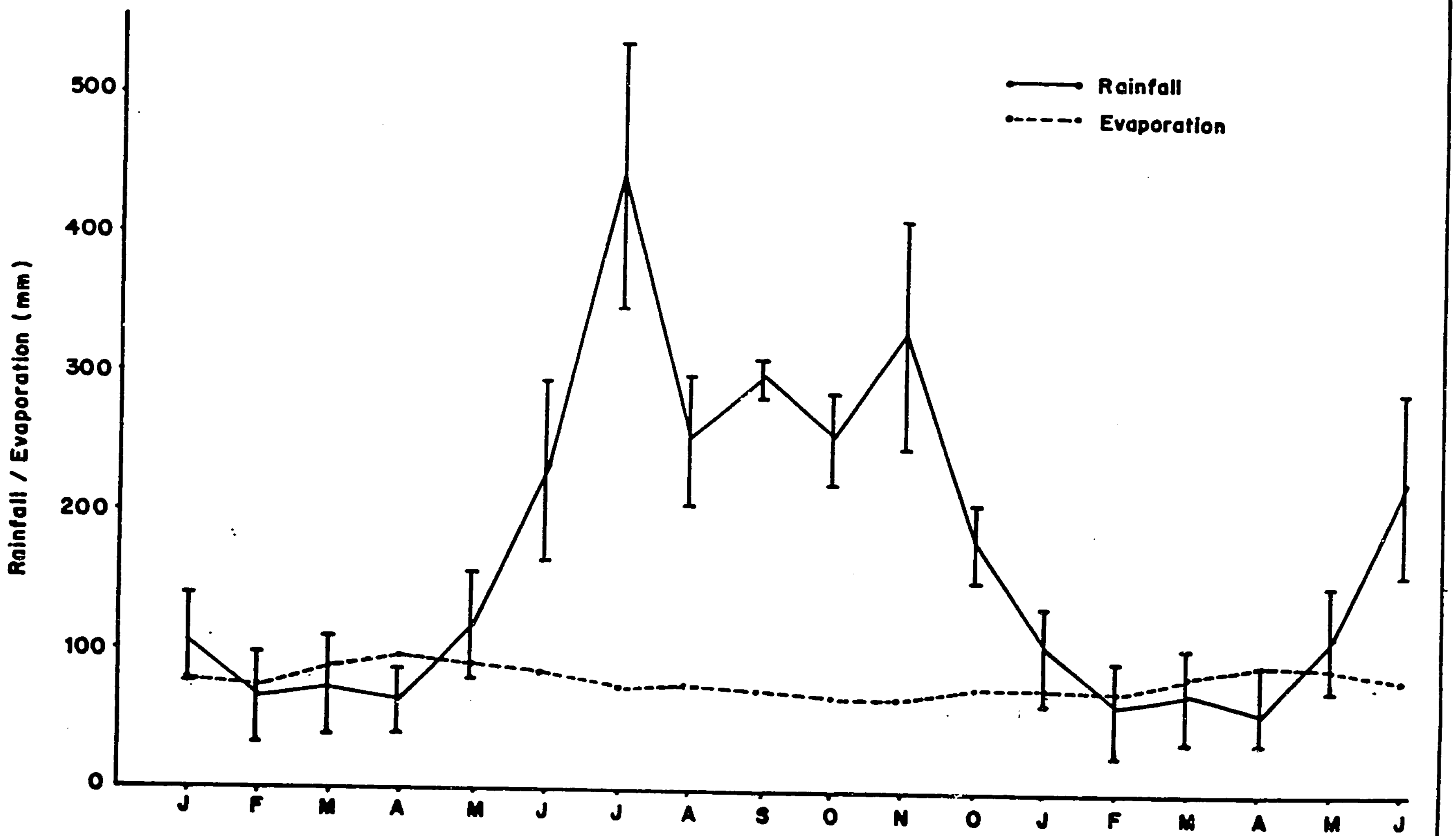


Figure 5. Monthly Rainfall, Evaporation rates at Pili, Camarines Sur.
Vertical lines represent standard error of means.

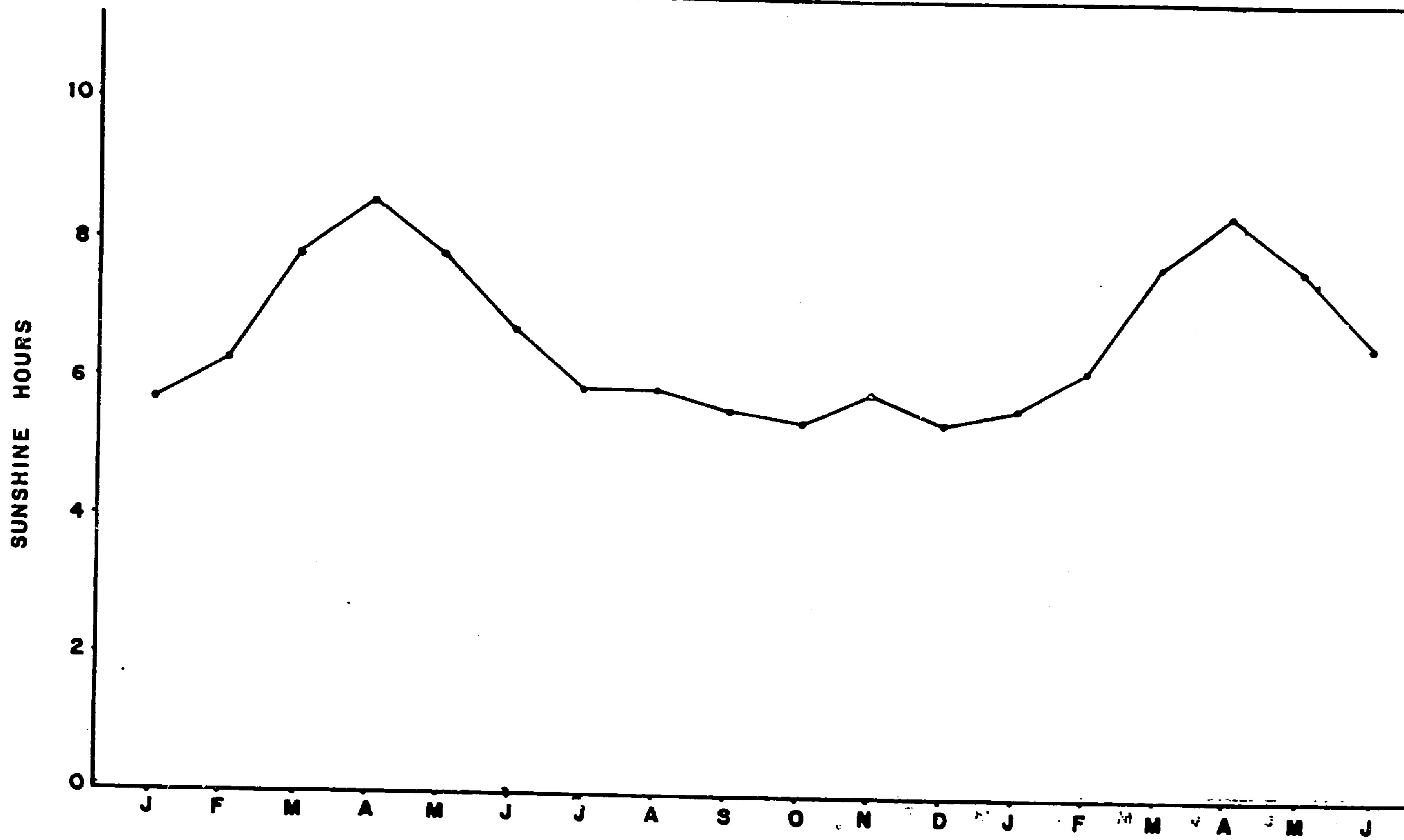


Figure 6. Monthly Distribution of Mean Daily Sunshine Hours Pili, The Bicol Region

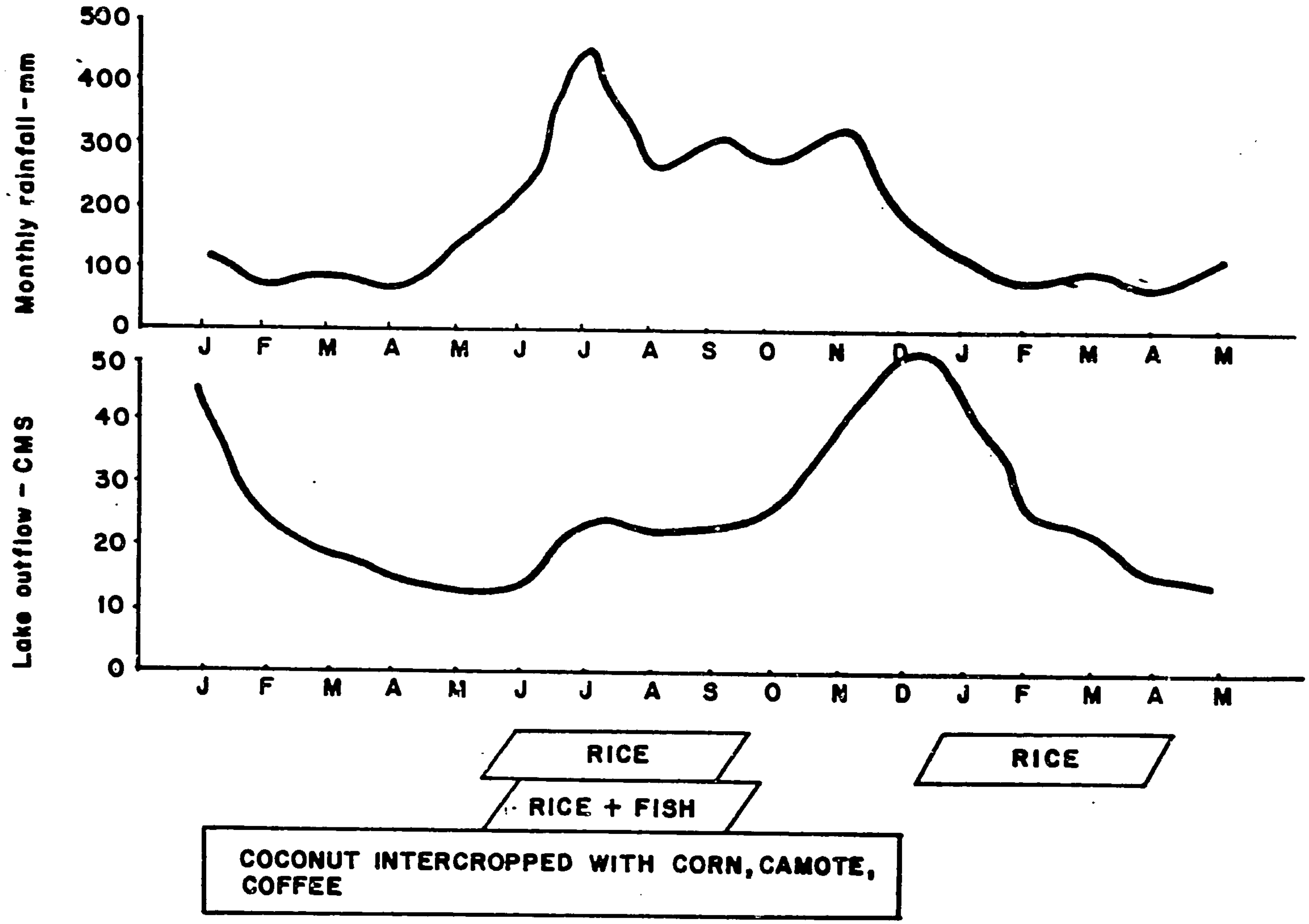


Figure 7. Seasonal Calendar

Rice yield in rainfed (Figure 8) is generally lower than in irrigated areas (Figure 9). However, the latter is still low, at about 60 cavans per hectare (roughly 2.4 t/ha). Considering the fact that high yielding varieties are used (e.g. IR-36, IR-60) the low yield may be attributed to low fertilizer input. Wet and dry season rice crops do not differ very much, suggesting that solar radiation may be another limiting factor due to cloudiness.

The demand for labor is high during the planting and harvesting season and low in between. Labor surplus may exist in the crop intervals (Figure 10) but many farmers take advantage of the break to do some off farm activities.

Flows

Rice Production and Marketing

The flows for irrigated and rainfed rice are presented in Figures 11 and 12. The estimated costs of production are also given. Farmers spend more on seeds in rainfed compared to irrigated farms. This is due to the difference in planting method. In rainfed farms, two methods are used: the "dapog" method (broadcast) and the direct seeding method. Together these two require more seeds compared to the sole use of "dapog" method in irrigated farms.

There is also a significant difference between the two farms in the amount spent on fertilizer, insecticide, and herbicide. It seems that farmers invest more money on crop maintenance of irrigated rice compared to rainfed rice. It is also surprising that net return from irrigated rice is more than triple that of the rainfed rice.

The flow of rice produced in irrigated and rainfed differs slightly. Two-thirds of the produce in the former is sold compared to 44% in the latter.

Impact of Irrigation Water

The supply of irrigation water is dependent on a number of factors such as rainfall, inflow from local sources, the watershed condition and decisions on lake water utilization. Adequate supply, in turn, affects rice productivity and ultimately the farmers' income, social processes like cooperation and conflict regarding water distribution and the opportunity to enhance the organizational capability of irrigator's association (Figure 13).

