EPM 33

COASTAL RESOURCES MANAGEMENT AND ENVIRONMENTAL ASSESSMENT NEEDS FOR AQUATIC RESOURCES DEVELOPMENT IN INDONESIA

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TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY

1. INTRODUCTION 1

1.1 Scope and Organization of the Report 1
1.2 Background for Aquatic Resources Development 2

2. STUDY METHODS 6

3. COASTAL RESOURCES IN INDONESIA: RESULTS AND DISCUSSION 8

3.1 Description and Interrelationships of Indonesia's Important Coastal Ecosystems 8
3.1.1 Interrelationships among Ecosystems 10
3.1.2 Agroecosystems 10
3.1.3 Freshwater Ecosystems 18
3.1.4 Beaches 19
3.1.5 Estuaries 21
3.1.6 Tidal Swamp Forests 22
3.1.7 Mangroves 23
3.1.8 Seagrass Beds 26
3.1.9 Coral Reefs 27
3.1.10 Pelagic and Demersal Ecosystems 30

3.2 Coastal Resources and Their Future Demand in Indonesia 32
3.2.1 The Significance of Coastal Land and Water Resources .. 32
3.2.2 Population Growth and Demands for Coastal Resources ... 33

3.3 Major Coastal Resource Development and Management Problems ... 37
3.3.1 Transition in Coastal Resource Development 37
3.3.2 Lack of Integrated Planning and Management 38

4. COASTAL RESOURCES MANAGEMENT AND ITS ROLE IN AQUATIC RESOURCES DEVELOPMENT 50

4.1 The Need for Coastal Resources Management 51

4.2 Coastal Resources Management as a Complement to Aquatic Resources Development 51

4.3 The Governmental Context for Developing a Coastal Resources Management Initiative in Indonesia 56
4.3.1 National Policy 56
4.3.2 Sectoral Line Agency Development Principles 57
4.3.3 Provincial Levels' Emphasis..... 57

Page

4.3.4 Implementation Problems at the National, Provincial and Local Levels 58
4.3.5 Specific Measures to Improve Implementation 59
4.3.6 Other Legal Instruments Related to Coastal Resource Initiatives 60
4.3.7 Key Institutions for Coastal Resources Management 61

4.4 Framework for Developing a Coastal Resources Management Initiative in Indonesia 65
4.4.1 Incorporating Other Countries' Experience in Coastal Resources Management 66
4.4.2 Improving National Resource Allocation Policies Related to Coastal Resources 71
4.4.3 Developing Provincial-Level Pilot Projects in Coastal Resources Management 72

5. RECOMMENDATIONS

5.1 Conceptual Approaches 74

5.2 Environmental Assessment 75
5.2.1 Background 75
5.2.2 Objectives 75
5.2.3 Recommendations 76

5.3 Coastal Resources Management 78
5.3.1 Background 78
5.3.2 Objectives 78
5.3.3 Recommendations 78

ACKNOWLEDGMENTS 93

APPENDICES
A. REFERENCES A-1
B. PARTIAL LIST OF CONTACTS B-1
C. PRELIMINARY ENVIRONMENTAL ASSESSMENT FOR PROPOSED AQUATIC RESOURCES DEVELOPMENT PROJECTS IN INDONESIA ... C-1

Page

LIST OF FIGURES

Figure 1. Principal Links and Natural Functioning among Important Indonesian Coastal Ecosystems 16

Figure 2. Multiple Use Strategies Adopted by Traditional Coastal Societies 38

Figure 3. Sectoral Approaches to Coastal Resources Development 40

Figure 4. The Ability of the Resource Base to Sustain Development under Poor Management 43

Figure 5. Major Fisheries Market Regions in Indonesia 52

Figure 6. National Level Framework for Instituting a CRM-ARD Initiative 83

Figure 7. Provincial Level Framework for Implementing CRM-ARD Projects 92

LIST OF TABLES

Table 1. Breakdown of Total Indonesian Land and Water Areas, in Square Kilometers 3

Table 2. Preliminary Classification of Marine and Coastal Habitats in Indonesia 9

Table 3. Coastal Ecosystems in Indonesia 12

Table 4. Future Land Requirements for the Development of Aquaculture 36

Table 5. Outline of Recommendations for Improved GOI Environmental Assessment Procedures 77

Table 6. Example of the Steps for Implementing a Major Coastal Resources Management Project in Indonesia 80

Table 7. Examples of Coastal Resources Issues of National Importance and How They Could be Addressed in CRM Project..... 84

Table 8. Examples of Major Provincial Resource Issues that Could be Addressed as Part of CRM Regional Demonstration Projects ... 87

EXECUTIVE SUMMARY

Indonesia's coastal and aquatic ecosystems are perhaps more diverse, complex, extensive, and productive than those in any other nation of comparable size. These systems already provide the major source of protein to the country's population of 160 million, as well as many other valuable materials and uses.

Because these ecosystems offer more promise than any of Indonesia's other land or water resources for intensifying and diversifying the country's resource development beyond present levels, the coastal regions of Indonesia will be the focus of much of the development activity required to support the needs of the population in the year 2000. While expanded aquatic resources development on a sustainable basis is certainly possible, especially in the eastern half of the archipelago, this task is made complex by the presence of three factors.

First, Indonesia's coastal and aquatic ecosystems are interconnected in terms of energy flow and subsidies, nutrient and mineral cycling, the movement of water and organisms, the protection afforded by some ecosystems to others, and the requirement for some species in one system to complete portions of their life cycles in others, including many species of economic and ecological significance. In one respect, this interdependence increases the resilience of the larger system to withstand natural perturbations and stresses. In another, external influences that drastically alter the functioning or structure of one ecosystem can have a rippling effect on other interrelated systems.

Second is the realization that upland, lowland and coastal activities are intimately linked by water draining to the sea. The coastal regions are therefore susceptable to the impacts of land use and resource management activities upstream.

Third, Indonesia's productive coastal ecosystems are concentrated along a relatively narrow zone near major human settlements and economic activity areas. Thus, the country's coastal resources are not only more accessible to development, but also are more vulnerable to disturbance, particularly as population and development increase.

Because of these factors, any projects undertaken in aquatic resources development and coastal resources management will have to take into consideration the environmental, socio-economic, resource, and political consequences inherent in such projects. The skills needed for such projects will require not only a high degree of technical expertise, but also the ability to weigh the effects of policy initiatives and to coordinate the efforts of many decision-making entities.

The scale of development that will have to be accomodated by the year 2000 will require both improved management and control over existing

development and far-sighted approaches to future development. The ability to manage Indonesia's coastal resources will hinge on the government's provision of the framework necessary to make sound decisions and to implement them.

Indonesia's development interests are increasingly turning towards the country's immense aquatic resources -- marine and freshwater fisheries, mangrove forests and swamplands -- and the coastal zone in general. This increasing attention is manifested in a number of projects or programs that are being proposed by the Government of Indonesia or foreign donors and investors.

In order to determine the feasibility of incorporating coastal resources management (CRM) activities into aquatic resources development (ARD) projects, we assessed the status of the important coastal ecosystems in Indonesia, the government institutions responsible for their management, and the possible environmental effects resulting from CRM and ARD activities. Our principal findings and recommendations follow.

PRINCIPAL FINDINGS

1. The inherent productivity of Indonesia's coastal resource systems is being reduced by the various and sometimes synergistic impacts of deforestation, accelerated runoff and associated soil erosion, sedimentation, fires, landfilling, dredging, excavation, and pollution. These impacts have led to declines in water quality and reductions in the abundance and diversity of commercial species of fin and shellfish through reduced larval recruitment, physiological stress, increased mortality, and severe reductions in habitat structure, quality, quantity and function.

2. Many of these impacts were clearly avoidable and the severity of others could have been reduced substantially had there been appropriate knowledge, planning, siting, and design of projects and ventures prior to making decisions on their implementation.

3. The present rate of stress on and degradation of coastal resources in Indonesia is so accelerated that it is not an exaggeration to state that future opportunities for expanded levels of resource use will be severely reduced, if not eliminated. Present levels of production already reflect a reduction of natural productivity in some areas of the country, including Java and Sumatra.

4. Several constraints are frustrating the Government of Indonesia's efforts to improve the framework of decision making on the nation's resources. These include:

   - The enforcement of conservation policies formulated at the national level is inadequate at the provincial level.

   - Indonesia has few scientists and professionals with the background to research and advise decision makers on better procedures and the ultimate choices to be made. But choices will continue to be made on such vital issues as transmigration, tambak production, forestry,

agriculture, and fisheries, whether or not the decisions are good ones. Clearly, the distribution of the country's resources, people, and decision makers among 13,700 islands and millions of square kilometers of ocean does not help to improve the transfer and implementation of national policies down to the local level. By necessity, Indonesia's day-to-day decision making is decentralized and to a large extent inconsistently applied between provinces (states) and kabupatens (counties). This decentralization, and the lack of integrated planning and management, lead to both intra- and inter-sectoral conflicts at all levels of government.

5. The country's chief ministers and scientists with environmental responsibilities have an enlightened perspective on the need to manage coastal resources. Recent expressions of this concern include passage of important environmental and coastal legislation, regulations banning the use of destructive fishing gear and techniques, the upgrading of the State Ministry of Population and the Environment, the establishment of a network of environmental study centers at regional universities, the expansion of the institutes of nature conservation to manage the nation's many recently designated preserves and parks, efforts to establish a greater number of protected areas, and the presence of similar initiatives at the provincial level. The Government of Indonesia also has stated its goal to coordinate coastal resource management and has written environmental assessments for proposed projects.

6. Sound, integrated planning and management can still reverse the current pattern of degradation of coastal resources in Indonesia so that they can support future development. Proper siting, design, and operation of resource development projects is possible if the consequences of the projects can be accurately assessed in advance and mitigation or less disruptive options pursued. The important thing is to establish the framework and authority for systematic planning and to maintain the functional integrity of the resource base.

7. The Indonesian government's decision making processes can emphasize intersectoral coordination and foster integrated multiple use forms of development. For individual projects, this should include improvements to environmental assessment procedures. On a larger scale, this will require the establishment of a coastal resources management (CRM) process. Coastal resource management allows each development project to be evaluated in terms of the benefits and costs of a full range of uses and functions in addition to sector-specific purposes.

8. If underutilized resources in some regions are used to support the intensification of aquatic resources development (ARD), the productivity and stability of the supporting ecosystems must be monitored and maintained. All ARD projects must focus on (1) reducing pressures on coastal areas resulting from the overexploitation and degradation of coastal ecosystems, (2) factors relating to the impacts of upstream activities, (3) improving procedures for allocating coastal areas among competing demands for land, (4) managing the human use of exploitable resources in a sustainable manner, and (5) devising measures to reduce avoidable adverse environmental impacts.

9. The Government of Indonesia can make improvements in its development activities within its existing structure. These should focus on changing and clarifying resource management policies and procedures; training scientists, advisors, and decision makers; expanding the scope of the evaluation process to include a full range of possible options, including all costs and benefits (economic, environmental and social); ensuring that decisions are based on adequate and accurate information; and devising broad land allocation and management policies that stimulate the intensification and, where necessary, extensification of land use activities in areas where the resources base will be sustained and respond most vigorously to individual development initiatives.

10. A CRM implementation activity should be included in at least one province to demonstrate how aquatic resources development projects can benefit from a coastal resources management process. Additionally, we believe that a larger scale CRM program in Indonesia is warranted, including a national policy and coordinating component and several regional demonstration components as a means of accelerating the government's full implementation of a CRM program.

In summary, time is of the essence. Indonesia's valuable coastal ecosystems are being degraded steadily but measurably -- one mangrove forest, coral reef, and turtle nest site at a time. Future development opportunities are also being foreclosed rapidly. The Indonesian government recognizes this and is anxious to get on with the management improvements. We believe that leadership, sufficient financial support, and professional assistance can make the difference in developing the country's resources in ways that are environmentally sound while benefiting Indonesia's people and economy. Without question, establishing a successful CRM program in Indonesia will be a great challenge and has the potential to reap even greater benefits.

RECOMMENDATIONS

Below, we make recommendations in two major areas: environmental assessment and coastal resources management.

Environmental Assessment

The goals of environmental assessment procedures should focus on ensuring that environmental planning and coordination are initiated in the early stages of project design as needs are identified and problems are specified. In this way, the environmental, economic, and social consequences of a full range of alternatives can be considered before project decisions are made. Whether an ARD project, a CRM project, or a project incorporating both ARD and CRM is adopted, we recommend that the project incorporate the following recommendations on environmental assessment.

1. The GOI's procedures for environmental assessment should be improved, including the revision of regulations, training, and publication of manuals and other tools for use by the environmental study centers (PSLs), the Ministry of Population and the Environment (KLH) and its local counterparts (BKLH), and the sectoral (implementing) ministries and

their provincial counterparts (dinas). The focus should be on improving the environmental assessment process and not merely on preparing environmental documents for specific development projects.

2. Capable and willing PSLs should be sponsored to conduct environmental studies by supporting the preparation of preliminary EAs for coastal zone development projects.

3. As part of recommendation 1), support should be provided to the AARD's KEPAS Agroecosystem Network to expand their working groups to include mangroves, aquaculture, biophysical aspects of coastal resource systems and others, and a CRM workshop on the environmental and socio-economic implications of the intensification of ARD should be held.

Coastal Resources Management

We recommend that an ARD project with CRM components or a larger, separately sponsored CRM project with ARD components be adopted. Below, we discuss the project components of CRM initiatives at both the national and provincial levels, but concentrate on the former project type.

CRM initiatives would have the objectives of encouraging integrated and informed decision making at the national and provincial levels in order to promote sustainable intensification and use of aquatic and related natural resources, while at the same time promoting compatible multiple uses that do not foreclose future opportunities or reduce existing values. These goals would be accomplished through implementing the following recommendations.

1. Review CRM issues and policies, compile information bases such as resource inventories, and identify areas of potential sectoral development conflict and impact.

2. To promote improved economic evaluations, broaden current analyses to include environmental constraints and externalities as well as incorporate those analyses early in the planning cycle.

3. Improve the forecasting procedures for future land requirements in coastal areas.

4. To facilitate coastal and aquatic resources development, improve the decision making process at both the national and provincial levels.

5. Provide on-the-job and specialized training for GOI officials and researchers responsible for assessment, evaluation, and decisions regarding coastal development.

6. Develop additional workforces at government institutions and universities by identifying target positions to be staffed by professionals.

7. Improve the quality of information upon which development decisions are based by supporting the KLH data processing center, research, publications and workshops.

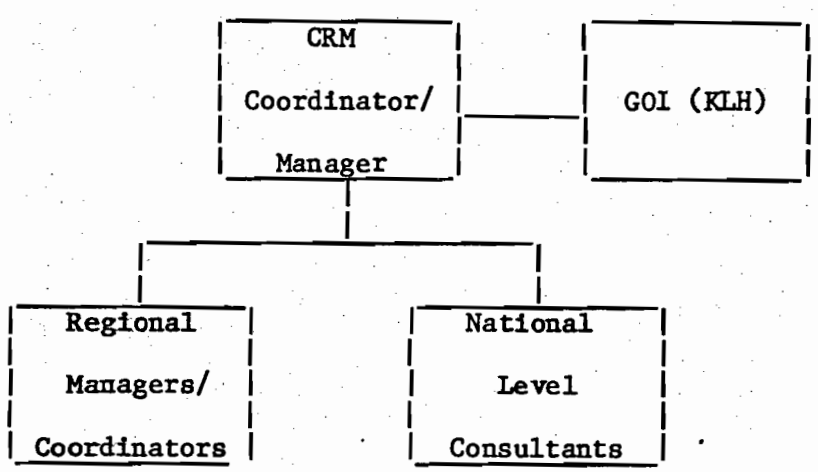
8. Revise national policies, laws, and regulations and devise resource allocation priorities to ensure consistent and clear application of CRM principles. This should include the development of management guidelines.

9. Implement regional or provincial demonstration projects to provide hands-on experience in planning for development within a CRM context on a day-to-day basis.

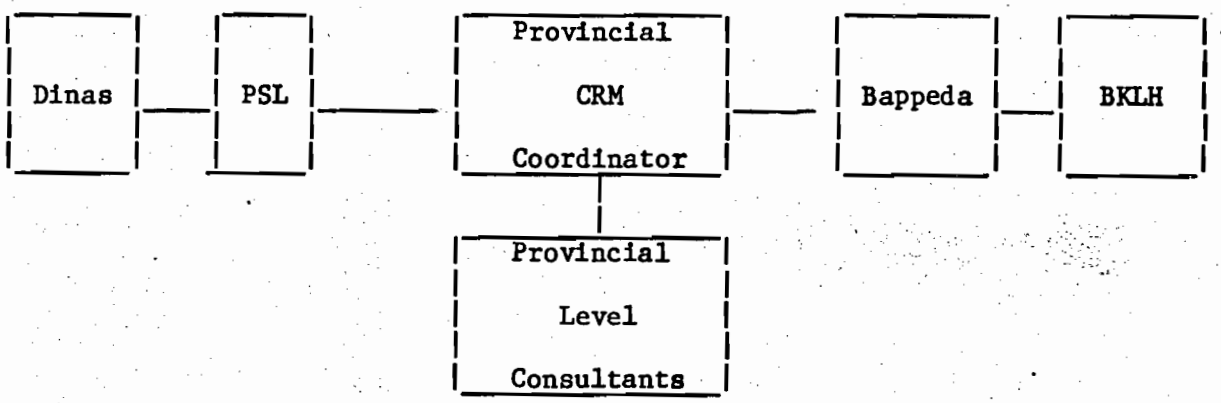
10. Encourage the expansion of the CRM initiatives beyond the selected provinces through training, workshops, publications, and incentive grants.

11. Communicate achievements and lessons learned on the CRM project to other provinces, kabupatens, and nations (especially in ASEAN).