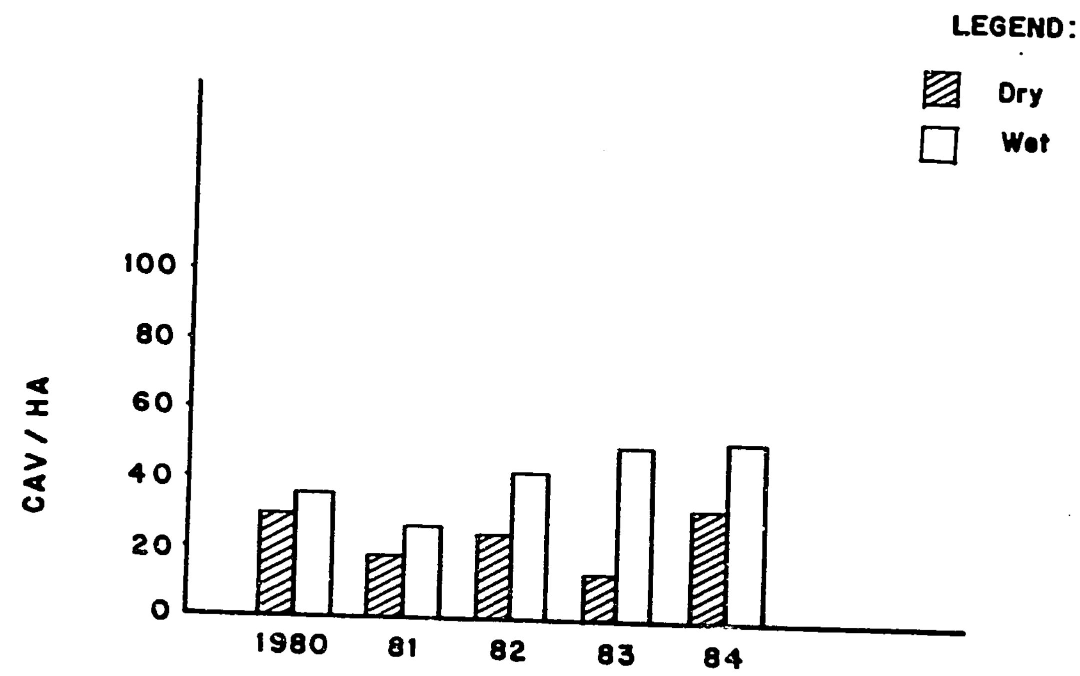


Figure 8. Rice yield in rainfed areas

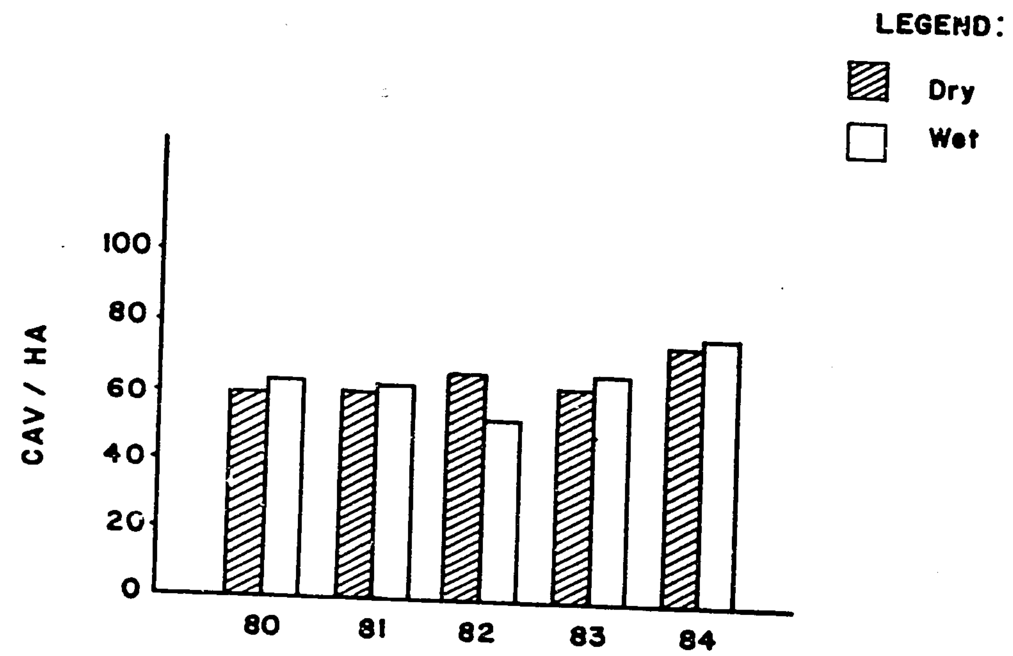


Figure 9. Rice yield in irrigated areas

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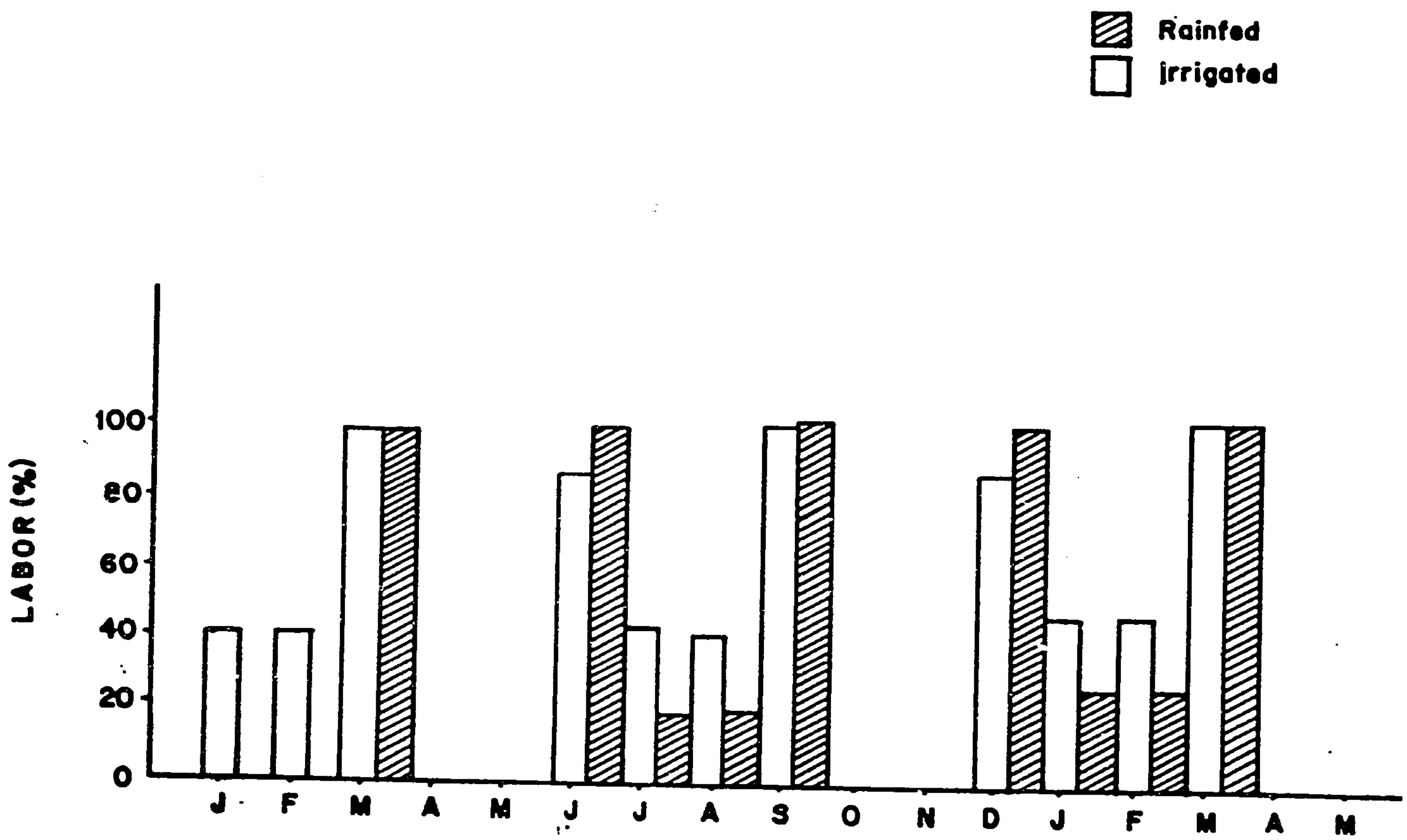

Figure 10. Seasonal Labor Calendar

Bottom diagram simply repeats top figures? Add in percentage

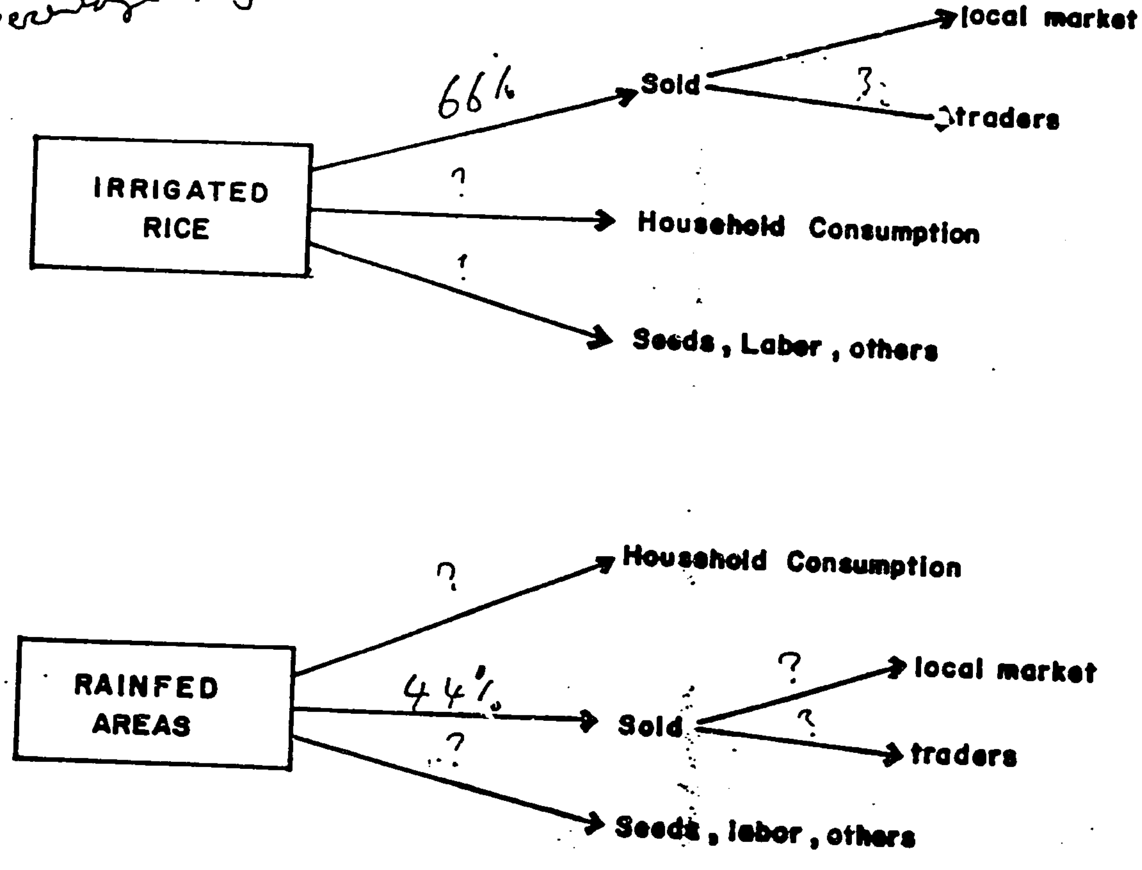

Figure 11. Rice Flow: Rainfed and Irrigated

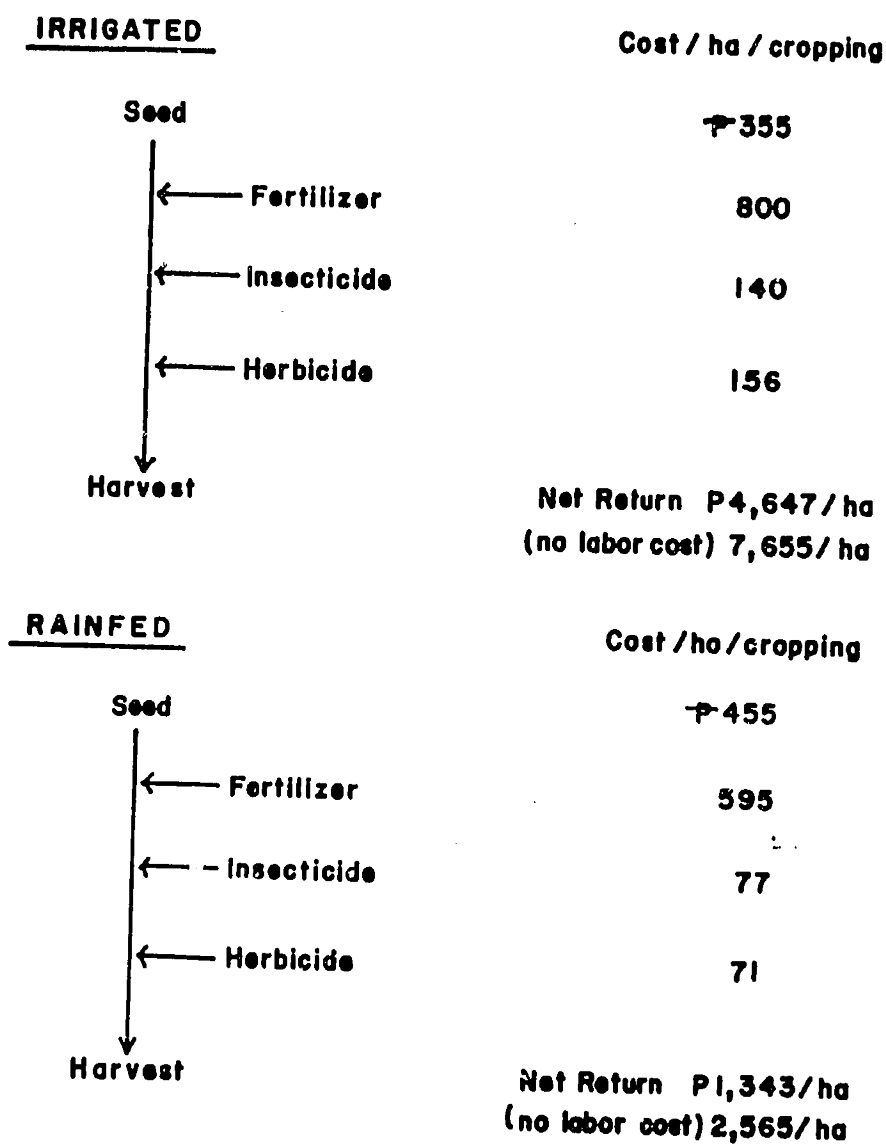

Figure 12. Production Flow for Irrigated and Rainfed Rice

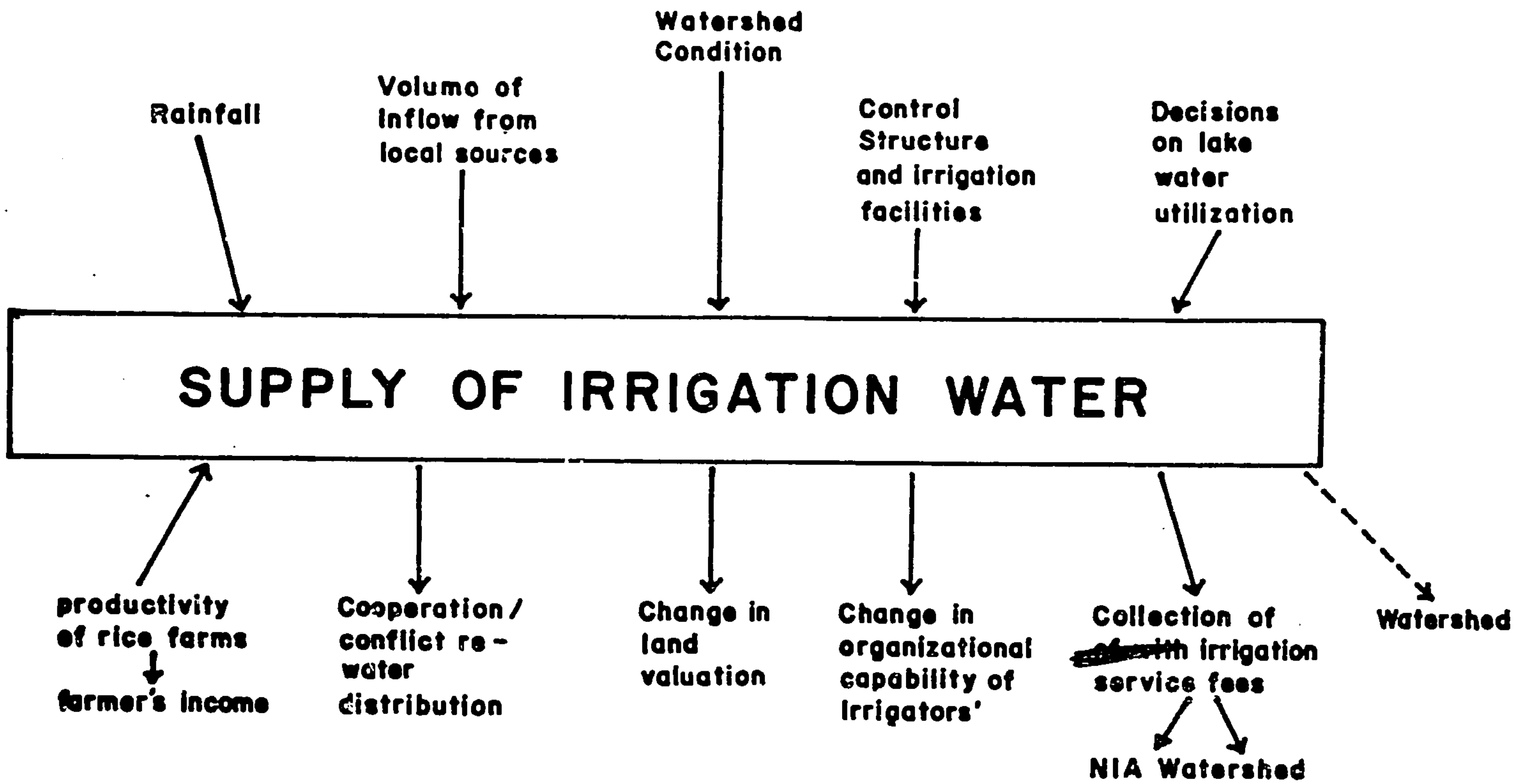

Figure ~~47~~ 13 Impact Flow of Water Supply

Decisions

Decision Tree

The primary source of household income is farming. This includes the production of annual and perennial crops as well as livestock and poultry. Seventy-five percent of household income is derived from this source.