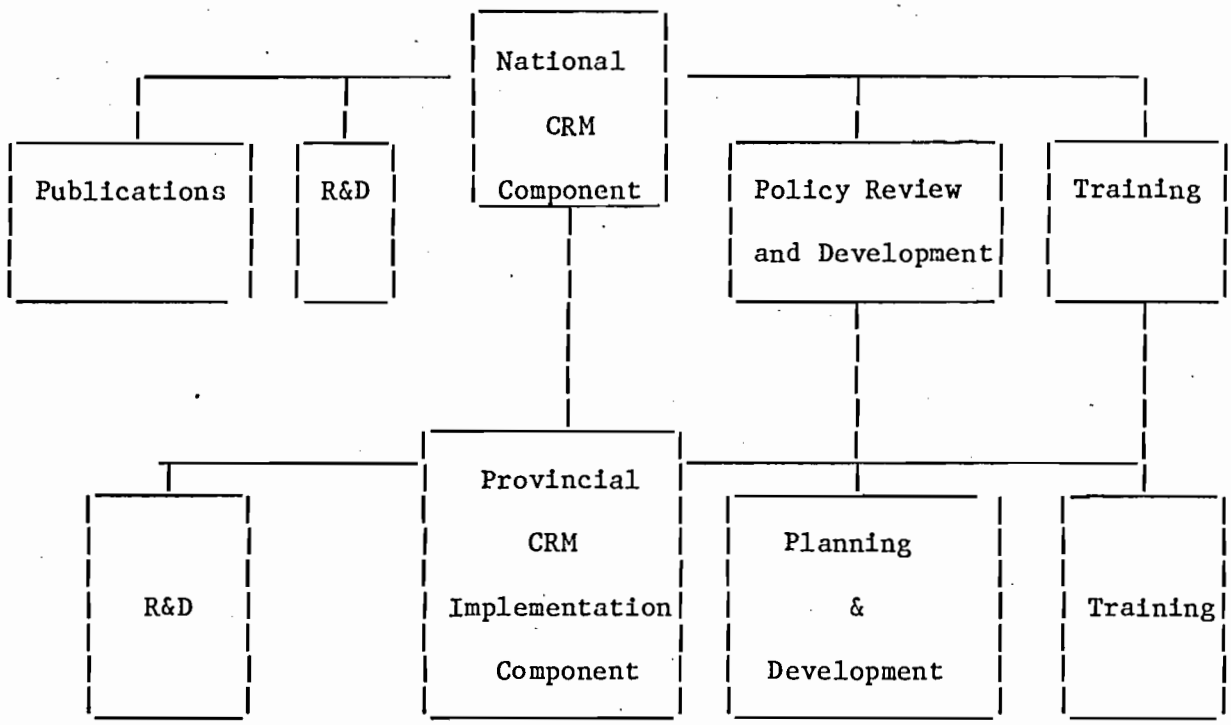
National Level Organization. The CRM component of an ARD project should provide for a senior CRM coordinator who will work with national KLH ministry counterparts, a regional (provincial) implementation coordinator, and short-term special consultants hired to work on national level R&D, training and publication tasks. For a larger, separate CRM project, the coordinator would serve as a project manager at both the national and provincial levels.



Provincial Level Organization. The national CRM coordinator (or the regional/provincial manager in a separate CRM project) would work with a lead provincial counterpart (Bappeda), the BKLH environmental advisor, Fisheries Dinas advisor, PSLs in the province, and short term special consultants working on regional level R&D planning, training, fisheries, engineering tasks, etc.



Project Components. If CRM is undertaken as part of an ARD project, it should have the following national and provincial components.



The goal of the national policy component would be to focus on establishing links with the KLH to develop a national policy on CRM including: revision or passage of a new CRM act; implementing regulations for use by the sectoral ministries; and development, publication, and distribution of a CRM manual. These initiatives will give greater authority to the provincial implementation projects and encourage consistent application of CRM policies.

The regional implementation projects will be established at provinces (South Sulawesi is recommended in Section 5) and will focus on evolving a regional operational program to promote development, including aquatic resources development, and to conserve coastal resources in the context of CRM principles.

The policy review development components would be responsible for devising and implementing development plans at the national and provincial levels, which could either be conceptual (emphasizing the procedures for decision making), geographic, or both.

The training components would initially focus on 1) project designs, program development, and policy analyses of coastal resources development and 2) national and regional officials responsible for the evaluation of

researchers who will be responsible for training others throughout the country. Later, additional training sessions and workshops would be sponsored to take advantage of experience and published materials.

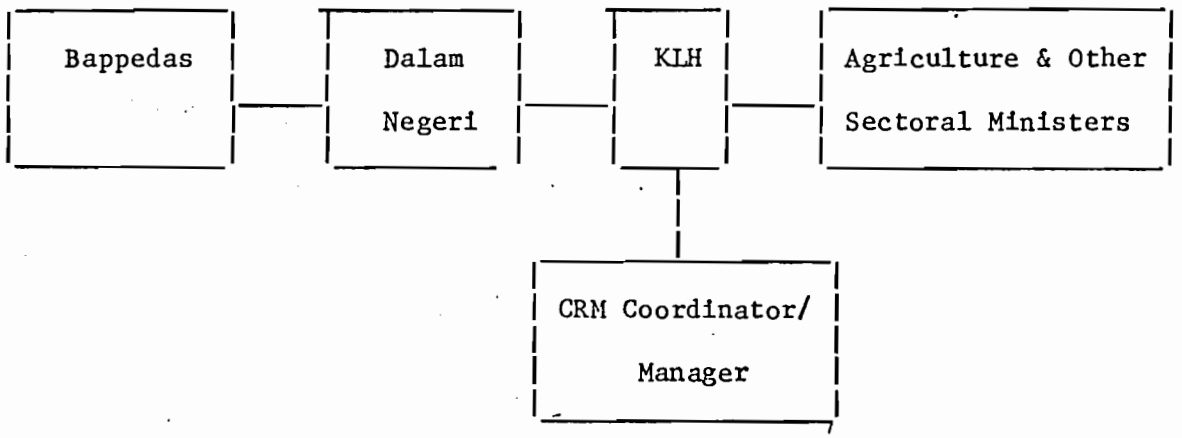
The research and development components would focus both on critical national CRM research needs (country-wide) and on research and development needs in the provincial implementation project regions.

A separate publication and media component would ensure timely and adequate reproduction and distribution of written products, and full implementation of the new KLH data processing center.

For a larger CRM project, the organization would be essentially the same, except that regional implementation components could be placed in more than one province.

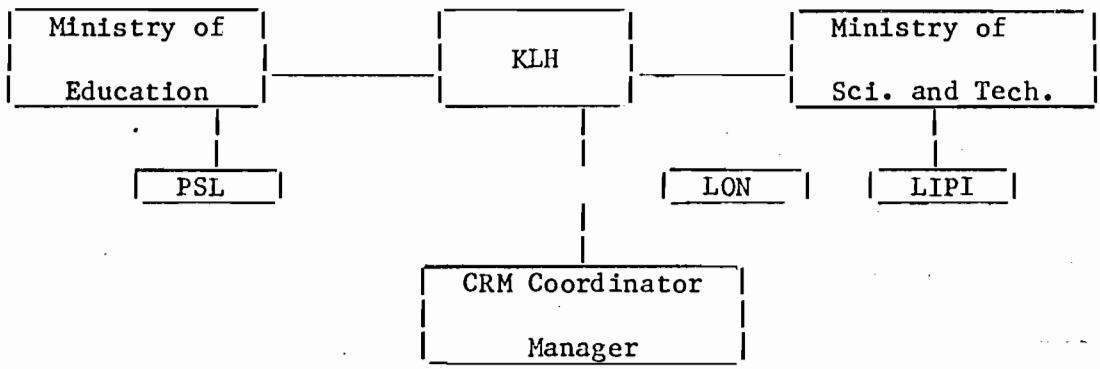
Coordination within GOI. Coordinating the national initiatives should be accomplished through the State Ministry of Population and the Environment (KLH), which in turn would be responsible for all other national level coordination among other GOI ministries, institutes and offices. The organization for national policy initiatives to be sponsored by a CRM project or a CRM component of an ARD project would have an organizational structure and components that are different from the corresponding research and development initiatives.

The development of improved planning procedures and the refinement of national policies on coastal resources management will need input from various sectoral ministries (Forestry, Agriculture, Transmigration, etc.) and project approval, at least in the beginning, from Bappenas. Dalam Negeri (the Ministry of Interior) would responsible for program guidance to the provincial Bappedas.



The suggested coordination framework for the national research and development initiatives to be supported by a CRM project is diagrammed below. The Ministry of Education would be peripherally involved because it provides financial support, but the Ministry of Population and the

Environment (KLH) can provide funds for research directly to the regional Environmental Study Centers (PSLs). The National Institute of Oceanology (LON) is organized within the Indonesian Institute of Science (LIPI). LIPI is organized within the Ministry of Science and Technology. However, LON has authority to work directly with outside donors and conduct research. Thus, we propose that LON be responsible for coordinating all national level remote sensing; environmental, ecological and oceanographic research related to coastal resources; and cooperating with selected PSLs and other institutions in accomplishing some of the national research.



Implementation Steps

1) Conduct workshop on CRM and ARD.

2) Select CRM project manager/coordinator.

3) Select provinces for implementation projects.

4) Select provincial CRM manager/coordinators.

5) Establish agreements and linkages with GOI counterparts in KLH.

6) Establish agreements and linkages with provincial GOI counterparts in Bappedas, PSLs, and BKLH.

7) Implement policy studies on revision of CRM laws and regulations.

8) Implement critical national level R&D.

9) Complete CRM manual, publish, and distribute.

10) Conduct workshop for counterparts in national or regional levels.

11) Initiate planning and development plans at Bappeda level, including intersectoral coordination.

12) Initiate regional R&D projects.

13) Complete and publish results of national R&D.

14) Encourage GOI passage of CRM plan and grants program (for research, training, extension).

15) Complete provincial development plans, publish and distribute.

16) Complete regional R&D projects.

17) Implement the provincial plans with outside consultant assistance working with counterparts.

18) Hold nationwide series of workshops to disseminate results of national and provincial initiatives to other provinces not served by the CRM project.

19) Hold international and ASEAN workshops to communicate CRM results that are applicable to other countries or involve international resources (migratory species, etc.).

20) Synthesize reports on achievements and lessons learned from CRM in Indonesia and disseminate reports to other countries.

21) Provide limited incentive grants to other provinces and Bappedas who adopt plans and the CRM planning process.

22) Develop and publish a CRM model for application to other countries.

23) Completion of project (5-7 years).