The cropping system varies by types of farm. There are two croppings per year on irrigated and rainfed farms while in the upland farms are grown perennial crops mixed with rootcrops and sometimes sugarcane (Figure 14).

Secondary income is derived from employment, business, fishing and cottage industries. The decision to engage in these endeavors is a function of such factors as possession of skills, opportunities, market and availability of capital (Figure 15)

Water Allocation

The decision on how to allocate water supply for the irrigation of rice farms is arrived at through the interaction of different social entities. The NIA together with the Irrigators Association (IA) decides on the volume and timing of water to be released (Figure 16)

This is based on the water requirements of the farmer's rice crops which in turn is estimated with some technical assistance of MAF. The local government, through barangay officials, assists NIA and the IAs enforcing operating guidelines and mediates between parties when there are disputes over water allocation. NPC has a fairly stable water requirement. While it has to agree with NIA on how its requirement is to be supplied, it does not directly participate in decision making regarding water allocation for irrigation of rice farms.

System Properties

The variables affecting system properties are shown in Table 1.

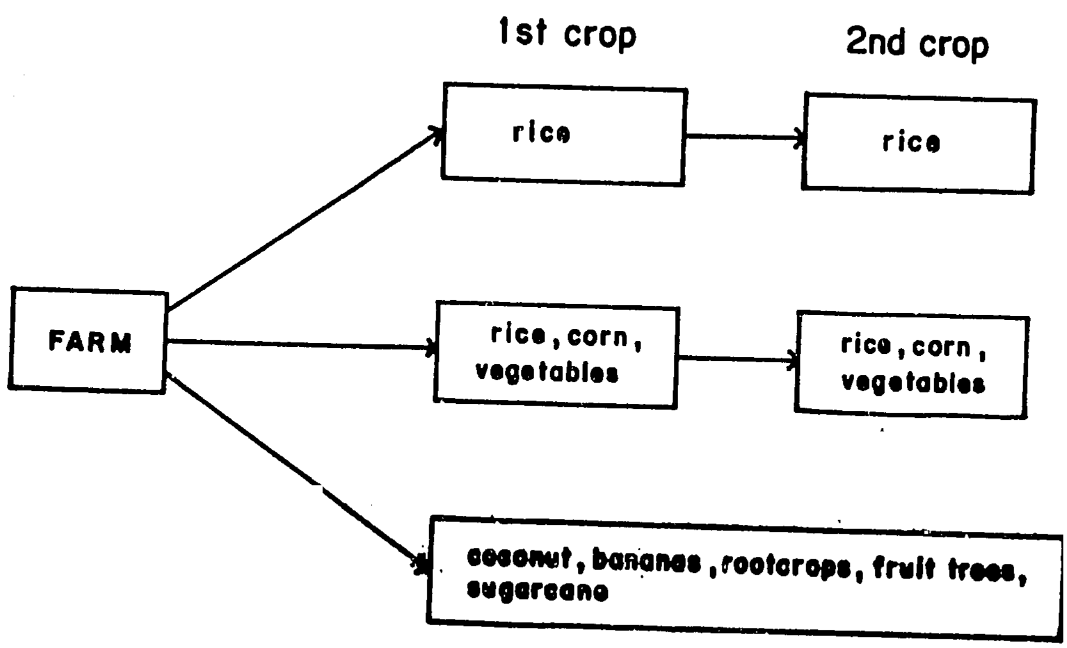

Figure 14 Decision Tree for Cropping Systems

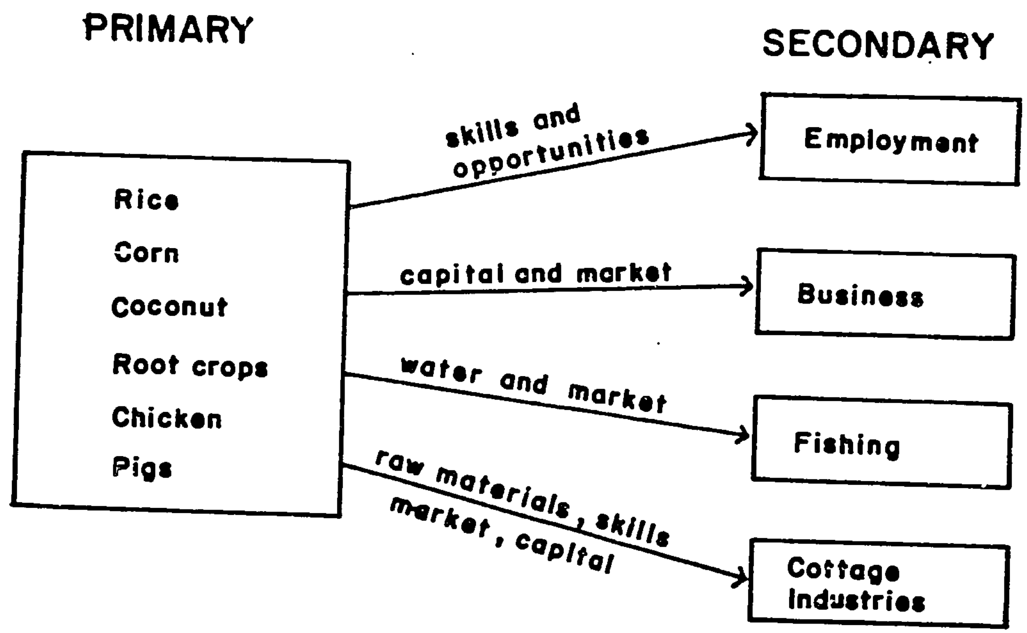

Figure 15. Decision Tree for Livelihood Systems

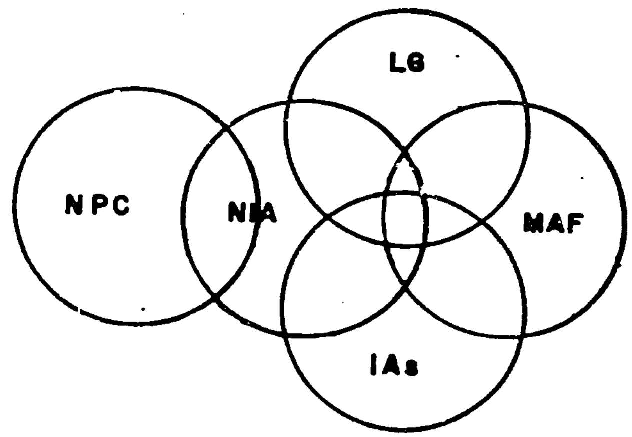

Figure 16. Venn diagram on water supply decision in service area

Table 1 VARIABLES AFFECTING SYSTEM PROPERTIES

+ ve	- ve
PRODUCTIVITY	
- Irrigation	- Inadequate farm inputs
- Farm inputs	- Poor farm drainage
- HYV, Fertilizer, Pesticides	- Improper cultural management
- Better cultural management	- Pests, disease
	- Typhoon, flood
STABILITY	
- Rice varieties	- Pest, disease
Resistance to some pests and diseases or water stress	- Typhoon
SUSTAINABILITY	
- Organic fertilizer	- Increasing acidity of soil
	- Changes in soil structure and nutrient composition due to continuous use of chemicals and continuous cropping
EQUITABILITY	
- Proper water management with participation of IAs	- Improper water management leading to inequitable water distribution
- Farm to market roads	- Poor irrigation facilities especially those servicing remote farms.
- Improvement of irrigation	- Transport problems for remote farms

4.5 THE BUHI SYSTEM

PERCY E. SAJISE, GORDON R. CONWAY AND
CORAZON B. LAMUG

This portion of the agroecosystem analysis examines the dominant properties and interactions of the whole Buhi System; the upper portion of the watershed, the lake area, the Tabao area, and the service area.

Socio-Economic Status

Population Composition and Changes

The population of Buhi municipality as of 1980 is 48,625. Figure 1 presents the recorded population from 1918 to 1980. The growth of the population over the immediate past two decades has been relatively constant with an annual growth rate of 1.019%.

Buhi is a net out-migration area, i.e., more people leave than come to settle in the municipality. Data on origin of the population in 1980 show that 98% of the population resided in the same municipality in 1975. Estimates for the Rinconada region reveal age and sex selectivity in out-migration. Annual female out-migration (1.2%) exceeds that for males (0.86%). Male out-migration is most likely to occur among those in the 15-29 age bracket, while that for females in the 20-34 age bracket. Almost half (47%) of the migrants move to Metro Manila and other Luzon provinces. A significant intra-region (Bicol region) migration (40%) also takes place. Barangay leaders give economic factors as the main reason for out-migration. There are few job opportunities and livelihood activities to attract people to settle in the area. In-migration does occur but its magnitude is very low.

The population of Buhi is distributed among 38 barangays, six of which are in the poblacion. The shaded areas in Figure 2 are barangays with large populations (exceeding 1,600). Sta. Justina has the largest population (3,426) while Divino Rostro has the smallest (353).

Over three-quarters (77.7%) of the local population resides in rural areas. The rural population consists of 51.5% males and 48.5% females while the urban population has 48% males and 51.4% females (Figure 3). Rural households have an average of six members while urban households have eight. There are approximately 139 persons/km2 in rural barangays.

The population is relatively young with about 59% below 19 years of age. Thirty eight percent of the population is of school age. About one-third of this category is in the primary level.

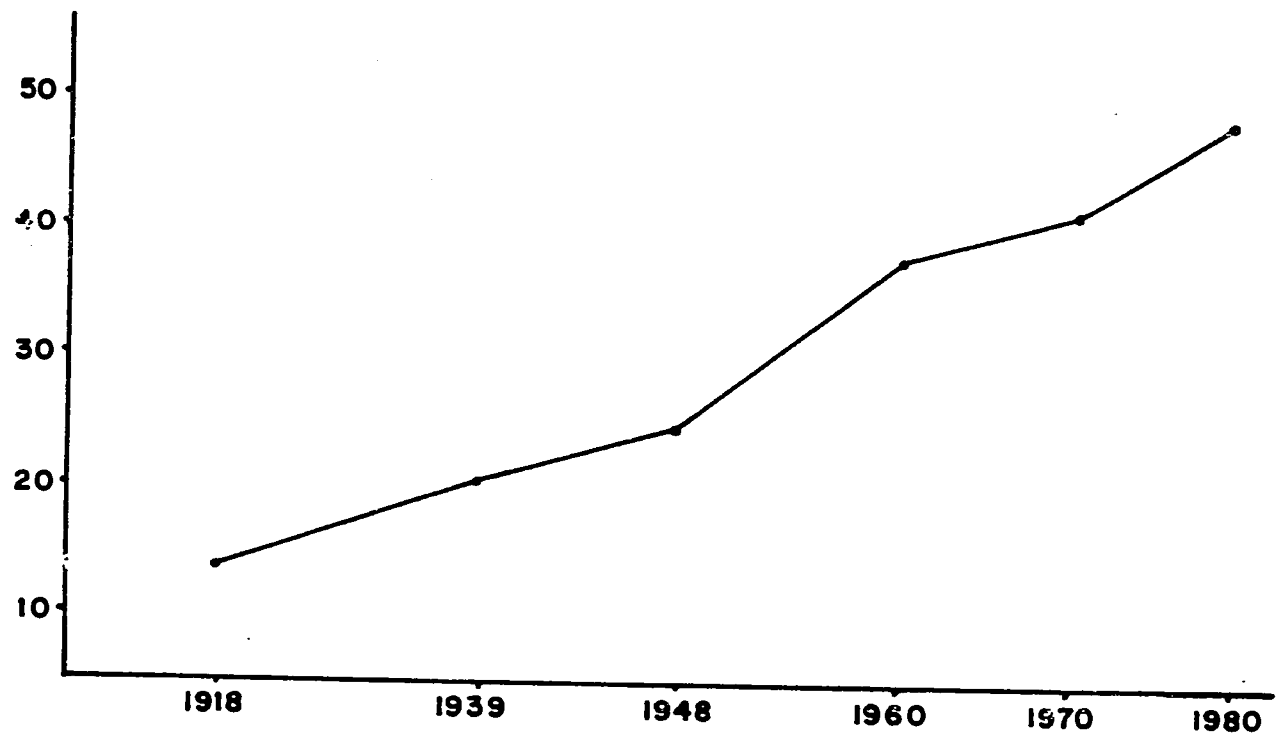

Figure 1. Population Growth, Municipality of Buhi.
Source: NCSO, 1980

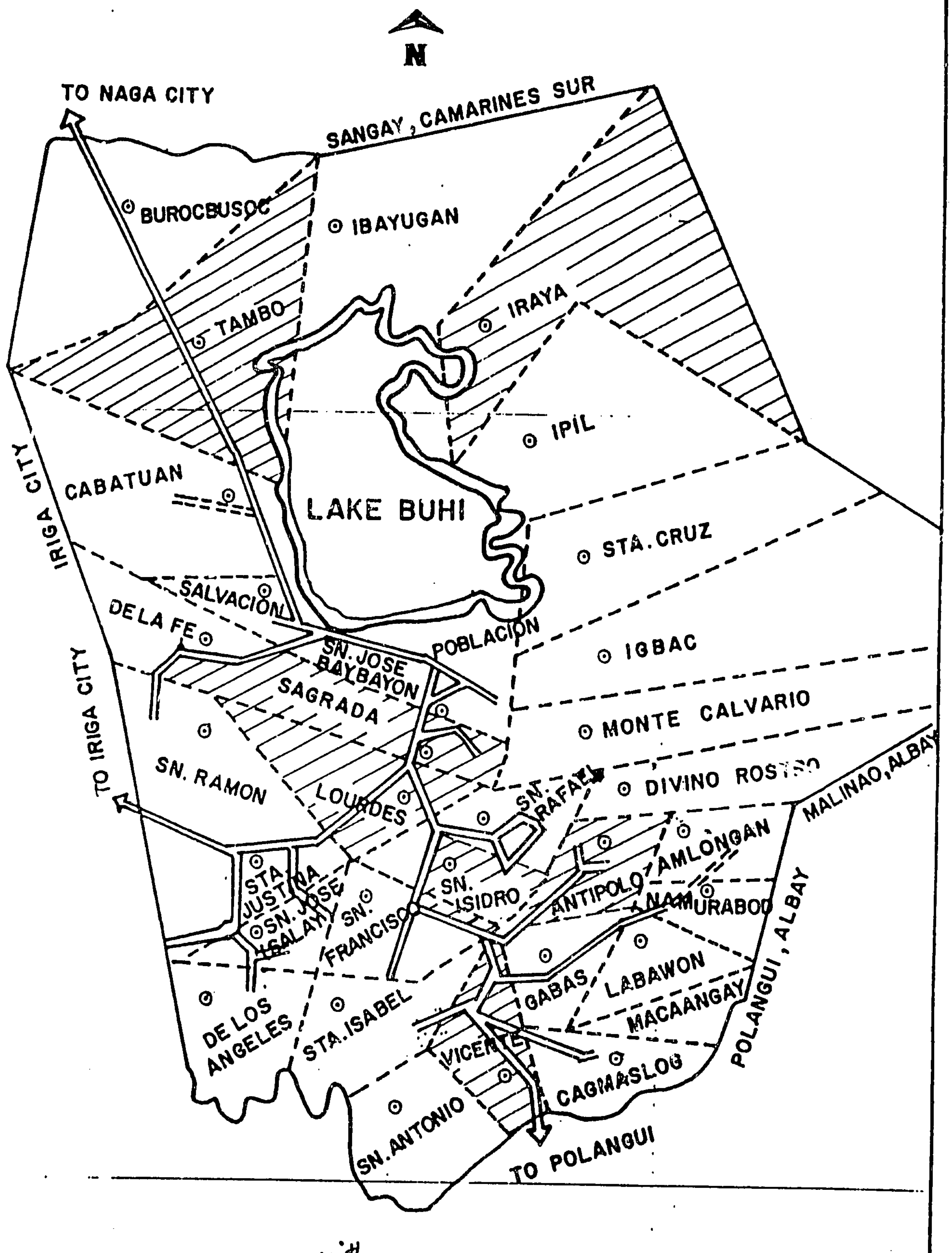

Figure 2. Barangays with relatively large populations (exceeding 1,600)

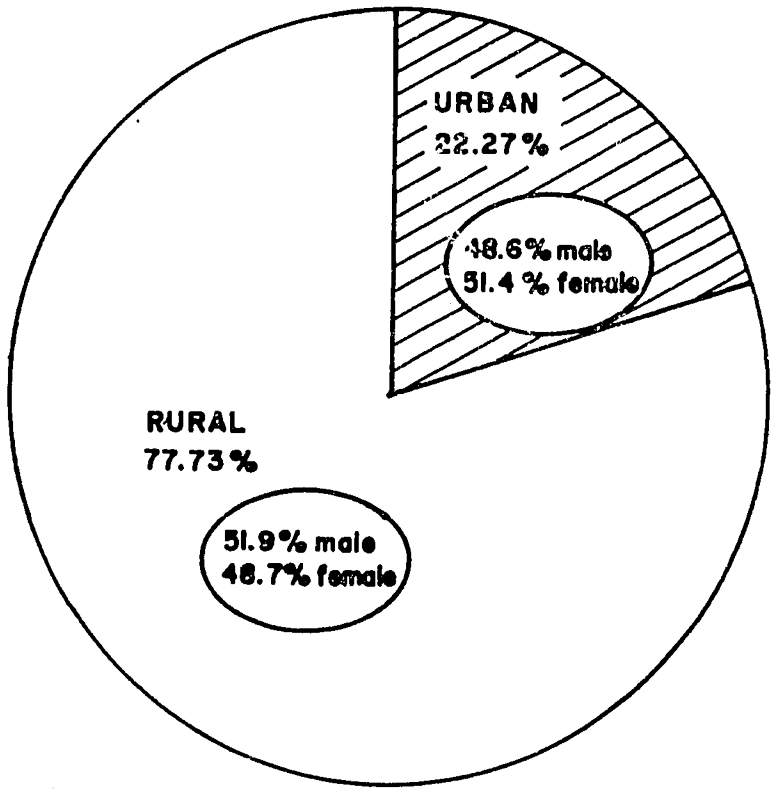

Figure 3. Rural/Urban population by sex, 1980
Source: NCSO

Buhi has its own dialect. About 95% of the local people speak Bicol. They also understand English and Tagalog. A few barangays in Buhi like San Ramon, Iraya and Ipil contain Agta communities.

Labor Force, Employment and Income

The 10-64 age group may be considered the potential labor force. The 1980 data show that 30,823 or 63% of the total population belongs to this category. There is, however, a wide discrepancy between the potential and actual labor force. Only 15,710 or 32% of the population was economically active. The economically active population of Buhi is engaged mainly in farming, fishing, and business. About 5% earn salary from private or government agencies and offices. No data are available on unemployment rate. The age-dependency is high. This is a ratio of the non-productive population (under 10 years old and over 65) to the productive age group (10 to 65 years). Every worker supports three dependents. However, if the unemployed are included among those dependent on the employed, regardless of age, then the effective dependency ratio is be higher.

The Philippine Government uses an annual household income of ₱3,000 as a poverty line. Using this criterion, 78% of the Rinconada population is below the poverty line. On this income, it is very difficult to have adequate access to basic needs. In addition, the growth of more effective demand for inputs to a more productive agriculture and for overall goods and services is hindered.

Income figures for Buhi are not available : but informants estimate that the proportion of population earning below the poverty line is close to that of Rinconada. One informant estimated that lakeside barangays have relatively higher income compared to upland barangays because residents in the former engage in both fishing and farming while those in the latter are limited to farming.

Amenities and Basic Services

Education: There are 32 elementary schools in 28 barangays in Buhi. Three barangays each have a barangay high school and the poblacion has three private high schools. Second non-formal education programs are available in Buhi.

The Public Schools District reports a total of 285 classrooms for the elementary level and a student-classroom ratio of 36:1. At the secondary level there is an estimated total of 143 classrooms. The estimated number of teachers is 167 for primary and 89 for intermediate levels. The student-teacher ratio is 38:1 for the former and 32:1 for the latter. For the secondary level, the number of teachers is 143 and the student-teacher ratio is 35:1.

Most of the elementary schools lack facilities. Except for the two central schools, all barangay elementary schools have no libraries. Only five schools have medical/dental clinics. The three barangay high schools use the facilities of their respective elementary schools.

Non-formal education programs have adults as their target popuation. Most projects are designed to develop skills for livelihood activities and to reduce illiteracy.

Health Services: The health facilities in Buhi include three private clinics. a private hospital, a rural health unit and a barangay health station. The rural health unit operates using the services of a physician, two nurses, and aides. The barangay health station has a nurse, 14 medical assistants and a barangay health administrator.

Water supply: This is a major problem in Buhi. With the exception of a few who have deep wells, the population relies on hand pumps, wells, springs and rainfall for their water needs.

Adequate nutrition is the most basic need of all. Of the 15,022 preschool and school children weighed through "Operation Timbang", 80% are in various degrees of malnourishment. Among the barangays with the highest proportion of malnourished children are De Los Angeles, Divino Rostro, Sta. Cruz, Gabos, Namurabod and several northwestern upland barangays (Figure 4) where corn-growing and soil erosion is prevalent.

The leading causes of morbidity and mortality are pneumonia, coronary thrombosis, a gastro-intestinal disorders and asphyxia neonatum. A family planning survey conducted in 1978 revealed a low proportion (10%) of respondents who use artificial means of birth control.

Protective Services: The 32-man local Integrated National Police Force is responsible for maintaining peace and order and enforcing the laws of the land. The policeman/population ratio is 1:1,519. The entire police force has only one patrol car and a motor boat. Its headquarters in the annex muncipal building is small. Assisting the police force is a PC detachment and the Integrated Civilian Home Defence Force. In addition, there is a Tanod Brigade for every barangay.

Quite unusual is the high murder rate in the muncipality. Forty percent of crimes committed are murder, 25% assault and physical injuries, 20% theft and robbery and 15% other petty crimes. An informant attributes the high murder rate to the operation of subversive elements in the municipality.

Physical Services: Utilities, communication, transportation and electricity are available in 14 of the 38 barangays (Figure 5). Of the 3,764 households in these 14 barangays, only 44% have electricity. A quarter of the households in Buhi use kerosene for lighting, only 18% use electricity.

There is no domestic water system in Buhi. Only five barangays have piped water system. The rest of the population rely on shallow wells, springs, and hand pumps for their water supply.

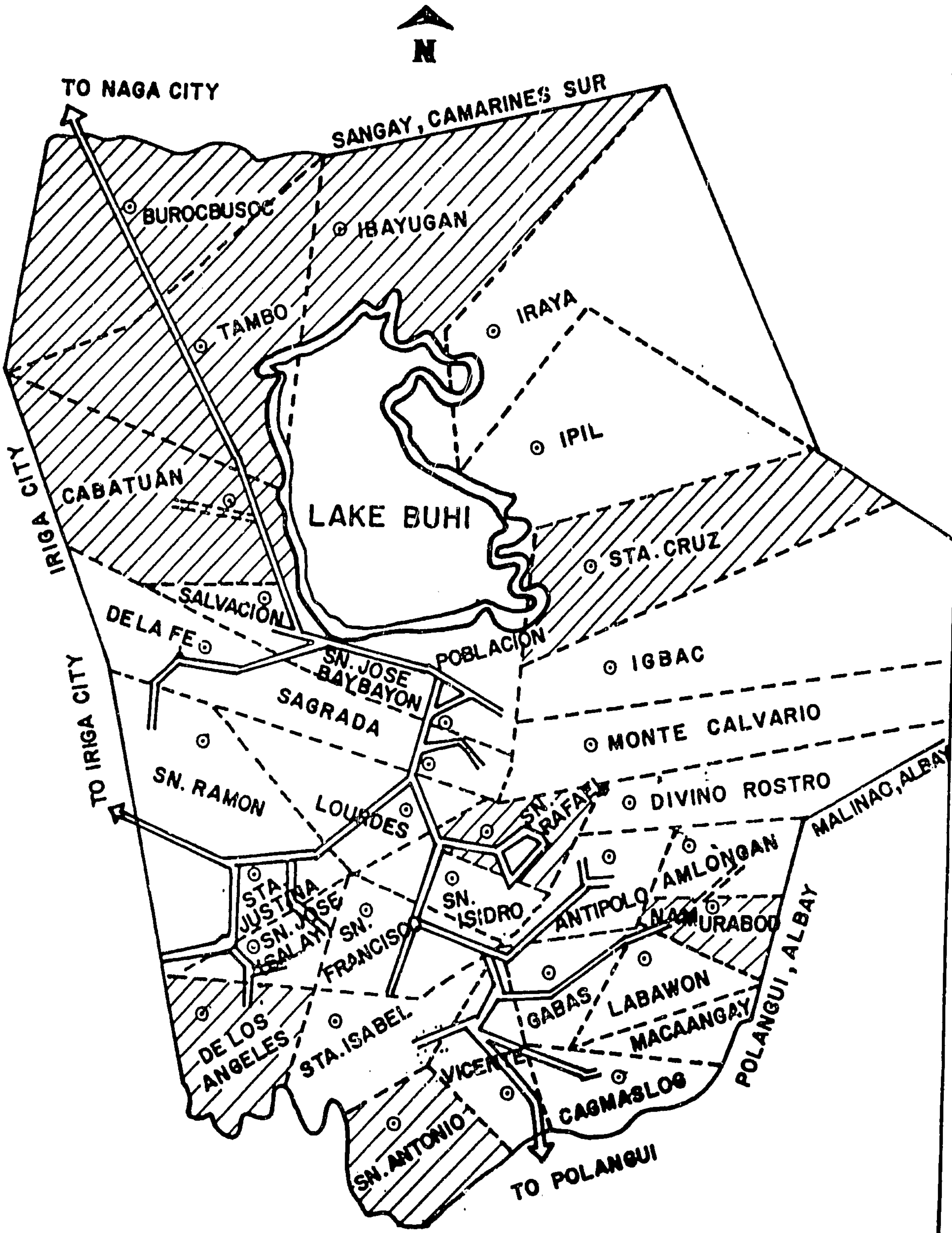

Figure 4. Barangays with relatively higher proportion of malnourished children.

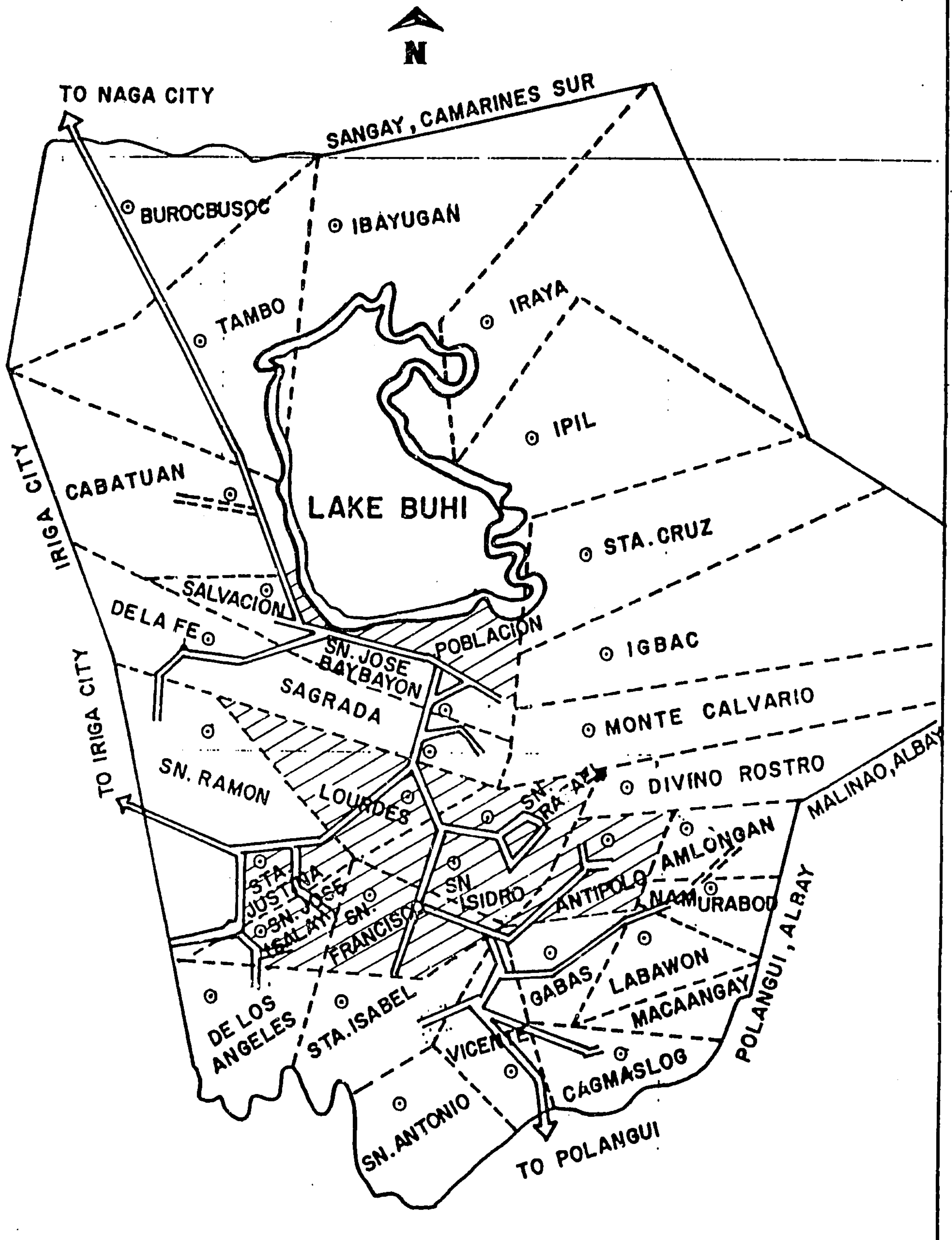

Figure 5. Barangays with electrical power service

Communication is facilitated by the existence of telecommunication facilities, postal facilities, print media and the radio. In 1980 there was a total of 90 telephone sets, 87 of which were in the poblacion. There are two telegraph stations. The one that is privately-owned has three telegraphic carriers while the government-owned one has none. The post office has four letter carriers for the entire municipality.

The major road in Buhi is the Buhi-Iriga road. Barangays within the poblacion and around the lake are accessible by road. Some barangays have graded trails while others can only be reached by foot paths. There is a total of 125 km of public roads in the municipality. Jeepneys and tricycles are the primary mode of transportation. A few buses make regular trips to Manila.

Social Equity

The BRBDP indicator of income distribution (Figure 6) shows that there was no improvement of equitability during the period 1978-1983.

System Transect

Generally, the Buhi System can be divided into upland zone, the lake zone, the Tabao area and the service area. The upland zone can still be divided further into the fishing-farming zone, which is the zone roughly within 2 kms. of the waterline, and the forest-kaingin area in the upper slopes (Figure 7).