Expected Products and Achievements

A successful CRM project will:

- improve the quality of decisions made on the development of Indonesia's coastal resources;
- allow successful intensification of aquatic resources use (a larger CRM project would allow intensification of all coastal resources including aquatic, agricultural, forest, mineral, etc.) without foreclosing future uses;
- avoid unnecessary damage to coastal ecosystems and habitats' functions and values;
- improve the quality and flow of research data of importance to CRM decisions;
- encourage more informed decisions on potential uses of coastal resources through the education, training, and experience of the researchers and government officials involved in the project;

- result in institution strengthening and building in many national and provincial agencies and universities;
- increase the size of the workforce responsible for management, research and training on coastal resource management;
- stimulate similar initiatives in provinces not receiving direct assistance and in other countries; and
- result in the dissemination of information and extension services on CRM that would be of interest to the public-at-large in Indonesia and other countries.

1. INTRODUCTION

1.1 SCOPE AND ORGANIZATION OF THE REPORT

Because of the continuing importance of Indonesian fisheries development, the U.S. Agency for International Development (USAID) requested that two study teams under contract to Resources Development Associates (RDA) and the International Institute for Environment and Development (IIED) evaluate the potential for aquatic resources development (ARD) in Indonesia. The Resources Development Associates' study (Bailey et al., 1985) made recommendations in the areas of marine fisheries, education and training in aquatic sciences, aquaculture development, and coastal aquatic resource management and development. The present study investigates the general environmental impacts of possible ARD activities in Indonesia and describes the need and possible actions for integrated coastal resources management (CRM) efforts.

CRM is defined here as an integrated and comprehensive planning and management framework in which the economic, social and environmental consequences of alternative development proposals are evaluated, compared, and coordinated among all decision makers before specific development plans are selected and implemented. The principal objective of CRM is to conserve and maximize the sustainable use of coastal resources.

Briefly, our specific tasks were to:

- describe the main productive ecosystems for key aquatic resource commodities and the factors constituting important links to the functioning of those systems;
- identify current practices and problems that may constrain sustainable ARD;
- identify critical gaps in the knowledge needed to assess ARD practices and problems;
- provide the scope for detailing environmental assessments for future ARD projects;
- identify the general coastal resource development and management problems in Indonesia;
- summarize the status of CRM policies and regulations, including the roles of key institutions and governmental authorities;
- assess the political interest, capabilities, and deficiencies in CRM on the part of the government agencies that are critical to the success of a CRM project in Indonesia;
- assess the applicability and utility of the CRM approaches taken by both developed and other developing countries that can be valuable to Indonesia;

- o review the relationship of existing and future CRM and ARD programs in Indonesia to other relevant regional and international initiatives; and

- o determine the need for and scope of a future workshop on the ecological and socioeconomic implications of current trends in and the intensification of aquatic resources production in Indonesia.

The remainder of this report is organized as follows. Section 1.2 gives background information on Indonesia's aquatic resources and the need for their development. Section 2 describes the methods and sources of information used in this study. Section 3 provides descriptions of the important coastal ecosystems in Indonesia (including examples of problems that are constraining the future development and sustainability of productive ecosystems as well as areas where ARD projects could be undertaken) and gives an overview of the country's future demand for coastal resources. Section 4 presents our conclusions on the need for CRM, its role in ARD, and the framework for developing a CRM project in Indonesia. Section 5 provides our recommendations for improving Indonesia's environmental assessment procedures and for the development a CRM project in Indonesia as part of an ARD project.

Appendices A and B provide references and a partial listing of the professionals consulted for this project, respectively. Appendix C presents a preliminary environmental assessment that includes locations for ARD projects suggested in Bailey et al. (1985)) and a scope of work for the environmental analyses necessary for these projects. This assessment was prepared in accordance with the U.S. National Environmental Policy Act, and Council on Environmental Quality and AID regulations; it should also meet the intent of counterpart Indonesian laws.

Although both the RDA and IIED reports were originally prepared as feasibility studies for a proposed USAID program initiative in ARD, this report is presented in general terms so that it can be applied to virtually any new ARD projects in Indonesia. It should be kept in mind that because the authors focused their field work and analyses on areas of primary interest to USAID (see Bailey et al. (1985), the present report should not be regarded as a comprehensive or definitive treatment. Furthermore, because documentation was not available and research has not been conducted for many of the impacts and coastal use conflicts, many of the problems discussed in this report are based on the observations and judgments of the authors.

1.2 BACKGROUND FOR AQUATIC RESOURCES DEVELOPMENT

The Republic of Indonesia stretches east to west over a distance of 5,000 km from the Indian Ocean to the Pacific Ocean and straddles the equator over a north to south distance of 2,500 km. The total water and land area of the country is almost 9 million km^2; of this area, land comprises only 1.9 million km^2 (see Polunin, 1983 and Table 1).

Table 1

Breakdown of Total Indonesian Land and Water Areas, in Square Kilometers. After Polunin (1983), Rushing (1984), and Indonesian Statistical Survey (n.d.)

Territorial land	1,905,000
Territorial seas to the 12 mi limit	
enclosed marine waters	2,700,000
open ocean waters	400,000
Continental shelf waters	1,500,000
Total water area (including EEZ)	6,846,000
Total land and water area	8,751,000

Particularly significant is that Indonesia consists of over 13,700 islands of varying size, about 3,000 of which are inhabited. The country's estimated total shoreline of roughly 81,000 km (Polunin, 1983) is the second-longest in the world (comprising 14% of the earth's shoreline), ranking behind only the Soviet Union.

For its size, Indonesia exhibits the most unusual and varied physical structure of any country in the world (Wyrtki, 1961). Its aquatic systems include abundant pelagic water bodies overlying deep ocean trenches, abyssal slopes, plains, straits, continental shelves, and nearshore water bodies. Indonesia has abundant coral reefs, lagoons, embayments, open coasts, enclosed seas, inland fresh and brackish water bodies, and wetlands including marshes, swamps, streams, rivers, ponds, and lakes. Blessed with numerous estuaries, upwelling zones, and other productive tropical coastal ecosystems (especially coral reefs, seagrass beds, and mangroves swamps), it is not surprising that Indonesia's rich and varied ecological resources contribute substantially to the support of its population, estimated in 1980 at 147.5 million with an average annual growth rate of 2.4%.

The country's geographic location and physical characteristics are particularly favorable for fisheries development, and Indonesia ranks twelfth among the world's fishing nations. The use of fishery resources is growing slowly but steadily to meet demands for protein food supplies; to provide more employment opportunities for fishermen, distributors, and processors; and to better the country's position with respect to foreign exchange. During the past 20 years, most of the increase in aquatic resources production was contributed by marine fisheries. Indonesia's aquaculture production acreage is also growing and now exceeds that of other Southeast Asian countries. Production from inland waters has declined slightly in recent years, possibly due to a variety of factors, including better job opportunities for fishermen and fish farmers in other industries, siltation and eutrophication in inland water bodies and wetlands, increased pollution including the use of pesticides and herbicides, and overfishing in accessible fishing grounds. Nevertheless, official government projections indicate that the present overall fisheries production of 1.4 million tons per year is only

30% of the potential national yield and could be increased to a maximum sustainable yield (MSY) of 4 million tons annually. Even if far more conservative estimates of future MSY are used, it is clear that significant increases in production are possible from all components of the nation's aquatic resources sector, including inland/freshwater capture fisheries, fresh and brackish aquaculture fisheries (including tambak), and mariculture and marine capture fisheries.

Despite the significant contribution of fisheries to the country's total consumption of animal protein (62%), the economic contribution of the fisheries sector to gross domestic production in 1981 was only 1.58%. Although the sector currently provides employment for 3 million fishermen and fish farmers (or 5% of the total national workforce), the majority of workers earn very low incomes (about $300/year on average) and have very low standards of living (Rushing, 1984). It is believed that most fishermen and fish farmers have little access to adequate marketing facilities, which constrains their ability to sell outside their local market and fish collection systems. Other factors constraining the increased marketing of fisheries products include poor processing techniques, which reduce quality and export demand, and infrastructure and management problems within the aquaculture industry.

Another important problem is that in-country demand for fisheries products is much higher in western Indonesia (especially Java and Sumatera), where populations are much greater. Most of the country's fishermen live in these areas and have access to very productive coastal fishing grounds. As a consequence, the local MSYs for coastal fisheries production off the crowded western islands have probably already been achieved or exceeded (except perhaps for offshore pelagic fisheries). Furthermore, there is little incentive for the majority of the fishermen on Java and Sumatera to exploit underdeveloped fishery stocks in eastern Indonesia unless a variety of constraints related to transportation, fishing range, marketing, storage, and processing can be overcome.

The Government of Indonesia (GOI) has clearly recognized that most of the country's aquatic production lies in the waters of the eastern half of the archipelago, while most of the demand for fisheries products lies on the islands of the western half. This supply-demand problem is part of the general protein shortage and over-population problem on Java and Sumatera, and is a factor in the GOI's programs to relocate large numbers of people off the crowded western islands to the more sparsely populated eastern islands (moving the people to the fish). The GOI also recognizes the need to increase fisheries production and distribution to the western islands (moving the fish to the people) where per capita animal protein consumption is very low and substandard for low income groups. As a consequence, the government has established in its latest Five Year Plan, Repelita IV (1984-1989), the following broad policy objectives with respect to fisheries development:

- increase the income and standard of living for small fishermen and fish farmers and extend employment opportunities;

- improve the productivity of fishermen and fish farmers and at the same time increase total fish production;

- increase fish consumption, particularly among low-income population groups;
- increase exports and decrease imports of fishery products; and
- improve management and utilization of fisheries resources.

The GOI has also established target levels under Repelita IV for increases in national fish production, consumption, and exports. All these goals point to the GOI's recognition of the importance of fisheries development in assisting one of the lowest income groups in the Indonesian economy (fishermen) and providing the most important source of animal protein (fish) to the Indonesian diet.