The areas covered by both the upland and service area zones are the biggest (11,000 and 10,503 hectares respectively). The area covered by the lake is not known precisely (1,345-4,000 hectares) and needs to be ascertained. The Tabao area is the smallest among the different zones. In terms of population, the number of households in the upland and service area is also the biggest compared with the two other zones. Based on net annual income, the households located in the uplands are the lowest, followed by those in the service area zone, especially those households in the rainfed portions of the service area. Higher incomes were noted among the households in the fishing-farming zone.

There is less security of land tenure for occupants of the upland and Tabao zone and the level of government intervention is inversely proportional to the distance from the government center service area. The upland has the least degree of government intervention in terms of delivery of support services and implementation of rules and regulation regarding resource utilization. Peace and order is also less stable or more disturbed in zones located at both ends of the transect (upland and service area).

The combined socio-cultural parameters indicate the more critical situation of both the upland and service area zones,

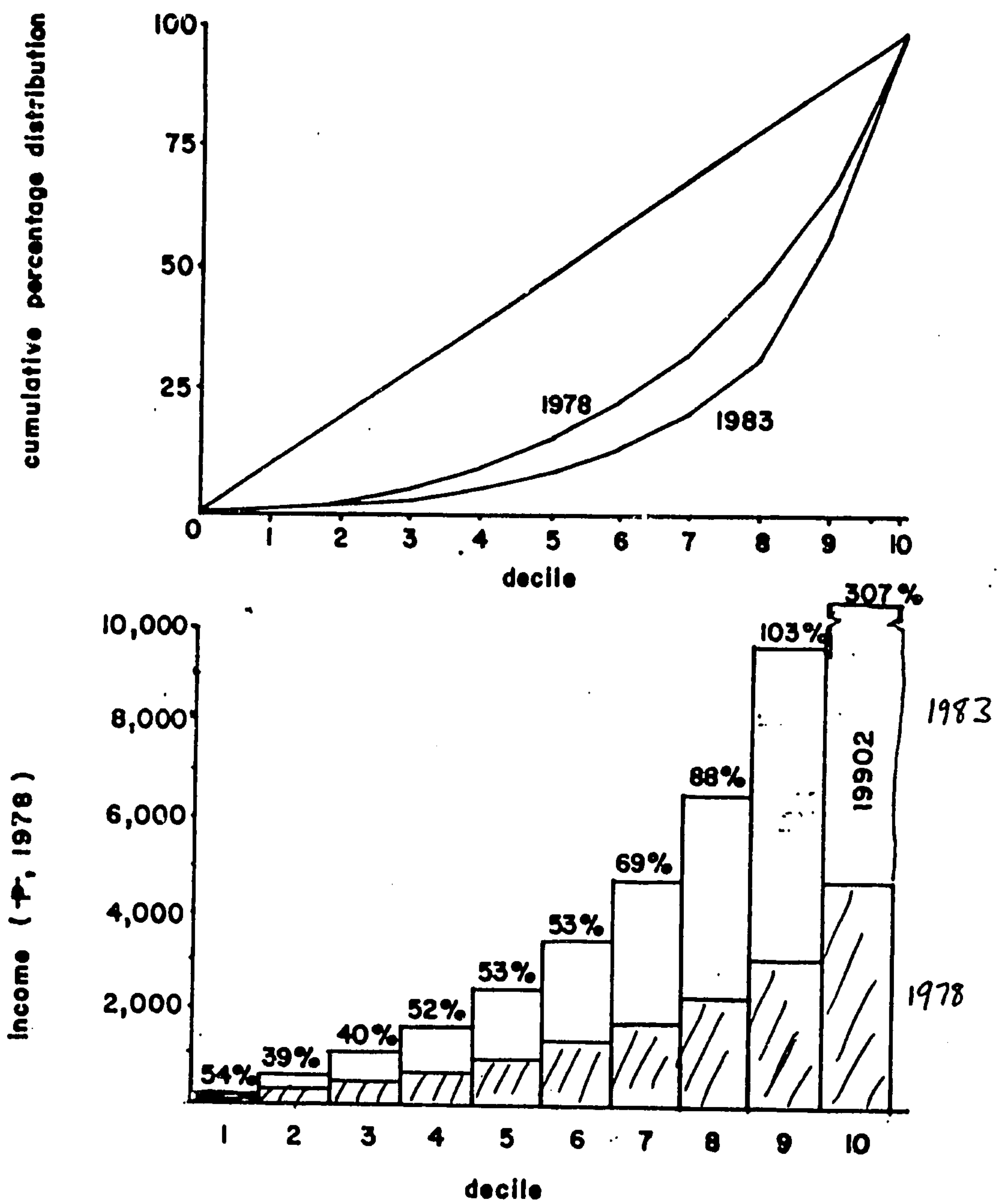

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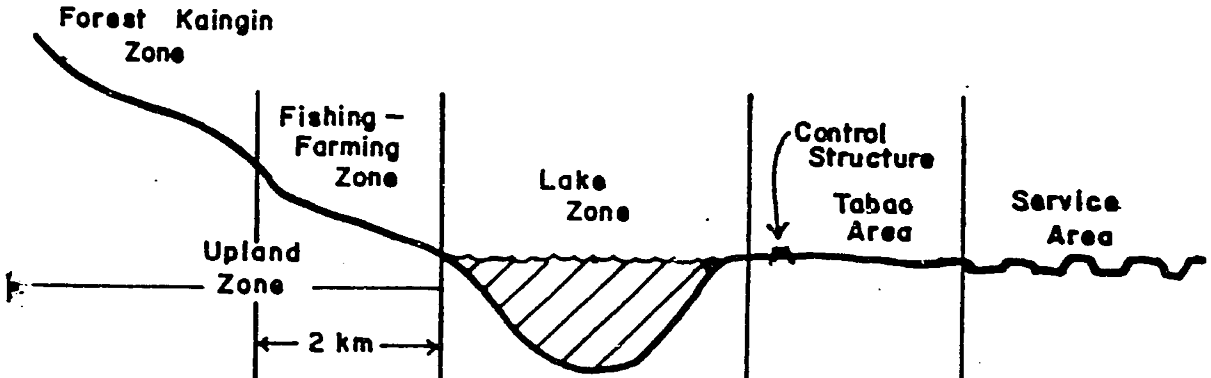
FIGURE 6. Indicator of Income Distribution (Ref)



Socio - Cultural

	Upland Zone	Fishing – Farming Zone	Lake Zone	Tabao Area	Service Area (Rainfed)	Service Area (Irrigated)
Area (ha.) Coverage	11,000		1345, 1500, 1800 ?	100	3169 (Present) 10,000 (Projected)	
Population	1548		700 - Capture F 556 - Fish Cage O	200	1781	
Net Income (₱/ha)	Very Low (-₱504 (AW)) ?	High (₱4769 - ₱21,000)		Medium (₱3460)	Rainfed (₱1343 (k)/ha) ?	Irrigated (₱4647 (k)/ha) ?
Securing of Land Tenure	Insecure	Partially Secure	Secure	Partially Secure	Secure	Secure
Levels of Gov't Intervention	Low	Medium		High	High	
Peace & Order Situation	Inception Stage	None Yet		None Yet	Problem	

FIGURE 7. Buhi Watershed System Transect

based on area coverage, numbers of households involved, and levels of income. In these zones, there are more households affected, the influence area is bigger, and income levels are low. There is insecurity of land tenure especially in the upland which may have been the cause of the peace and order problems in these zones. The Tabao, lake and farming-fishing zones are socio-culturally more stable, but may also deteriorate if problems with the present control structure will not be solved.

The different zones in the transect can also be analyzed in terms of the ecosystem properties of productivity, stability and sustainability before and after the control structure was built. There is no change in the ecosystem properties for the forest-kaingin portion of the upland zone. However, the change from a low to a high productivity, stability, and sustainability of the irrigated portion of the service area is a force that is changing the properties of the forest-kaingin, lake and Tabao zones. The general objective must be to maintain the overall productivity, stability and sustainability of the whole Buhi System with proper management and control of water use. Also important is the need to improve the ecosystem properties of the forest-kaingin area of the upland zone for long term productivity, stability and sustainability.

Resource Flows

The principal resources of the Buhi muncipality are its forest timber, fish, and crops such as rice, corn and sweet potatoes and water. Although a small proportion of these is utilized in the municipality, the major part flows out (Figure 8).

In return, the people of Buhi gain some income from the sale of fish, rice, and corn. However, a considerable amount of timber is cut illegally and passes to the muncipality. Also a sizeable proportion of the fish cages and the fishing operation are owned by outsiders so that part of the income remains in Buhi. Finally, at present, the muncipality obtains no return from the export of its water.

The return could be improved by:

1. Municipal control over fish cages and fishing in favour of the Buhi inhabitants;

2. Strict control over illegal cutting;

3. Cooperative marketing of rice, corn, sweet potato, etc., and

4. A charge on the water users in the service area.

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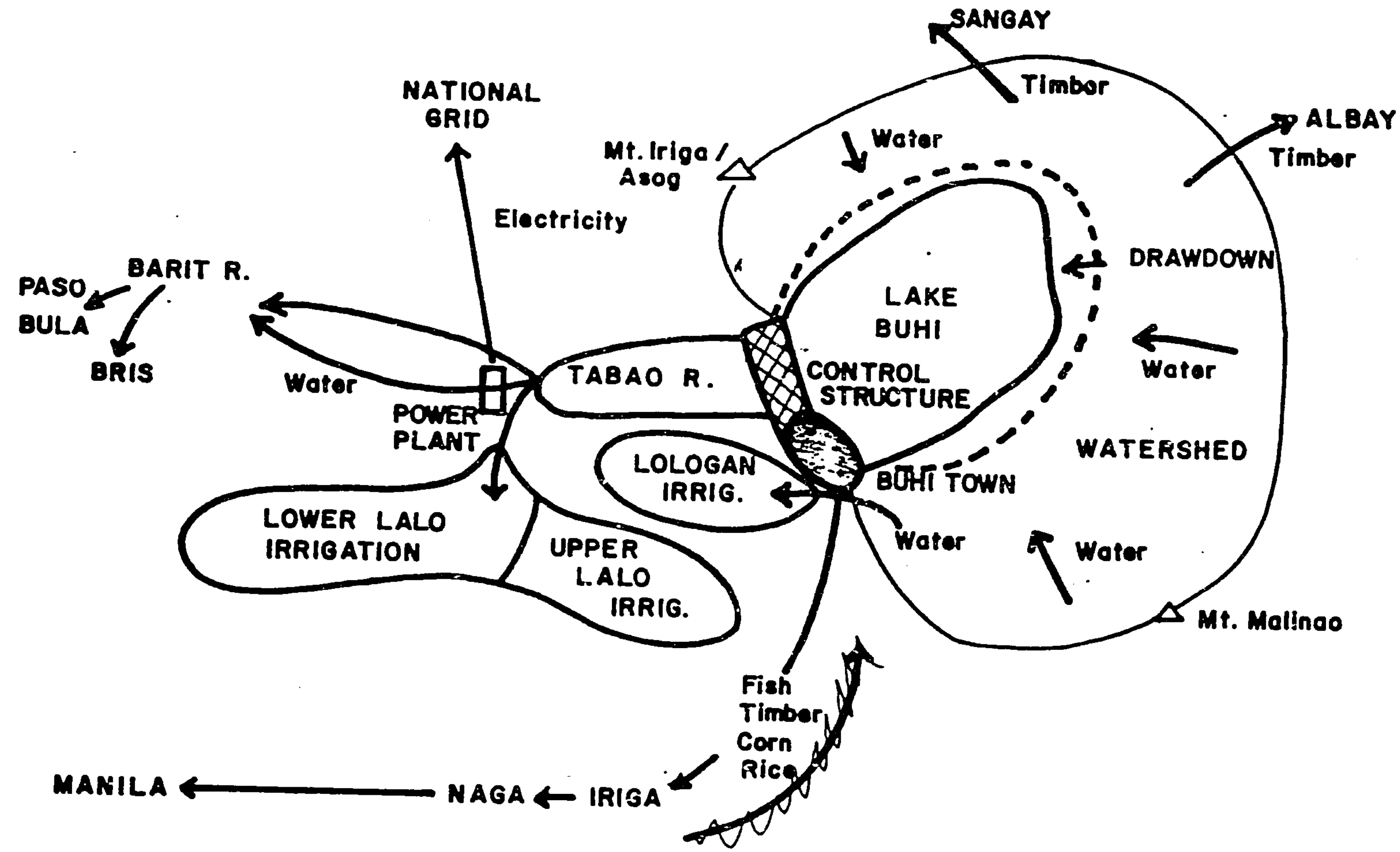

Figure 8. Resource Flows of the Buhi System

Seasonal Constraints

The dominant seasonal factors are the rainfall and the incidence of typhoons (Figure 9). The wettest months are June to December, but with particularly high variability in June, July, and November. Typhoons are particularly prevalent in October and November. During the typhoon season it is highly risky to harvest or plant rice or to stock or harvest fish cages. Another limiting factor is the occurrence of sulphur or "kanuba" which restricts fish production from July to October.

As a consequence of these constraints, the fish cages start to be stocked with fingerlings in December and thereafter, producing a harvest from April onwards. Similarly, in the service area, dry season rice is transplanted in November/December, after the typhoons, for harvesting in April/May in the dry season, while the wet season crop is transplanted in May/June for harvesting before the typhoon in August/September.

In order to service the irrigated area, the lake level has to be at a maximum in January so that water can be release to at least the end of April. Virtually no water is required in May but demand begins to build up again in June.

April and May are critical months for the Buhi fish cage operators since these are the first, and possibly peak, months of harvest. A low lake level at this time can cause drying out of the cages and loss of the fish harvest. Lower demand at this time could be achieved by earlier synchronous planting of the service area in late November rather than December. This would mean an earlier harvest and hence no water requirement in April.

Rice growing in the drawdown can be fitted in between February/March to April/May.

Water Allocation

The water in Lake Buhi is required for the following functions:

1. transport in the lake
2. fish cage and open fish capture operation
3. electricity production
4. irrigation of the Lower Lalo
5. irrigation of the Pili-Bula, BRIS and other irrigation schemes

The problem is that there is insufficient water to satisfy all these needs as defined by the users and responsible agencies.

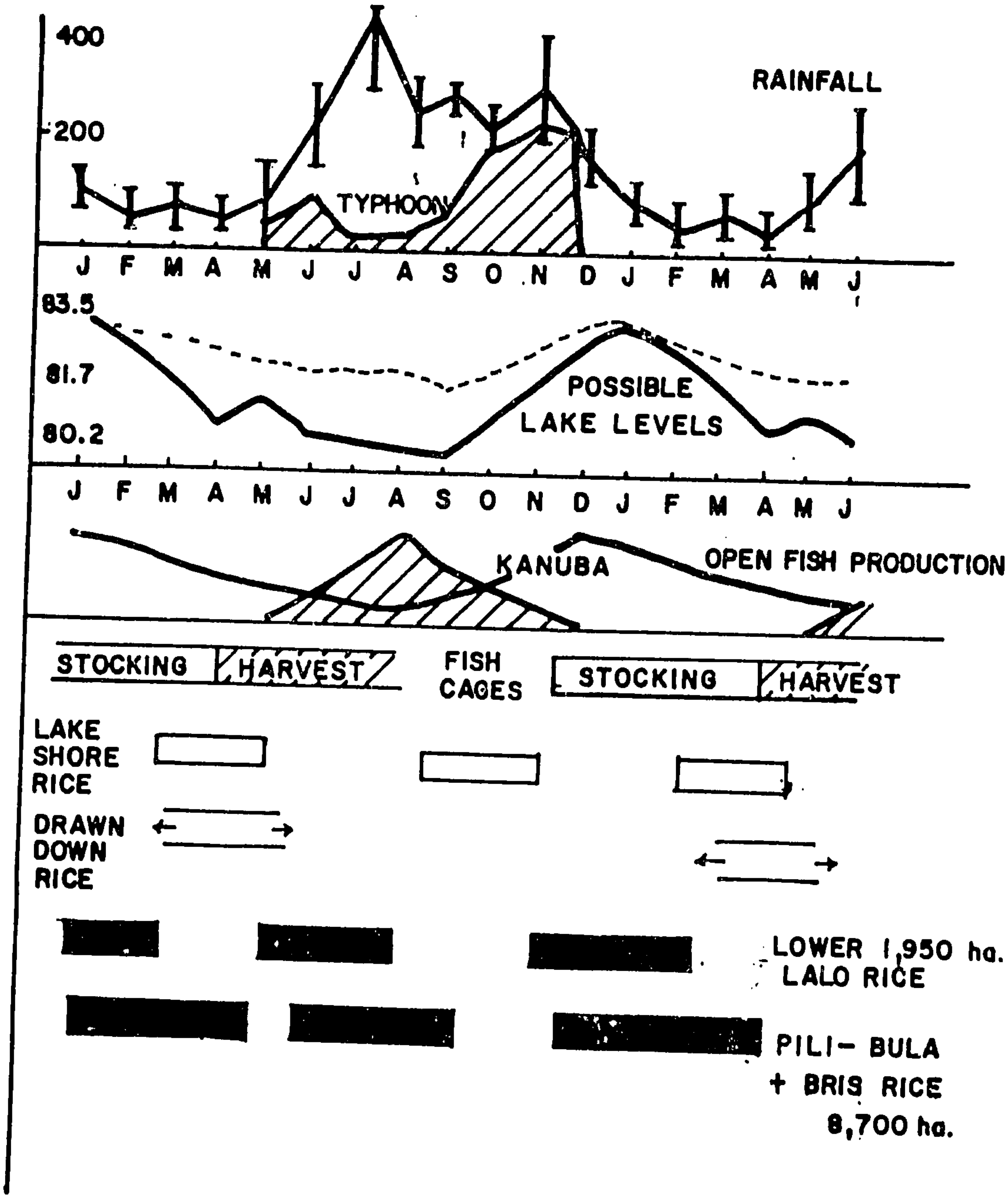

FIGURE 9. Seasonal Constraints

1) According to the inhabitants of Buhi they require a minimum of 82 meters of lake level throughout the year to prevent fish cages from drying out and to make transport in the lake feasible.

2) The National Power Corporation has a goal of 10 megawatt hour/year electricity output.

3) The total service area of Lower Lalo- Pili-Bula, BRIS and other systems requires irrigation of a total of 10,502 has. in the wet and dry season for the cropping patterns described in Figure 10.

The National Irrigation Administration has recently completed simulations for several scenarios, using both modal and mean values. The results are presented in Figure 11. They show that if the irrigation requirement is fully satisfied, making full use of the lake capacity, the power production is well below target and the lake level falls to nearly 803 meters for several months. On the other hand if a minimum of 81 meters for each month is set and full power production allowed this still does not meet the 10 megawatt target and in the dry season only 44.1% of the service area is irrigated. This is primarily because water is diverted to the power plant in amounts in excess of the needs of the BRIS system and the Pili-Bula system (of 5,5000 has) is deprived. The compromise solution is to fix a minimum of 81.7 meters which produces 80-90% irrigation and power production of about 5.5 gigawatts (modal values) or 6 gigawatts (mean values).

Possible solutions to the problem are, one or a combination of:

1. To raise the ogee of the lake from 83.3 to 84, 85.

2. To minimize delivery to the service area in April (by earlier planting of the dry season crop).

3. To insert a new mini-hydro power plant in the Right Connect or Canal, so allowing higher power production while ensuring water delivery to the Bula System.

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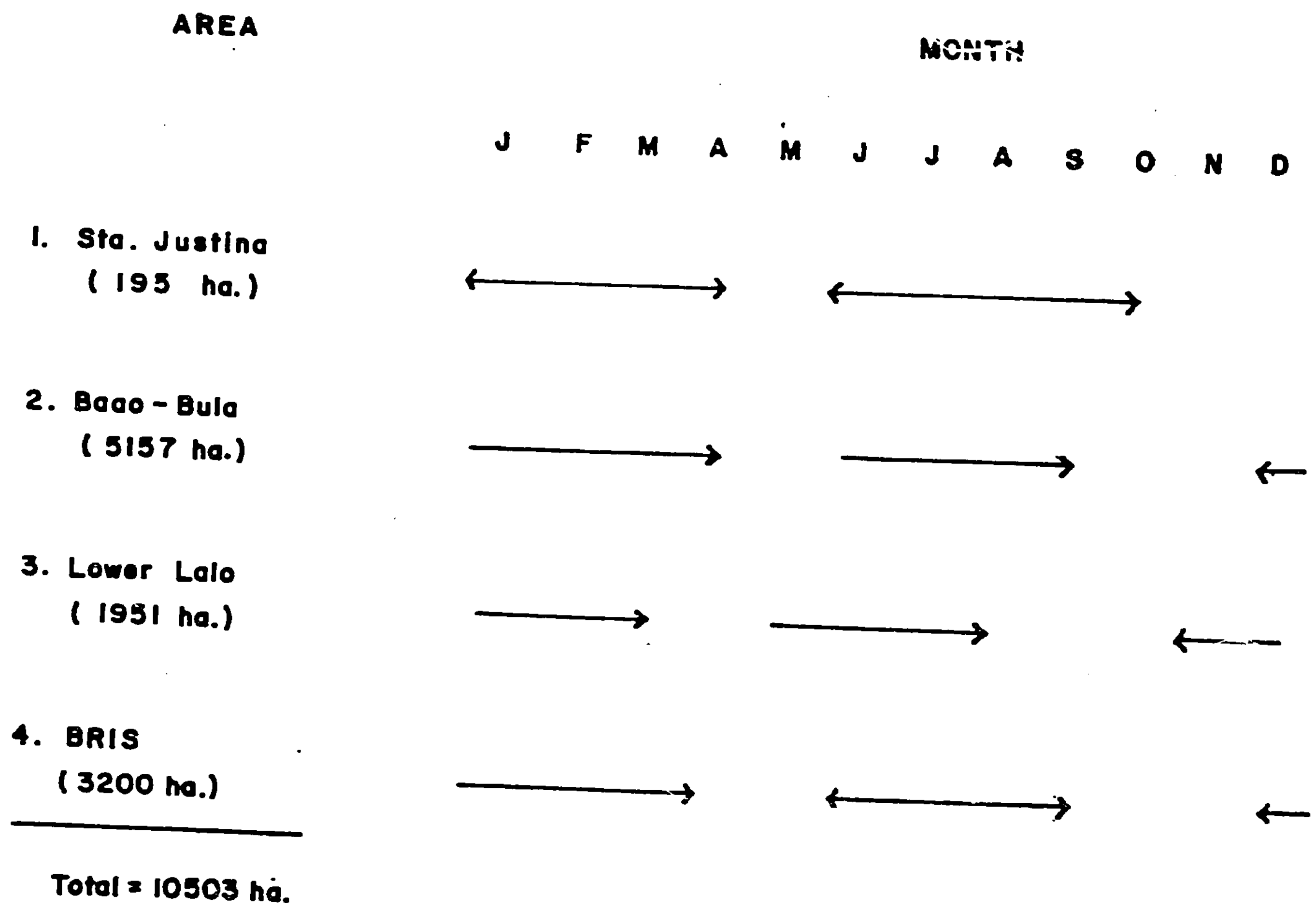
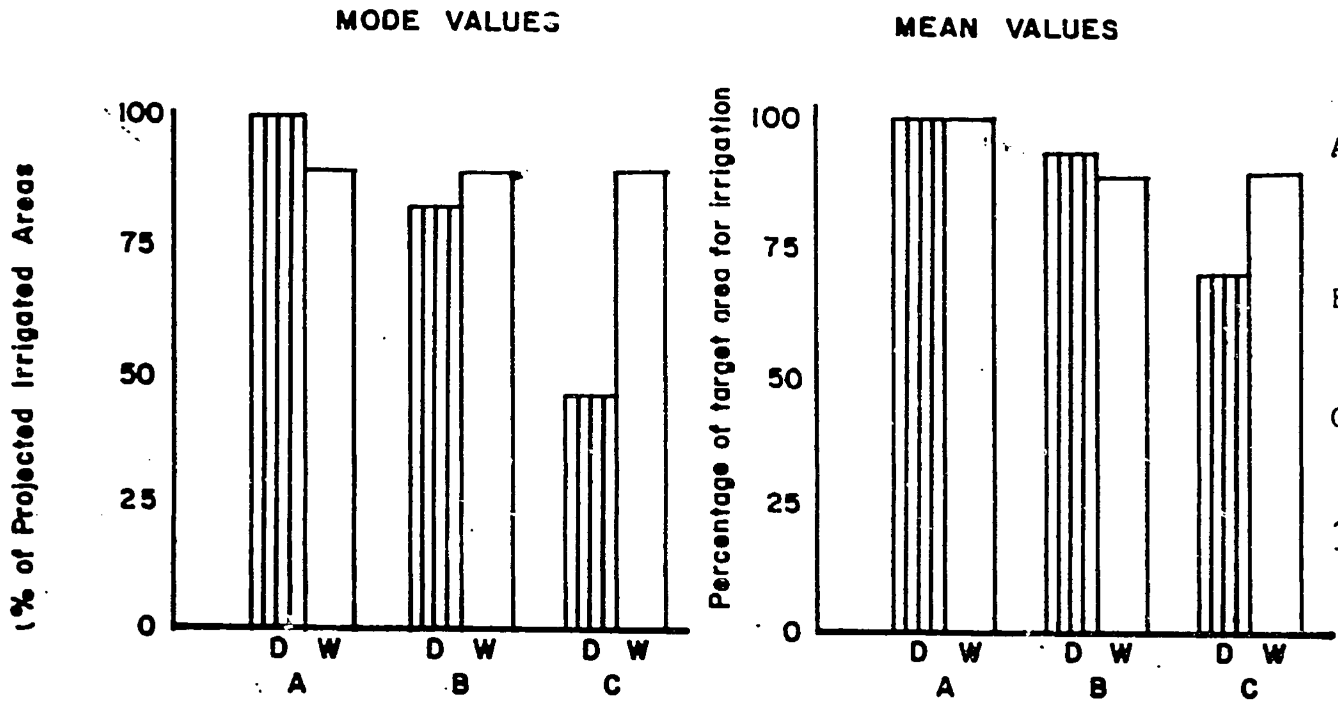


FIGURE 10. Service Area of Lower Lalo, Pili-Bula, BRIS - and Cropping Pattern



A. Irrigation is priority, no power constraint, no drawdown constraint

B. Irrigation priority, No power constraint, drawdown constraint

C. Power priority, Irrigation relaxed, Drawdown constraint

D. Dry season
W. Wet season

	Mode A	Mode B	Mode C	Mean A	Mean B	Mean C
power (Giga volts per year)	2.5	3.2	5.5	6.7	6.2	8.4
minimum water level	80.3	81.7	81.7	80.3	81.7	81.7

FIGURE 11. NIA Simulations Using Mean and Modal Values

PART FIVE

RESEARCH AND DEVELOPMENT PRIORITIES

5.1 KEY QUESTIONS, HYPOTHESES AND GUIDELINES

In this chapter we list the key questions produced during the workshop. They are presented under the heading of the Watershed, Lake, Tabao River, Lower Lalo Irrigation Scheme and the Buhi System as a whole.

BUHI SYSTEM

Key Question for Research

1. How can a satisfatory minimum lake level (81.7 m) be maintained throughout the year, or at least be guaranteed up to end of May?

Research Hypothesis:

A satisfactory minimum can be maintained by one, or a combination of, changing service area demand, raising ogee or adding a mini-hydro plant, and still satisfy major requirements of NIA-NPC.

Actions Required:

Compute simulation models to investigate effects singly and in combination of

1. raising ogee to 86-85 m
2. providing no irrigation to service area in April (earlier dry season planting)
3. establish in Buhi a satisfactory minimum at least to end of May.

Justification:

Buhi municipality insists on minimum of 82 m to protect fishcages and transport. The critical months are April and May when fish cages are being harvested. Simulations have already shown that 81.7m is possible but insufficient irrigation and power is produced.

Key Question for Development

1. How can Buhi Municipality obtain a better return for the export of their resources?

Guideline:

The Buhi Municipality should take greater control over its resources.

Working Hypothesis:

Buhi can obtain a better return by a combination of control over exploitation, cooperative marketing, and a charge to irrigation for water use.

Actions Required:

1. Establish municipality control over fish cages, fishing, and timber cutting.
2. Cooperative marketing of fish, rice, corn.
3. Impose a charge on on the service area for water use to establish a Trust Fund for Buhi.

Justification:

Buhi exports timber, fish, rice, corn, sweet potato, and water. It gets no income for water and much of its timber. Outsiders control several of the resources and income does not get back to Buhi.

BUHI WATERSHED

Key Questions for Research

1. What is the maximum sustainable productivity of the watershed area?

Research Hypothesis:

The maximum sustainable productivity can be determined from a survey of the land and human resources of the watershed.

Action Required:

Land and human resources evaluation and appraisal using techniques of aerial photography, land use mapping, resource inventory, agroecological and life zone analysis and household survey.

Justification:

The current lack of baseline information on the watershed is hampering planning of long term optimal productivity.

2. What soil conservation amd agroforestry practices are effective for farmers with different tenurial status and farming practices at different landscape positions in Buhi watershed?

Research Hypothesis:

The use or adoption of soil conservation and agroforestry practices by upland farmers is determined by tenurial status, farming system and landscape position of the farm.

Action Required:

1. Field interviews of Buhi Lalo Upland Development Project (BLUDP) participants and non-participants in the watershed, on various soil conservation and agroforestry techniques and constraints or problems on the use of particular techniques.

2. Assessment of

   A. Vegetative Control

      1. Contour Orchards
      2. Reforestation
      3. Grassed Waterways
      4. Contour Strip Cropping
      5. Crop Rotation

   B. Mechanical Control

      1. Contouring
      2. Terracing
      3. Small earthen or rock dams

   C. Organic Fertilizer and Mulching

   D. Institute Proper Land Use

Justification:

Current problems are caused by improper land utilization, kaingin practices and illegal cutting. Lessons can be learned from the BLUDP projects to establish better intervention strategies so as to promote soil conservation and agroforestry in the watershed.

3. What will be the overall consequences for productivity, stability, sustainability, and equitability of building an access road over the lake

Research Hypothesis:

Low agricultural productivity is the result of high transport costs but access may have other consequences on the system.

Action Required:

Determination of the mode of transport; cost per unit commodity; road design standard; maintenance responsibilities; EIA, Environmental monitoring, etc.

Justification:

1. Transport cost in the area is very high.

2. Change agents/service agents are discouraged from visiting the area due to absence of transport facility.

3. There will be faster integration of these communities in the socio-politico-administrative system of the municipality.

4. Is the lack of suitable multiple cropping which provides adequate ground cover between annual crop plants the cause of soil erosion during cropping period?

Research Hypothesis:

Soil erosion in the annual crop farm is mainly due to unsuitable ground cover between crops during rainy period.

Action Required:

1. Survey of crops grown in the area that can be used as intercrops.

2. Soil survey of the experimental site.

3. Conduct of field trials.

Justification:

There is a need to reduce soil erosion in the annual crop farm and so increase land productivity.

5. Is the low animal production in the upland caused by lack of knowledge on feed management?

Research Hypothesis:

The low animal production is due to not fully using available animal feed in the upland.

Action Required:

Survey of animal feeding techniques, availabiility of feed, kinds and number of animals being raised, constraints in animal production and others.

Justification:

Animal production can be increased by utilizing indigenous feeds and encouraging farmers to grow low input-requiring crops for animal feed.