2. STUDY METHODS

Summarizing accurate ecological and coastal resource utilization data for a country with a combined land and water area equal to that of the United States and with coastal ecosystems of greater magnitude, relative importance and diversity is a formidable task. To accomplish this work, several approaches were used.

We relied heavily on literature reviews (Appendix A) and on interviews with GOI and AID officials, fishermen, scientists, and others knowledgeable about the ecosystems and coastal resources of significance in Indonesia (Appendix B). In addition, one of the authors has had considerable experience in CRM issues in Indonesia since 1978, and participated in a major environmental sector review (Burbridge, 1983). This review helped to expand the universe of our analysis, and to clarify the relationship of ARD and CRM to other similar programs and initiatives within Indonesia and adjacent Southeast Asian countries.

We also recognized the value of presenting site-specific evaluations of several selected regions in Indonesia as a means of gaining a more thorough perspective on the nature of the ecosystems of importance and their management problems. These regional evaluations were based on site visits and supplemented with information obtained from the literature, interviews, and previous experience. The visits to provinces in Indonesia included: South Sulawesi, Maluku (particularly the Ambon area), Bali, West Sumbawa, South Sumatera, and West Java. These provinces offered a good cross section of issues and problem areas that would be encountered with either an ARD or CRM program of national scope. Also, Burbridge's previous experience within Java, Sumatera, and Kalimantan contributed additional regional information.

In each of the above regions, we attempted to visit potential coastal resource fishery and fish culture sites in areas with significant terrestrial and coastal ecosystems. In these areas, we observed ongoing management practices (exploitation, conversion, conservation, grazing, agriculture, etc.) and interviewed individuals in and out of government about the values, functions, demands, and management problems associated with coastal ecosystems in the region. Attempts were also made to contact representative officials from environmental agencies and university environmental study centers within each region.

Although the regional descriptions and analyses presented in Section 3 offer useful examples of the enviromental issues facing the country's coastal ecosystems, our geographical "sampling" was very small. Nonetheless, we feel we have covered the most important types of environmental and coastal resource issues present in most of the important types of ecosystems. Furthermore, through the literature review, we were able to judge whether the issues were more likely to be of regional or national scope. We relied heavily on the regional analyses and on consultations with the literature to develop priorities on management recommendations.

In evaluating the coastal resource management strategies that may be of value to Indonesia, a variety of established and proposed developed and developing country models on coastal zone and coastal resource management were analyzed.

3. COASTAL RESOURCES IN INDONESIA: RESULTS AND DISCUSSION

3.1 DESCRIPTION AND INTERRELATIONSHIPS OF INDONESIA'S IMPORTANT COASTAL ECOSYSTEMS

Wallace (1869) was the first to record that the physiography of the Indonesian archipelago has western and eastern halves with different origins and characteristics. To the west are several very large islands, abundant continental shelves, shallow seas, heavy rainfall, lush vegetation, and terrestrial fauna more closely associated with the Asian continent. To the east is a more oceanic environment with many smaller islands, abundant coral reefs, and terrestrial biota more closely associated with the Australian continent. The marine biota, however, may be more homogenous throughout the archipelago because water is a more efficient medium for the dispersal and transport of aquatic species.

Natural scientists have only begun to describe the major categories of marine and coastal ecosystems and their distribution in Indonesia, although a number of cultures have relied upon these systems for many centuries. Indonesia's marine biota are located within the center and most diverse part of the Indo-Pacific biogeographic province, and many marine tropical species groups are relatively more abundant within Indonesia than regions west, north, and east of Indonesia and south of Northern Australia (see Polunin, 1983). Although the exact reasons for the evolution of this biological richness over recent geological time are not conclusively known, it is probable that habitat diversity, magnitude, and perhaps climatic stability over long periods are contributing factors.

Useful recent syntheses of available information on Indonesia's coastal ecosystems, including human impacts, have been compiled by Soegiarto and Polunin (1982) and further refined by Polunin (1983). More recently, Knox and Miyabara (1984) have described and analyzed coastal zone resources and their development and conservation in Southeast Asia, with special focus on Indonesia. Another recent comprehensive study sponsored by the International Union for the Conservation of Nature and the World Wildlife Fund (IUCN/WWF) has contributed considerably more information on the quality and distribution of marine and coastal habitats (Salm, 1984 a-f). This project also reviewed existing conservation programs and policies, inventoried valuable areas, and recommended the formal protection of a number of those areas. Salm (1984d) also gives a preliminary classification system for marine and coastal habitats in Indonesia (see Table 2 below) which includes 45 separate categories. The distribution of many of these habitats are compiled on maps. The IUCN/WWF work represents a major contribution to the knowledge of coastal ecosystems in Indonesia and will be a valuable reference for future ARD and CRM projects, particularly for the inventory and evaluation of areas designated for protection or management on a sustainable basis.

Table 2

Preliminary Classification of Marine and Coastal Habitats in Indonesia. After Salm, 1984d.

1. Coastal Environments

   1. Sand beach
   2. Shingle beach (coral rubble)
   3. Cobble beach (rock, small rocks)
   4. Rocky shore
   5. Cliffed shore
   6. Bay
   7. Estuary
   8. Brackish barrier lagoon
   9. Atoll lagoon
   10. Back-reef lagoon
   11. Intertidal sand/mud flat
   12. Intertidal reef flat
   13. Delta
   14. Dune
   15. Limestone/sea cave
   16. Coastal plain

2. Offshore Environments

   1. Coral cay
   2. Oceanic volcano
   3. Other oceanic island
   4. Alluvial bar/bank
   5. Continental shelf soft bottom
   6. Continental shelf hard bottom
   7. Continental slope
   8. Submarine plateau/bank
   9. Abyssal plain
   10. Ocean trench/trough
   11. Ocean ridge
   12. Basin
   13. Strait
   14. Gulf

3. Pelagic Environments

   Upwelling

4. Coast-associated Habitats

   1. Algal beds
   2. Seagrass beds
   3. Salina/saline marsh
   4. Mangrove forest backed by swamp forest
   5. Mangrove forest backed by dry ground
   6. Deltaic mangroves on accreting coasts
   7. Mangrove on limestone
   8. Dwarf mangrove on reef flats
   9. Coastal swamp forest
   10. Beach forest
   11. Coastal shrubland
   12. Coastal grassland
   13. Coastal palm forest

5. Coral Reefs

   1. Atoll
   2. Barrier reef
   3. Fringing reef
   4. Patch/platform reef

In this report, a simpler and more functional set of ten ecosystem categories is described. The categories were selected on the basis of greater relative importance and magnitude. Several of the individual habitat categories described by Salm were combined within broader categories (for example, within the categories of coral reefs, mangroves, and freshwater ecosystems). The category of agroecosystems was included on the basis of its major influence on most of the other nine "natural" ecosystems. Table 3 presents a list of the coastal ecosystems discussed here, and their values,

functions, and interrelationships, as well as the negative impacts that human practices have had on these systems. As noted earlier, specific geographic examples of problems and issues encountered during the field visits are included in the discussions below to provide additional dimension and insight. More comprehensive geographic coverage of the issues and problems is found in the above-listed references.

3.1.1 Interrelationships among Ecosystems

Technically speaking, the ten ecosystem categories described below do not reflect the reality of nature because none of them exists in isolation from the others. It is widely recognized that many coastal ecosystems are closely associated with one another because of the flow of energy and mineral resources among systems, their physical interdependence, similarities in physical tolerances between one system and another, and the presence of many organisms that are characteristic of one system but spend part of their life cycle in other systems. Figure 1 presents a theoretical approximation of the important irrelationships that might be expected among the major Indonesian ecosystems treated in this report, including agroecosystems but excluding other external human factors (urban, industrial and petrochemical activities, and pollution). These other factors are reviewed in Burbridge (1983) and in Knox and Miyabara (1984).

There have been only a few studies of the interrelationships and functioning of closely related or adjacent aquatic ecosystems in the tropics. Berwick (1983) used a systems approach to evaluate the physical relationships among coral reefs, seagrass beds, and mangroves and the possible factors responsible for their frequent spatial association. Under a certain set of conditions, all three can exist in close proximity or be dependent on one another, but under other conditions, only one or two might occur at a particular site.

This raises an important and closely related point that all geographical expressions of a particular ecosystem type do not exhibit equivalent values or functions. Some coral reefs, for example, may be more productive than others due to a variety of physical, biological, or historical factors, while marginally "valuable" examples of such reefs are often located near areas where the extremes in physiological tolerance of corals or other dominant reef organisms are approached or exceeded. This fact has important environmental implications for aquatic resources development and coastal resources management: some coral reefs, for example, may be more valuable than others and may need to be afforded higher priority for protection or sustainable use than others. Hence, inventory projects like the IUCN/WWF study are especially valuable in providing first approximations of the ecosystems deserving priority attention.

3.1.2 Agroecosystems

Agroecosystems, which are described briefly below, provide the major subsistence and economic support to the population in terms of food, fuel, construction materials, other domestic products, and employment. Agroecosystems include lands that are intensively managed or established for the purposes of growing crops (agriculture) forestry products (silviculture),

livestock and poultry (animal husbandry), and fishery products (aquaculture) for human consumption. In Indonesia, these ecosystems include four activities that are intensively managed in terrestrial watersheds throughout the country:

- o agriculture (the principal crops grown are rice, cassava, vegetables, fruits and melons, maize, coconuts and copra, sweet potatoes, sugar cane, natural rubber, palm products, soybeans, groundnuts, coffee, tea, and tobacco);*
- o livestock (the principal livestock include chickens, ducks, goats, cattle, sheep, pigs, buffalos, and horses);
- o silvaculture (the principal forestry activities include fuelwood, sawlogs, industrial wood, mine timber, and pulpwood (Indonesian Statistical Survey, n.d.)); and
- o aquaculture (including tambak or brackishwater pond culture); the present major aquaculture species in Indonesia are milkfish, bannana prawn, tilapia, other penaeid prawns, and crabs.