6. What agroforestry and livestock production system, suited to the Integrated Social Forestry (ISF) area, would promote soil and forest resource conservation and improve the nutrition of the farmer?

Research Hypothesis:

ISF clienteles' productivity and nutrition can be improved by suitable integrated agroforestry and livestock production systems in the watershed.

Action Required:

Community rapid appraisal to understand the present production system and identify what agroforestry and livestock production should be tried and to determined appropriate intervention strategies.

Justification:

There is a need to promote soil and forest resource conservation and to increase the productivity of ISF participants.

7. Is the absence of workable institutional linkages among the organizations involved in research and action projects and the farmers the cause of the slow development in the upland?

Action Required:

1. Inventory research and development projects already completed and being implemented in the upland.

2. Monitoring and evaluation of the research development projects in the watershed.

Justification:

Establishment of practical and community based institutional linkages among organizations involved in upland resource development is needed to make the community a partner in watershed rehabilitation and protection.

8. Will integration of various government offices involved in forest protection result in better enforcement of exisitng forestry rules and regulations?

Research Hypothesis:

There will be better enforcement of forestry rules and regulations if activities are integrated.

Action Required:

Determination of functional overlaps among the various agencies in forest protection.

Formulation of mechanism for inter-agency integration as well as budget requirements.

Justification:

.Functional overlaps exist among various agencies, e.g. BFD, LGU, PC/INP, FMIB, WIDA, MOE/NPC, NIA.

9. What is the potential for resettling people from the forest/kaingin zone to lower area of the watershed?

Research Hypothesis:

There is potential for resettlement of people to the more productive zone in the lower watershed which will result in lower pressure on the upper zones.

Actions Required:

1. Assessment of potential for fishing and farming activities in lower zones of watershed.

2. Identification of possible sites for relocation.

Justification:

The upper zone of the watershed is suffering from soil erosion and overexploitation due to population pressure and illegal cutting.

Key Questions for Development:

10. How can implementation of agency environmental goals and policies be improved?

Guideline:
Improved environmental management requires a multi-disciplinary, multi-sectoral approach.

Working Hypothesis:

Environmental management in the Lake Buhi Watershed can be made more effective by designing and implementing policies and programs.

Action Required:

1. Assessment of existing government programs and projects in Buhi Watershed to determine the extent of deficiencies in environmental practices.

2. Appropriate programs or projects for Buhi Watershed should be designed and implemented to rectify deficiences in environmental practices.

3. Design and recommend appropriate implementation schemes of existing laws, regulations, policies and ordinances to properly utilize and control the Buhi Watershed Resources.

4. Design and recommend policies, programs and projects that would enhance the immediate rehabilitation of Lake Buhi Watershed.

Justification:

Sound environmental practice in the Lake Buhi Watershed is apparently absent.

11. How can the people be motivated towards production and watershed protection?

Guideline:

Improved motivation can be attained through information dissemination and training

Working Hypothesis:

1. Clientele - If the perception, attitudes and values of the people be properly understood they can easily be motivated in favor of production and watershed protection.

2. Government Workers - If the government workers can be properly motivated they can deliver services effectively.

Action Required:

Buhi People

1. Survey the perception, attitudes, and values of the people on productivity and watershed protection. Survey will be the basis for the formulation of information dissemination, training and community organization.

Government Workers

1. Study on the motivational factors of government worker in delivery services.

2. Study their perception, attitude and values towards the clientele and the watershed.

3. Identify their training needs.

4. Formulate training design.

5. Training

Justification:

There is a need to unify the perception, motivation, and values within and among government workers and the clientele towards a common goal to increase productivity and watershed protection in order to improve the quality of life of the "Buhinon".

12. What government policy should be adopted to settle tenurial conflicts and human settlement problems in the Tabao Channel Watershed?

Guidelines:

1. Properly implement existing government policies on tenurial conflicts and settlements.

2. Consider local government development plans and line agencies programs during implementation of Buhi project.

3. Consider demands of people directly involved in the program.

Working Hypothesis:

1. Tenurial conflicts destabilize the area.

2. Proper implementation of government policies on tenurial conflicts and settlement problems will minimize these problems.

Action Required:

1. Identification and review of government policies.

2. Creation/ operationalization of an inter-agency body to assess/resolve these problems.

3. Documentation of all Tenure Conflicts and Human Settlements problems.

4. Conduct information, education, communication and motivation activities in the area.

Justification:

1. Reduction of conflicts caused by land tenurial disputes and human settlements is required.

2. The area needs to be stabilized.

Lake Buhi

Key Questions for Research

1. What are the socio-economic costs and benefits that would accrue to the lakeside inhabitants at the minimum and maximum elevation of the lake water (79.65, 83.5 and 85 m.á.s.l.?

Research Hypothesis:

The socio-economic impacts of elevation 83.5 m.a.s.l. are:

- increased fish production

- decreased crop production

- damaged to public and private properties

The socio-economic impacts of elevation 79.65 m ASL are:

- decreased fish production

- increased crop production

- increased transport cost

- drying of shallow wells

- health sanitation

- social conflict over drawdown area's use

Action Required:

1) Establish exact delineation of drawdown and inundation areas at 79.65, 83.5, and 85 m.a.s.l. respectively.

2) Determine actual areas (dry/inundated).

3) Estimate costs and benefits of productivity changes in

   - fisheries

   - farming

   - domestic water supply

4) Review and update existing laws on riparian (drawdown) land rights.

5) Determine the impact of drawdown and inundation on incidence of gastro-enteritis and other water-borne diseases.

Justification:

Agreement on the future operation of and further modifications to the Control Structure depends on a full understanding of the consequences of maintaining various water levels in the lake.

2. What is the maximum sustained yield of fisheries and subsequent fishing efforts that can be carried by the Lake?

Research Hypothesis:

- Development of fisheries and coastal agriculture help conserve the watershed of the lake by providing livelihood for more people.

The lake's productivity can be improved by increasing fish cages and cultivating drawdown land.

Action Required:

1) Determine optimum fish population carrying capacity of lake for dominant fish species with current technology (capture and cage).

2) Evaluate crop suitability of drawdown land areas.

3) Establish the minimum household income requirement and determine human population capacity of the Lake based on fisheries and coastal agriculture.

Justification:

Policy/Decision makers have insufficient data on the productivity potential of the lake.

3. What are the key limiting factors in fish production as result of fluctuating lake levels?

Research Hypothesis:

Physico-chemical and biological characteristics are affected positively and negatively by fluctuating lake level.

Action Required:

1. Baseline and monitoring surveys of physico-biological parameters at different lake levels affected by fluctuating lake levels.

2. Study specific impact on "Kanuba" and other pollution factors (Nitrogen and Phosphoros).

Justification:

1. The fluctuating lake level probably intensifies the negative effects of "kanuba" and other pollution factors, but this is not scientifically proven.

2. The agroecosystem properties depend on favorable water quality.

4. Are the existing cages and fish corrals in the right locations?

Research Hypothesis:

A significant number of fish cages and corrals are not properly located in terms of agroecosystem properties.

Action Required:

1. Inventory of fish cages and corrals as to size, number, location, ownership and productivity / performance.

2. Inventory fishing gears (bancas, nets, electro-fishing, tests).

Justification:

Fisheries technologies have positive and negative impacts on system properties and need careful selection.

5. What would be the long-term effect of sedimentation and human activity on storage capacity of lake?.

Research Hypothesis:

The lake's shape and size will change in response to the following processes:

Geological processes

- sedimentation
- erosion
- seasonal fluctuation in the lake's water level

Human processes

- man-made structures
- agriculture and fishing activities
- illegal cutting

Action Required:

Geological mapping

1:50,000 (whole area)
1:10,000 (selected areas)

Soil Stability Measurement

soil creep

land slide

rock slide

Run-off Measurement

velocity

quantity

water density

analysis of the soil's water absorption, porosity and, permeability

analysis of the bathymetric survey

Justification:

The rate of sedimentation and geological forces will affect the long term storage capacity of the lake. The projected change should be monitored.

6. What is the most appropriate technological option for fisheries?

Research Hypothesis:

New technologies can be found which will improve all the system properties of the fishery.

Action Required:

1. Inventory of information on fisheries technology potential for Buhi
2. Pilot testing and monitoring.
3. Apply technology assessment techniques.
4. Package technology.
5. Disseminate.

Justification:

Introduction of new technology (species, cage construction, time cage and floating in lined cages, use of poison and electricity) will alter system properties.

Key Questions for Development

7. How can Lake Buhi be managed effectively as a multipurpose resource?

Guidelines:

Organize one formal body to represent concerned agencies and lake users and empowered to manage the development of Lake, incl:

- zoning/planning
- licensing and other control measures
- inter-agency coordination in development.

Working Hypothesis:

A single accountable and responsible body will minimize if not eliminate, actual and potential conflicts in the multiuses of the lake and better ensure its productivity, stability, sustainability, and equitability.

Action Required:

1. Review policies and existing practices in the management of the lake using agencies and sectors.

2. Create an inter-agency, multisectoral Task Force to recommend alternative lake management and administrative structures in lake level control.

3. Subject administrative recommendations to public hearing/consultation.

4. Propose legal issuance as appropriate.

5. Execute provisions of legal issuance.

6. Set up interim multipurpose management group.

Justification:

1. There is confusion and conflict among agencies and interest groups as to the management of the lake.

2. There is no integrated and coordinated management (conservation and development) plan for the lake.

3. Lake Buhi is deteriorating and experiencing significant stress on its integrity.

8. Can water hyacinth, bamboos, and tourism be developed as source of livelihood to inhabitants?

Guidelines:

Exploit local, indigenous resources for the benefit of local inhabitants, using local labour and skills.

Working Hypothesis

1. Development of indigenous materials for cottage industries promotes local socio-economic upliftment.

2. Lake Buhi is a tourist spot that can further be promoted to increase local revenues and benefits to the community.

Action Required:

1. Compile and evaluate existing technologies for utilizing indigenous materials.

2. Organize and train local people through Local Government (LG) and National Cottage Industry Development Authority (NACIDA) through Philippines Tourism Authority (PTA).

3. Formulate tourism development master plan.

4. Identify and obtain support for small/cottage industry development.

Justification:

1. Indigenous materials are abundant and can be used to augment household income.

2. Harvesting hyacinth mitigates pollution.

3. Potential export (dollar-earning) products exist.

4. Local labor is available.

9. How can marketing and credit provisions for small farmers and fishermen be improved?

Guideline:

Agree on integrated support services delivery.

Working Hypothesis:

Availability of Integrated Social Services Development improves properties of the Lake System.

Action Required:

1. Look into status of social services development in municipality.

2. Seek integration of concerned agencies.

3. Identify funding sources for Integrated Social Services.

Justification:

Present social services development in Buhi is inadequate and disorganized. Integration will improve social services to contribute more effectively to productivity, stability, sustainability, and equitability.

10. How can health problem associated with the drawdown be solved?

Guideline:

Government agencies should make health education and nutrition services available.

Working Hypothesis:

Improvement is possible in existing services.

Actions Required:

1. Evaluate constraints to health service delivery

2. Implement corrective measures

Justification:

In recent years drawdown has resulted in increased illness of inhabitants, in particular gastro-intestinal disorder.

11. What is the possible future water supply for people whose groundwater sources have dried up?

Guideline:

An alternative source of groundwater must be found.

Working Hypothesis:

Construction of level 2 water supply is a possible solution to the problem.

Action Required:

1. Assessment of location and number of people affected.

2. Local government negotiate with NIA, Provincial Government and other agencies for funds for the construction of level 2 water supply.

Justification:

Drying up of groundwater supply is creating social problems such as lack of water for household use, health and nutrition.

12. How can help be provided to fishermen whose fish cages have been affected by drawdown?

Guideline:

Fishermen whose cages have been damaged have a right to some form of recompense.

Working Hypothesis:

The construction and operation of the control structure and the abnormal dry season caused sudden fluctuations of the lake level water.

Action Required:

Work with NIA for just compensation of affected fishermen.

Justification:

Drying up of lake and consequent lowering of lake level causes damage to fish cage fishing and is a source of social problems.

Tabao River

Key Questions for Research

1. How effective is the earth fill dam at the old Tabao River for water impoundment and as a means of transport?

Research Hypothesis:

1. The earth dam at old Tabao River as designed and constructed can withstand a 26-year flood and an intensity - 26 earthquake.

2. The designed width of Tabao roadway could adequately accommodate traffic needs.

Action Required:

1. Review of engineering design.

2. Evaluation of construction.

3. Sensitivity analysis of the adequacy of design and construction.

Justification:

1. Collapse of structure poses danger to residents

2. Traffic safety must be assured.

2. Will filling-up of the old Tabao River be beneficial to the people of Buhi?

Research Hypothesis:

Filling-up of old Tabao River will be beneficial to the people of Buhi.

Action Requires

1. Economic analysis of urban expansion requirements of Buhi municipality and other alternatives.

2. Social soundness analysis of urban expansion plan and other alternatives.

Justification:

The old Tabao River area has to be developed for more productive and efficient use.

3. Will traditional fishing and fish caging be viable in old Tabao Channel with the operationalization of the Buhi-Lalo project?

Research Hypothesis:

Productivity of traditional fishing and fish caging will be improved or maintained during the operationalization of the project.

Action Required:

1. Water analysis for nutrient contents

2. Benefit-cost analysis of traditional fishing and fish caging at various levels of water in the Tabao Channel.

Justification:

Traditional fishing and fish caging are among the major sources of livelihood for Tabao Channel residents.

Key Questions for Development

4. Considering the demand of Buhi Local Government (BLG) to bring up the minimum drawdown to agreeable level, is there a need to channelize (deepen) the Tabao River?

Guidelines:

1. NIA-NPC agreement on water allocation must be considered.

2. Ecological impact on the lake channel and needs of Buhi residents including human rights must be considered.

3. Government policies on water use for agricultural development must be considered.

Working Hypothesis:

1. Maximum requirement for channeling depends on the minimum drawdown.

2. Drawdown below 82 MSL is detrimental to the ecology and socio-economic needs of Buhi people.

Action Required:

1. Evaluation of the current status of accomplishment of Tabao channel work.

2. Negotiate for agreeable minimum drawdown among BLG, NPC, and NIA.

3. Conduct information, education, communication and nutrition activities for the Buhinons.

4. Assessment of water supply and water use needs.

5. Monitor effects of various drawdown levels.

Justification:

1. There are considerable potential savings to NIA in not deepening the channel.

2. The potential ecological and socio-economic affects detrimental to Buhi and its people would be minimized.

3. It would stabilize also the physical and social ecology of the Tabao channel system.

5. How is access for people across the west side of Tabao channel to be improved?

Guidelines:

1. Provide small bridge safe enough for people and animal drawn carts or sledges to get across the Tabao Channel.

2. Maximize the use of locally available materials.

3. Enlist participation of local people in the design and construction of the bridge.

Working Hypothesis:

1. Access of people can be improved by constructing a small bridge across the Tabao channel using locally available materials and enlisting their participation in the undertaking.

2. Funding could be made readily available for the purpose by the Tabao channelization Project and the local government of Buhi.

Action Required:

1. Plan and consult with the local leadership in the community regarding the need to improve their access across Tabao River to decide on:

   a) the type of bridges

b) exact location of bridges

c) funding source

d) commitment of local people to the undertaking

2. Design the bridges and secure funding.

3. Construct the bridge.

Justification:

The channelization of Tabao River has made more difficult the access of people from the west side of the channel to market center and other services and facilities for social amenities.

6. What government policy should be adopted to settle tenurial conflicts and human settlement problems in the Tabao Channel System?

Guidelines:

1. Properly implement existing government policies on tenurial conflicts and settlements.

2. Consider local government development plans and line agencies programs during implementation of Buhi project.

3. Consider demands of people directly involved in the program.

Working Hypothesis:

1. Tenurial conflicts destabilize the area.

2. Proper implementation of government policies on tenurial conflicts and settlement problems will minimize these problems.