Management Practices and Effects. Aside from displacing natural terrestrial and aquatic ecosystems, the principal agroecosystem activities that can influence natural tropical ecosystems include land management practices that increase the erodibility of soils and change water runoff characteristics; excessive livestock grazing pressure on ground cover; short cycle swidden agriculture (slash and burn); use of pesticides, herbicides, and fertilizers; deforestation; excess clear cutting; and diversion of water for irrigation. A discussion of the adverse environmental effects of Indonesian agricultural practices is found in Knox and Miyabara (1984) and Smithsonian Institution (1974); these effects are infilling and sedimentation, water pollution, and eutrophication downstream.

During our field visits, we observed a number of agricultural and related practices that are detrimental to other ecosystems. For example, slash-and-burn using a very short rotation cycle was reported in nearly all areas, but was particularly damaging in Sumbawa where steep erodible soils, arid climate, and heavy livestock grazing pressure appear to have resulted in considerable soil erosion, and sediment transport and deposition to coastal and aquatic areas. In another instance, we observed a major freshwater marsh in West Sumbawa that was rapidly being filled in, probably due to sedimentation from upland agriculture and water diversion for irrigation. Also, turbid estuarine waters and extensive salt pans and mud flats were observed near the mouths of several large rivers; accelerated upland soil erosion may have contributed to the situation. In contrast, the relatively virgin forested areas we visited in central Sumbawa lacked visible evidence of much soil erosion, and adjacent coastal waters appeared free of siltation. Although government officials in Sumbawa pointed out that regulations prohibit slash-and-burn agriculture, it was clear to us that these laws were not being enforced. It was also clear that livestock, range

* The products for the first three ecosystems are listed in descending order of tonnage, head, and cubic meters produced, respectively.

Table 3

Coastal Ecosystems in Indonesia

CATEGORY	POSITIVE VALUES, FUNCTIONS & USES	DETRIMENTAL USES & PRACTICES	ADVERSE ENVIRONMENTAL CONSEQUENCES
Agroecosystems	food production livestock production timber products fuel fish production	short cycle slash & burn (swidden) agriculture overgrazing by livestock overexploitation/clear cutting of forests inappropriate application of fertilizers, pesticides & herbicides deforestation	soil erosion loss of soil fertility sedimentation downstream pollution & contamination within ecosystem and downstream reduced production within ecosystem and downstream infilling of wetlands, estuaries, seagrass, reefs
Tambak	increased fishery production increased income, living standards increased per capita protein consumption	unnecessary conversion of mangroves & other valuable coastal systems water pollution, poor siting, excessive pesticide uses	loss of fishery resources reduced prawn & milk fish fry (and natural stocking) reduced marketability
Freshwater ecosystems (including lakes, marshes, rivers, wetlands, streams)	natural flood control & storage water supply and recharge nutrient and sediment sinks, water bird habitat food production building & energy materials	conversion to dry land conversion to wet agriculture sedimentation from soil loss irrigation withdrawal flood control channels	increased flooding degradation of habitat infilling & water pollution downstream infestation by aquatic weeds reduced fishery yields reduced water quality

Table 3 (continued)

Beaches (including associated beach forests)	nesting habitat for birds, sea turtles pupping habitat for dugongs? recreation tourism fishing habitat (recreational & subsistence) timber & fuel protection from coastal hazards	coastal structures aggravating beach erosion exploitation of eggs & adult turtles excessive beach & reef mining conversion of beach forest & dunes to urban use oil pollution	decline in sea turtles loss of beaches degraded tourism value damage to coastal structures & buildings reduced fishery values water pollution from eroded beaches loss of habitat, timber & fuel increased coastal erosion
Estuaries (including associated mud flats and embayments)	nutrient influx to coastal waters fisheries production nursery & spawning areas for many coastal fish links to mangroves, seagrasses, pelagic & demersal fisheries	urban pollution (sewage, thermal) industrial pollution hydrologic modifications (upland irrigation and water withdrawal) conversion to tambak & fast land over exploitation of resources	reduced fishery production reduced habitat for adults and fry of fishery species infilling & sedimentation reduced estuarine habitat degradation of water quality
Tidal swamp forests	habitat for fish, wildlife & plants flood storage links to mangroves timber and fuel links to rice culture fisheries production	excessive logging conversion to tambak conversion to dry land reclaimation & irrigation destruction of mangrove buffer inappropriate channelization transmigration sites	reduced fishery yields reduced timber & fuel degradation of habitat loss of wildlife & plants reduced rice yields disruption of hydrologic regime, acid soils, loss of peat

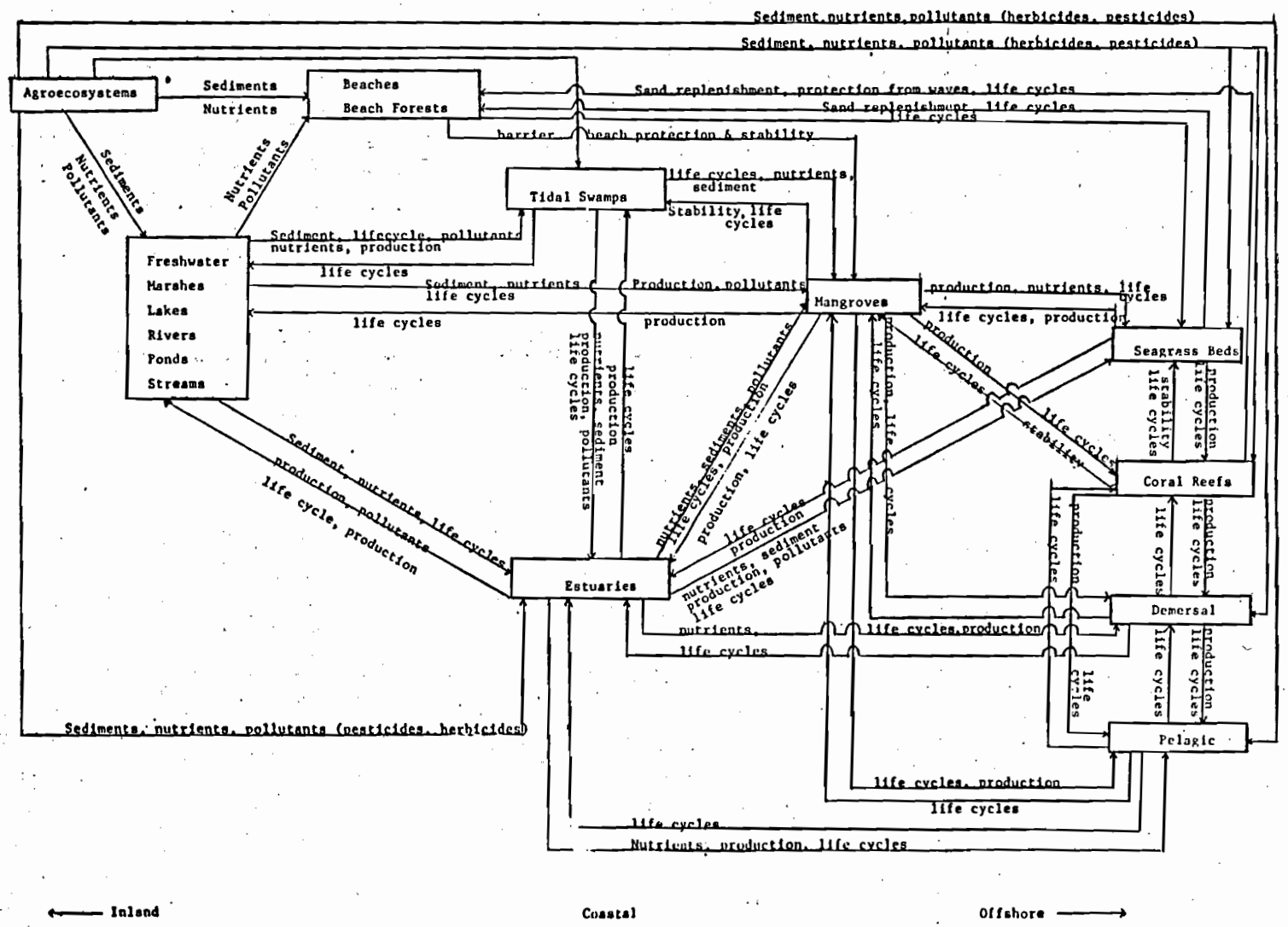
Table 3 (continued)

Mangroves	sediment filter nutrient filter fishery resources (fin & shellfish) net transfer of production to coastal fisheries breeding & spawing grounds for many coastal species nursery ground for coastal & estuarine species links to seagrass, coral reefs shoreline protection buffer for tidal swamps timber fuel tanning & other chemicals	transmigration sites conversion to dry land excessive upland soil erosion overexploitation of wood overexploitation of fishery resources upland irrigation & water withdrawal oil pollution	degraded coastal water quality loss of most values, functions & uses loss & degradation of habitat due to sediment infilling reduced fishery production reduced fry production reduced nursery habitat secondary impacts to reefs, seagrasses, swamps
Seagrass beds	nutrient filter net transfer of production to coastal fisheries feeding habitat for green turtles, dugongs, nursery grounds for coastal fisheries links to mangroves, coral reefs fishery production, esp. finfish	coastal urban pollution-- thermal & domestic sewage industrial pollution coral mining (excessive) excessive upland soil erosion overexploitation of fisheries inappropriate coastal development construction & dredging oil pollution	degradation of habitat loss of habitat due to infilling loss of habitat due to hydraulic changes displacement of seagrasses reduced fishery production loss of fry & breeding habitat

Table 3 (continued)

Coral reefs	links to seagrass, mangroves, beaches & coral islands shoreline protection beach sand replenishment, production high internal productivity shellfish production finfish production spawning grounds for fish nursery grounds for fish tourism & recreation ornamental species (shells, corals, fish, etc.) sea weed harvesting mariculture	excessive coral mining sedimentation dredging & filling over exploitation industrial discharges fishing with poisons & explosives urban pollution oil pollution water pollution	coastal erosion degraded tourism loss of nursery and spawning habitat for fish destruction from sedimentation, filling & dredging degradation from water pollution destruction of habitat
Demersal ecosystems	high productivity in up-welling areas & coastal areas high prawn and finfish production	overexploitation excessive coastal pollution oil pollution inappropriate fishing techniques	loss of fishery habitat reduced fishery production degraded & tainted catch
Pelagic Ecosystems	high productivity in up-welling areas high yield migratory species	overexploitation oil pollution	reduced fishery production degraded & tainted catch

Figure 1
Principal Links and Natural Functioning among Important Indonesian Coastal Ecosystems



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or game management was not being practiced there, based upon the degree of groundcover denudation and soil exposure observed in many arid agricultural areas and on a small offshore island (Pulau Rakit) used for hunting deer.

It was also brought to our attention that in some areas, government sponsored transmigration projects rigidly advocate wet rice culture development. In the Maluku Islands, such attempts failed because the steeply sloping hillsides characteristic of the islands were ill suited for the introduction of rice culture. Without proper technical guidance and flexibility, such projects have the potential to fail economically and generate unnecessary adverse impacts to coastal ecosystems as a result of sedimentation.

Potential for ARD. Two tangible possibilities exist for ARD in agroecosystems: the expansion of rice and fish paddy culture (especially with carp, catfish, tilapia, and perhaps other species) and tambak intensification. Paddy culture has been successfully practiced for long periods in Indonesia, but increased pesticide and herbicide use in rice production may be responsible for contributing to declines in freshwater fish production, thus posing environmental constraints for future paddy culture expansion.

Unlike agriculture on land, tambak production is almost entirely dependent on wild populations, and larvae for the ponds are either recruited on the tide or stocked with larvae caught in the wild (Polunin, 1983). Knox and Miyabara (1984) indicate that Indonesia has 185,000 ha of tambak and the potential for dramatic increases, with one source suggesting a total of 660,000 ha in tambaks. The value of increasing total production from tambak culture has been given high priority by the government of Indonesia (GOI), and much of the tambak production is exported, especially prawns. Tambak culture is also a central component in many GOI sponsored transmigration projects. Additional characteristics and functions of tambak are discussed at length in Bailey et al. (1985).

Basically, there are two approaches to increasing tambak production: extensification (opening up additional land or water areas for ponds) and intensification (increasing the yields from existing tambaks).

Most of the official national and provincial tambak policies advocate intensification as the preferred approach, as it is thought to have the least potential for ecological damage. A number of factors can improve tambak production through intensification: improving the supply of fish fry and post larval prawns, improving the control of fertilizer and pesticide use; proper pond construction and maintenance, proper design of canals, flood control, extension services, and marketing; pollution control; and avoiding acid-sulfate soil problems (see Knox and Miyabara, 1984).

The development of hatcheries to increase milkfish and prawn fry stocking levels in ponds is a major potential component of a tambak intensification program. Provided that future hatcheries are located in areas that serve existing tambak systems, direct and indirect environmental effects should be minor. Conversely, if hatcheries are placed at sites where few existing tambaks are located, the hatcheries may directly prompt tambak

extensification and additional loss of mangroves and estuarine habitat.

Extensification, theoretically, is not always the environmentally less desirable option, especially if marginal rice lands, mud flats, salt pans or other less productive lands are used. (We observed suitable extensification areas on mud flats in Sumbawa, for example.) The problem has been that, in practice, tambak extensification is occuring haphazardly and has reduced the productivity of habitats that once had multi-purpose uses by converting them to single-purpose uses. This problem has reached crisis proportions, particularly for mangroves and their associated ecosystems (see Section 3.1.7).

Tambak production is sensitive to water pollution, heavy sedimentation, oil pollution, and contamination from pesticides (see Polunin, 1983). These external and difficult to control factors pose constraints to ARD involving tambak culture.

3.1.3 Freshwater Ecosystems

Little ecological information is available on the freshwater marsh, lake, pond, river, and stream habitats in Indonesia. They are categorized together here because they all serve to some extent as sinks for sediments, runoff, fertilizers, organics, pollutants and other substances derived from terrestrial ecosystems. They also serve as conduits for the transfer of these substances to other ecosystems further downstream.

Management Practices and Effects. The major beneficial functions and uses of freshwater ecosystems are water purification; recharge; flood storage, control, and discharge; waterfowl and fish habitat; and wet agriculture (rice, lotus, taro, reed culture, etc.). While there is little documentation available on the adverse impacts to these systems in Indonesia, they largely result from municipal sewage and industrial waste discharge, including mine tailings. Also, surface runoff, the discharge of sediments, fertilizers, pesticides, and herbicides can lead to eutrophication, infilling, and water quality degradation in the receiving waters. Irrigation, hydropower and other water diversion or withdrawal projects can measurably alter the size and quality of freshwater ecosystems and adjacent estuarine-dependent ecosystems downstream (see Turner, 1975 for an excellent example).

The only major freshwater ecosystem we observed during our field visit was the large freshwater marsh in western Sumbawa mentioned earlier. The local fisheries office brought this site to our attention because they believed that aquatic weed infestation was reducing fish (tilapia) production in open water areas and was hampering experimental fishery studies at the site. This occured first when draught conditions lowered the water table and allowed weeds to move into the central part of the lake. After the draught, in our opinion, the effective depth of the marsh has been reduced due to organic matter deposition, sediment infilling and irrigation water withdrawal from upstream. Thus, shoaling during the dry season (when water levels are lowest) may have promoted the regular seasonal establishment of rooted aquatic weeds throughout much of the marsh. We concluded that the weed infestation problem would be difficult or expensive to solve and that

increased fish production will require regularly harvesting the weeds or increasing water depth to maintain open water areas. We were also told that about 50 species of birds use the marsh and that it has been designated as a nature conservation area.

Potential for ARD. The major future potential ARD projects in freshwater systems include fish cage culture and stocking fish and prawns in selected lakes, ponds, rivers, and wetlands. However, the causes of the recent total decline in national freshwater fisheries production may need to be considered and overcome if projects are proposed in affected areas.

3.1.4 Beaches

Beaches, beach forests, and dune habitats are widely distributed in Indonesia along shorelines and offshore as cays and barrier beaches adjacent to mangroves, coral reefs, seagrass beds and other marine ecosystems. Coral reefs protect beaches from wave action, and reef and seagrass beds constantly replenish sand reservoirs; also, currents, waves and longshore transport of sand typically keep beaches in a dynamic state of equilibrium with local oceanographic conditions. Beach size, slope and location are sensitive to subtle changes in oceanographic regimes, and many beaches undergo periodic fluctuations in response to seasonal differences in waves and currents.

Compared to other important tropical ecosystems in Indonesia, beaches are not organically productive or biologically diverse. While exposed beaches are often inhospitable environments for marine or strand species, they provide a number of important ecological values (see Soegiarto and Polunin, 1982 and Polunin, 1983) such as dissipating erosive wave energy and stabilizing and protecting other terrestrial and aquatic ecosystems. Although beaches *per se* support few fishery species, beach seining and the collection of milkfish fry take place in shallow sandy nearshore waters (see Polunin, 1983), as we observed frequently during our field visits.

Many offshore or less disturbed beaches in Indonesia provide important nesting and resting habitat for migratory and resident shorebirds and seabirds (Salm, 1984; Polunin, 1983; Soegiarto and Polunin, 1982). Tropical marine seals and possibly other marine mammals (dugongs) pup their young on less disturbed sandy beaches, although it is not clear from the literature whether this occurs in Indonesia.

The country's beaches serve as nesting habitat for marine turtles, whose populations are probably among the largest in the world due to abundant beaches and shallow foraging habitat. Salm (1984a) placed considerable emphasis on examining and evaluating turtle (and seabird) nesting grounds throughout the archipelago and has proposed many sites for protection and conservation. Many turtle and seabird nesting sites are already protected or proposed for protection under Indonesian law. Because sea turtle populations and nesting areas worldwide have been reduced or eliminated, the large Indonesian sea turtle population takes on greater significance.

Management Practices and Effects. The practices that have constrained or reduced the value of beaches include: mining iron sands (such as off Java); using beach sand as a source of construction material; constructing airports,

hotels and other structures too close to beaches or in offshore waters; and mining offshore coral rock on a large or commercial scale. The practices detrimental to important species that depend upon beaches include the collection of birds, turtles or their eggs for consumption or for their shells (as in the case of hawksbill sea turtles).

During our field visits to the outer islands, we were able to witness offshore coral mining activities on Bali and Sumbawa. Soegiarto (1983) summarizes the adverse effects of coral mining on reefs and beaches in Bali, especially the north coast. Here, traditional small scale collection of essentially dead and buried coral rock for processing into lime does not necessarily cause shoreline or beach erosion. However, when expanded to a much larger commercial scale, this activity leads to deepening of protective offshore reefs and beach erosion from currents and waves.