Action Required:

1. Identification and review of government policies.

2. Creation/ operationalization of an inter-agency body to assess/resolve these problems.

3. Documentation of all Tenure Conflicts and Human Settlements problems.

4. Conduct information, education, communication and motivation activities in the area.

Justification:

1. Reduction of conflicts caused by land tenurial

disputes and human settlements is required.

2. The area needs to be stabilized.

7. What technology can be applied to regulate growth and maximize economic use of water hyacinth?

Guidelines:

1. Productive, socially acceptable and ecologically sound technology should be adopted.

2. Low capital investment should be involved.

Working Hypothesis:

1. Growth of water hyacinth may be regulated and it can be used to provide economic benefits.

Action Required:

1. Inventory of available technology for regulating growth of water hyacinths and their possible use.

2. Identification of feasible and viable technology.

3. Market study

4. Training (e.g. cottage industries).

5. Establish support services/facilities.

Justification:

Water hyacinth grow abundantly in the area and pose environmental, health and sanitation problems.

8. What appropriate farming systems could be used to improve stability of the upland areas in the vicinity of Tabao channel?

Guidelines:

Production-oriented, socially acceptable and ecologically sound farming systems should be recommended.

Working Hypothesis:

1. Upland farming systems exist and may be used for erosion control in the area.

2. Alternative cropping/farming systems will increase productivity and stability of the upland.

Action Required:

1. Inventory of existing usable upland farming systems for soil erosion control.

2. Pilot demonstration of recommended/ feasible alternative farming systems.

3. Conduct information, education, communication and motivation campaign activities.

Justification:

Unabated soil erosion could lead to decreased productivity of upland areas and destabilize the area.

9. Assuming fishing/fish caging would not be viable any more at Tabao channel, what alternative livelihood system(s) could the people engage in?

Guidelines:

1. An alternative livelihood program should utilize indigenous resources.

2. There should be a ready market for the products.

3. Livelihood schemes should be provided for the area.

4. Appropriate training and support services should also be provided.

Working Hypothesis:

1. Indigenous resources can provide alternative livelihood schemes in the area.

2. Available manpower will readily adopt alternative livelihood schemes.

Action Required:

1. Inventory of indigenous resources.

2. Survey of acceptable alternative livelihood systems.

3. Market Study

4. Training

5. Establish support services/facilities (credit and technical).

Justification:

Loss of sources of income will lead to deterioration of standard of living of Tabao channel residents and other social oriented problems.

10. How do we resolve the conflict in the management of Tabao Channel System (TCS) so as to provide for the requirements of all users?

Guidelines:

1. Requirements of all users of water from Tabao Channel System (TCS) must be satisfied to the greatest extent possible.

2. Consider existing developmental goals/policies of the agencies (NIA, NPC, BFAR, etc.) involved and the Buhi Local Government.

Working Hypothesis:

1. Multi-sectoral management of the Tabao Channel System (TCS) will promote equitable water resource utlization.

2. Uncontrolled use of Tabao Channel System will decrease efficiency of NIA/NPC operations.

Action Required:

1. Organization/operationalization of multi-sectoral body to promote equitable use of water resources.

2. Inventory/assessment of water use requirements.

3. Conduct IECM activities.

Justification:

Multi-sectoral management of Tabao Channel System (TCS) is needed to minimize conflicts in water use and allocation.

11. How can Sinarapan be maintained in the lakelets in the upland of the Tabao River System?

Guidelines:

Sinarapan can only be preserved by strict regulation.

Working Hypothesis:

Sinarapan can be preserved by eliminating Tilapia and other competitors and predators and by strict regulation over fishery.

Action Required:

1. Declare the lakelets as protected reserve for Sinarapan.

2. Eliminate Tilapia and other competitors and predators.

3. Regulate the fishery.

4. Monitor population of Sinarapan.

Justification:

The Sinarapan is the world's smallest commercial fish. Previously it was abundant in Lake Buhi but it is now nearing extinction. It only continues to be common in the lakelets in the Tabao River System.

Lower Lalo Service Area

Key Question for Research

1. What improvements in crop management can increase the productivity and sustainability of irrigated rice farms?

Research Hypotheses:

1. A third crop in a sequential cropping pattern is viable.
2. Organic fertilizer can supplement inorganic fertilizer.
3. Use of high-yielding varieties increases rice yield.

Action Required:

1. Test viability of legumes as third crop on a pilot scale.
2. Test different forms of organic fertilizers, e.g. azolla, compost, etc.
3. Compare relative costs/benefits of organic and inorganic fertilizer used.
4. Test for viability and acceptability to farmers of rice varieties which are higher yielding than those currently used.

Justification:

Based on the following observations:

1. Rice yield is low.
2. Rice field is idle after the harvest of the second crop.
3. Soil structure and chemical composition are progressively deteriorating because of the use of inorganic fertilizer. There is a need to improve crop management production and sustainability.

Key Questions for Development

2. How can the functional capability of irrigators' associations be enhanced.

Guideline:

Success of irrigation depends on the capability of irrigator's associations.

Working Hypothesis:

The functional capability of IAs can be enhanced so that these can assume not only operation and management functions of the irrigation system but also some technical aspects of rice production and marketing.

Action Required:

Analyze the structure and dynamics of irrigators associations for the purpose of evaluating organizational capabilities and limitations.

Justification:

IAs are organized with the assistance of NIA for the operation and management of the irrigation system. If these associations can be optimally developed, they can perform not only O and M functions but also evolve crop management marketing strategies.

3. How can cropping patterns of the different irrigation areas in the system be synchronized for a rationalized allocation of water?

Guideline:

Scientific cropping patterns have specific volume and timing requirement for water.

Working Hypothesis:

The cropping patterns of different irrigation areas can be synchronized for a rationalized allocation of water.

Action Required:

Devise a rationalized scheme for allocating water to each area.

Justification:

The supply of water is not sufficient to irrigate all rice farm areas at the same time. Therefore, cropping patterns of the different areas should be synchronized so that the water requirement can be satisfied.

4. How can agricultural extension services with regard to irrigation management be improved?

Guidelines:

Adequate and effective extension services can contribute to farm productivity and sustainability.

Working Hypothesis:

Existing extension services can be improved.

Action Required:

1. Re-training/reorientation of extension agents.

2. Conduct farmer training in different aspects of crop management.
3. Add logistical and communication support systems.

Justification:

Low yield is attributed in part to low awareness of proper crop management. Extension agents can increase this awareness so that farmers' practices can be changed and yield increased.

5.2 PRIORITIES FOR ACTION

In this final brief chapter we present the results of the assessment of the key questions described in the previous chapter. The assessment was carried out by all the participants together on the last day of the workshop.

Table 1 presents the results of the assessment. For each key question the essential proposed innovation was identified and its potential impacts on the system properties of the relevant agroecosystem assessed. Crosses in the table indicate which properties are most likely to be affected.

The expected cost of introducing each innovation was assessed (as low, medium or high) as was the length of time that was likely to elapse before the benefits were realised (as short, medium and long). Finally the innovations were prioritized into classes 1, 2, 3 or 4 on the basis of these assessments. In general innovations given high priority were those of relatively low cost and short time to benefits, together with a potentially high impact on productivity and sustainability and/or equitability.

Table 1. Innovation Assessment

Change/ Innovation	Properties Most Affected						
	Productivity	Stability	Sustainability	Equitability	Cost	Time to Benefit	Priority
Buhi System							
1. System optimization	+	+	+	+	L	S	1
2. Resource income	+			+	L	L	2
Buhi Watershed							
1. Watershed planning	+	+	+		M	L	1
2. Soil conservation	+	+			M	M	2
3. Access road	+	+	+	+	L	M	1
4. Annual intercrop			+		M	S	4
5. Livestock feed	+		+		M	M	2
6. Agroforest/ livestock	+	+	+		L	M	2
7. Institutional links	+		+		L	L	3
8. Forest agency integration			+		L	M	2
9. Relocation	+		+		M	L	3
10. Environ. implementation			+		L	L	3
11. Training/ motivation	+		+		M	L	3
12. Tenure reform	+		+		M	M/L	1

Lake Buhi							
1. Lake kevel control	+	+	+	+	L	S	1
2. Fishery optimization	+		+		M	M	1
3. Pollution control	+		+		M/M	M	2
4. Fish cage location	+		+		M	S	2
5. Long-term plans			+		M/M	L	4
6. Fishing technology	+				M	M	3
7. Multi-purpose management		+	+	+	M	M	1
8. Tourism etc.	+			+	M	M	3
9. Market/Credit				+	M	M	2
10. Health	+			+	M	M	2
11. Water supply					M	M	1
12. Compensation				+	L	S	1
Tabao River							
1. Earth dam		+		+	L	M	1
2. Fill old Tabao River	+	+		+	L	L	1
3. Future fishing	+		+		L	M/S	1
4. Shallow channel				+	L	S	3
5. Access	+			+	M	M	1
6. Tenure reform	+			+	M	M/L	1
7. Hyacinth management	+				M	M	4
8. Upland farm systems	+		+		M	M	2
9. Alt. livelihood				+	M	M	2
10. Multi-Agency control		+			M	M	2
11. Sinarapan			+		L/M	M	1
Lower Lalo							
1. Crop management	+		+		M/M	M	1
2. IAS functioning	+		+		M	M/L	3
3. Cropping synchrony	+	+	+	+	M	M	2
4. Irrigation extension	+	+			M	M/L	4

The final list of priority (class 1) key questions are thus:

The Buhi System

1. How can a satisfacorty minimum lake level (81.7m) be maintained throughout the year, or at least be guaranteed up to the end of May?

Buhi Watershed

1. What is the maximum sustainable productivity of the watershed area?

2. What will be the overall consequences for the productivity, stability, sustainability and equitability of building an access road around the lake?

3. What government policy should be adopted to settle tenurial conflicts and human settlement problems in the Buhi watershed?

Lake Buhi

1. What are the socio-economnic costs and benefits that would accrue to the lakeside inhabitants at the minimum and maximum elevation of the lake water (79.65, 83.5 and 85 m.a.s.l.)?

2. What is the maximum sustained yield of fisheries and subsequent fishing efforts that can be carried by the lake?

3. How can Lake Buhi be managed effectively as a multipurpose resource?

4. What is the possible future water supply for people whose groundwater sources have dried up?

5. How can help be provided to fishermen whose fish cages have been affected by the drawdown?

Tabao River

1. How effective is the earth fill dam at the old Tabao River for water impoundment and as a means of transport?

2. Will filling-up of the old Tabao River be beneficial to the people of Buhi?

3. Will traditional fishing and fish caging be viable in the Tabao Channel with the operation alization of the Buhi: Lalo Project?

4. How is access for people across the west side of the Tabao to be improved?

5. What government policy should be adopted to settle tenurial conflicts and human settlement problems in the Tabao Channel system?

6. How can Sinarapan be maintained in the lakelets in the upland of the Tabao River system?

Lower Lalo

1. What improvements in crop management can increase the productivity and sustainability of irrigated rice farms?

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Volume II Fisheries Development
Volume III Irrigation and Drainage Improvement
Volume IVA Watershed Production Management
Volume IVB Secondary and Feeder Roads
Volume V Lake Bato Regulation and Lake Bato-Pantao Brgy. Division
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APPENDIX A

WORKSHOP TIMETABLE

BUHI AGROECOSYSTEMS ANALYSIS WORKSHOP
NOVEMBER 14-18, 1985
NAGA CITY

PROGRAM OF ACTIVITIES

<u>November 13 (Wednesday)</u> Arrival of Participants

<u>November 14 (Thursday)</u>

8:00 - 8:30	Registration of participants
8:30 - 9:30	<u>OPENING CEREMONY</u>
	Moderator: Dr. Wilfredo Olano
	1. The Phil. National Anthem
	2. Welcome Address - Dir. Carmelo Villacorta Program Director-BRBDP
	3. Message - Gov. Felix A. Fuentabella Cam. Sur (Delivered by Constancio Cater, Provincial Development Coordinator)
	4. Remarks - Mr. James W. Dawson Chief Regional Development Division USAID
9:30	PLENARY SESSION
9:30 - 10:30	5. Introduction of Participants
	Objectives of Workshop
	Review of Timetable - Dr. Percy E. Sajise UPLB Program on Environmental Science and Management (PESAM)
10:30 - 10:45	BREAK
10:45 - 11:00	History of Bicol River Basin Dev't Program and Integrated Area Dev't-Rinconada/Buhi-Lalo - Dr. Wilfredo Olano, Deputy Director Planning, BRBDP
11:00 - 12:00	Policy and Goals Papers
11:00 - 11:15	a) BRBDP - Dir. Carmelo R. Villacorta
11:15 - 11:30	b) MAR - Dir. Salvador Pejo

11:30 - 11:45	c) NIA - Dir. Florentino Camarador
11:45 - 12:00	d) BFD - Dir. Sabado Batcagan
12:00 - 1:00	LUNCH
1:00 - 3:15	8. Policy and Goals Papers (Continuation)
1:00 - 1:15	e) BFAR - Dir. Jose Urbano (Delivered by Romy Gonzales
1:15 - 1:30	f) MAF - Dir. Agustin B. Mago (Delivered by Justino Ranosa)
1:30 - 1:45	g) BL - Dir. Flor Pelayo
1:45 - 2:00	h) NPC - Mr. Ramon Aril (Delivered by Jose Balictar)
2:00 - 2:30	9. Discussion
3:00 - 3:15	BREAK
3:15 - 4:30	10. Policy and Goals Paper
3:15 - 3:30	i) Buhi Municipality - Mayor Crispin Mercurio
3:30 - 3:45	j) Buhi Fishermen Association Mr. Efren Bon
3:45 - 4:00	k) Upland Farmers Association (Mr. Teotimo Gonzaga)
4:00 - 4:15	l) Irrigators Association Pili-Bula - Mr. Eliodro Estadilla

<u>November 15 (Friday)</u>

8:30 - 9:30	Agroecosystems in Buhi	Dr. Gordon Conway
9:30 - 10:30	Agroecosystem Analysis	Dr. Gordon Conway
10:30 - 10:45	BREAK	
10:45 - 11:00	Study Groups Briefings	
11:00 - 12:00	Break into four case study groups	

1. Upland Agroecosystem
2. Lake Buhi Agroecosystem
3. Tabao River and Control Structure
4. Service Area

Tasks: System Hierarchies
Pattern Analysis: Space, time, flows, decisions
System Properties: Productivity, Stability, Sustainability, Equitability

1:00 - 5:00 Study Groups Sessions (Continuation and Distribution of study material)

November 16 (Saturday)

8:30 - 9:45 Upland Report

9:45 - 10:30 Lake Buhi Report

10:30 - 1045 BREAK

10:45 - 12:00 Tabao River Report
Service Area Report

12:00 - 1:00 LUNCH

1:00 - 5:00 Study Groups Session

Tasks: Key Questions for Research
Key Questions for Development
Guidelines for Development
Working Hypotheses for Development

Integrated Study Groups Session

November 17 (Sunday) Plenary Session
Chairman: Dr. Percy E. Sajise

8:30 - 10:30 Upland Agroecosystem
Lake Buhi

10:30 - 10:45 BREAK

10:45 - 12:00 Tabao River/Structure
Service Area

12:00 - 1:00 LUNCH

1:00 - 2:00 Report of Integrated Study Group

2:00 - 6:00 Discussion of Key Questions) Dr. Gordon Conway
Guidelines and Working Hypothesis)
Innovation Assessment) Dr. Gordon Conway
Program Priorities) Dr. Gordon Conway

Review of Workshop Dr. Percy E. Sajise

Closing Address Director Carmelo Villacorta

November 18 (Monday)

Participants Departure

APPENDIX B

LIST OF SUPPORT PARTICIPANTS

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