Beaches are popular recreational areas, and Bali, Minahasa, Nusa Ina (Ambon), Bintan, Jawa Timur, and Jakarta are all listed officially as priority areas for marine tourism in Indonesia (Soegiarto, 1983). We witnessed a classic case of poor resort construction planning near Bali's Kuta Beach. Our observations and interviews indicated that construction of the large airport runway into offshore waters to the south (and upcurrent) of Kuta Beach in 1967 may have involved the mining of beach sand and disruption of offshore sand movement which caused major erosion and damage to the beach and its buildings by 1971. In response to the erosion threat, additional smaller groins and protective seawalls and revetments were constructed, further aggravating shoreline erosion for at least 2 km to the north of the airport. Our observations of fresh erosional beach scarps, and recent construction of additional seawalls and protective structures (particularly around the Pertamina Beach Cottages) indicates that Kuta Beach has not stabilized and is still eroding, threating the loss of the beach, additional buildings, and the value of tourism in the area. Corrective action, if feasible, will be costly.

While many seabird nesting and breeding colonies can shift to other sites to avoid disturbance from the collection of eggs and the capture of adults for human consumption, sea turtles are different. Female hatchlings will eventually return to the same nesting beaches as adults where their mothers layed their eggs. Hence, chronic disturbance to specific nesting beaches can lead to extirpation of local breeding populations.

Despite the national and provincial protective status afforded to sea turtles throughout Indonesia, we witnessed the marketing of adult turtles or eggs in Ujung Pandang, Ambon and Bali. Salm (1984a) identified Ujung Pandang as a major market and Bali as the principal marketing center for turtles in the country. Interviews in Bali indicated that green sea turtle meat is consumed heavily on the island because of its cheap price and long tradition of use in religious (Hindu) feasts. It was suggested that providing cheaper sources of fish for use in ceremonies, and initiating dialogue and cooperation from local religious leaders could discourage the continued heavy exploitation of sea turtles.

There are projects and programs in Indonesia geared towards the conservation of sea turtles. We visited an experimental sea turtle

propagation site on Serangan Island off Bali. Although the workers there exhibited considerable motivation, interest and dedication to reestablishing nesting sea turtle populations on the island (by transplanting turtle eggs from disturbed nesting habitat on Java to the experimental beach incubation site on Serangan), none were trained in turtle management, technical supervision and guidance were minimal, no written manuals were available, and turtle specialists visited Serangan only during times of egg hatching and tagging of released turtles. Many of the hatchlings were not released and were being fed (coconut husks in one case) as part of a captive rearing study, while others were eaten, and still others distributed to residents of the island for their disposition. In addition, a pen of captive adult turtles is kept nearby for the benefit of visiting tourists. Eventually, the same turtles are transferred to the local market for sale as meat. We left the island with the sense that this project needed both direction and technical management. We doubt that many of the transplanted hatchlings will survive and return as adults to the island to breed. This same opinion was voiced by some of the workers themselves.

At the time this report was written, we were not able to review all the important turtle literature for Indonesia, particularly a very recent IUCN report on turtle management, nor contact turtle specialists stationed in the country. Although we were not able to assess the long term implications of heavy turtle consumption in Indonesia (Bali in particular), the degree of exploitation and destruction of nesting areas appears alarming.

3.1.5 Estuaries

Because of its plentiful rainfall and the presence of many rivers, streams, brackishwater wetlands, embayments and coastal shallows in close proximity to one another, Indonesia has many rich, large, and diverse estuaries. Estuaries are often closely associated with other coastal land forms (e.g., deltas and embayments) and with important coastal ecosystems (e.g., tidal swamp forests, mangroves, and seagrass beds).

Functionally, estuaries encompass areas where significant volumes of fresh and marine waters meet and mix, usually creating two-layered water environments. Tidal and riverine flow are important because they facilitate the mixing and distribution of nutrients, which stimulate associated high rates of primary and secondary productivity. Flowing fresh water continually discharges sediment, minerals and nutrients into estuaries, replenishing the raw materials needed to sustain high productivity. As a consequence, estuaries are among the most productive ecosystems and valuable fishing areas in Indonesia and support large populations of adult species. Also, many marine species that spend a part of their life cycle in both fresh and salt water use estuaries as aquatic pathways during their migrations. Consequently, estuaries are important nursery sites for the larvae, post larvae, or juveniles of many finfish and shellfish species.

A number of important Indonesian fisheries are located in or are associated with estuaries. Many species depend upon estuaries for part of their life cycles, but not much research on the life history of important fishery species in Indonesia has been conducted. Thus, it is not possible to document the extent of these links.

Management Practices and Effects. A number of activities can degrade water quality, reduce habitat, or reduce fisheries production within estuaries. A useful review of environmental problems occuring in Indonesian estuaries is found in Bird (1982) and Knox and Miyabara (1984).

Villages are often located near estuaries to take advantage of the availability of both fresh water and rich coastal fisheries (Polunin, 1983). Urban landfilling and discharge of domestic sewage and wastewater into estuaries will be a growing problem in Indonesia as population growth continues and shifts to coastal areas. Similarly, estuarine fisheries close to population centers are subject to greater levels of exploitation, particularly off Java (Polunin, 1983). Excessive discharge of sediments, pesticides and herbicides and other pollutants directly into fresh waters and ultimately into estuaries can disrupt the habitat and biology of estuarine organisms. Deforestation in Palembang (South Sumatera) and Kalimantan is occuring at a rapid rate and could cause major sedimentation in downstream estuaries (Polunin, 1983). Irrigation and water supply projects that divert fresh water have the potential to reduce the functional size and quality of estuaries downstream. Thermal pollution from powerplants that discharge into confined estuaries can disturb the larval and adult stages of many tropical aquatic species that live near their upper lethal temperature limits (see Johannes and Betzer, 1975). The extensification of tambak into estuaries can disrupt water circulation and reduce the amount of natural productive habitat.

During our field visits, we observed estuaries in Jakarta contaminated by urban pollution and estuaries in eastern Sumbawa possibly degraded by siltation from upland deforestation and agricultural soil erosion. The use of fine mesh nets by bagan (lift net) fishermen was observed virtually everywhere and can be destructive to juveniles of important fishery species. It was suggested several times that regulations are needed to require larger mesh size for lift nets to allow a greater proportion of immature fish to escape and survive.

Potential for ARD. Several informants indicated that estuarine fisheries expansion is possible in underutilized, sparsely populated and remote estuaries in the eastern archipelago. However, research on stock assessment was strongly recommended to ensure proper assignment of harvest yields and suitable sites. Estuaries, especially those in protected areas, appear to be ideally suited for many types of aquaculture or mariculture projects, including cage culture of desirable fish, oysters, mussels, cockles, clams and seaweeds.

3.1.6 Tidal Swamp Forests

This category of freshwater wetlands deserves special attention because of its agricultural and ecological value and extensive distribution along the coasts of several of Indonesia's islands. These forests occur within major river deltaic regions of Sumatera, Kalimantan, Irian Jaya, and to a lesser extent, northwest Sulawesi. Approximately 5 million ha of tidally influenced swamp forests with fresh water and peat soils occur in Indonesia. A good proportion of these contain eutrophic (nutrient rich) waters, but others contain oligotrophic (nutrient poor) waters due to variations in hydrologic, soil and biological factors.

The swamps are dominated by hardwood tree species that form dense canopies and thick layers of peat soils due to the slow decomposition and mineralization of leaf fall. The thick tree canopy maintains high humidity and decreases loss of moisture from the peat soils. Although the swamps are subject to tidal action, they are freshwater swamps because they are found inland from brackishwater mangrove zones and sometimes barrier beaches that tend to buffer and isolate the system from marine waters.

Considerable freshwater discharge into the swamps from rivers with elevated stages during rainy periods results in overtopping of natural river levees. The runoff is absorbed efficiently by the expansive peat soils of the swamp, functionally elevating water levels within the poorly drained but tidally influenced systems.

There have been few biological studies of tidal swamp forests in Indonesia, and many of their potentially important functions and values have not been documented. Nevertheless, they serve as important links to both mangrove and other freshwater ecosystems in term of lifecycles for organisms and nutrient/mineral cycles.

Management Practices and Effects. Approximately 300,000 ha of tidal swamps in Kalimantan and Sulawesi have been reclaimed within the last century for transmigration and irrigation, especially for rice culture. Typically, shallow canals are dug between the swamps and rice paddies perpendicular to rivers and have bottom elevations slightly above low tide level. Tidal action, which can extend up to 100 km inland in extreme cases, becomes a form of pump, pushing fresh water into the canals during high tides, while falling tides allow the rice fields to drain. This pumping action provides fresh water and nutrients for irrigation, and leaches salts or acids from the soils. Eutrophic peats support much higher rice yields, and Driessen (1974) suggested that the majority of all eutrophic peats in Indonesia are already under cultivation.

Tidal swamp forests also have potential value from forestry products. However, their peat soils and low hydrological gradients make them sensitive to disturbance from poorly designed forestry and agriculture practices. The stripping of the peat soils and heavy harvesting of wood products have been documented as leading to destruction and conversion of the forests to less valuable habitat including nipa palm forests. A cycle of disturbance often results in acid sulfate soil conditions and declining productivity and suitability of reclaimed swamps for rice and other agriculture.

The east coast of Sumatera is one of the major regions where the destruction and degradation of tidal swamp forests has occurred. However, there has been little documentation of the impact of this habitat destruction on coastal fisheries and other major beneficial uses of tidal swamp forests.

3.1.7 Mangroves

Although there is not a consensus on the total surface area covered by mangroves in Indonesia (the estimates range from 1.6 million ha to 6 million ha), it is generally accepted that Indonesia has approximately 3.8 million ha (Burbridge and Koesobiono, 1982)--more mangroves than any other country in

the world. Mangroves are found in nearly all areas of the country. Over half of the total is located in Irian Jaya (2.9 million ha), with Sumatera (417,000 ha) and Kalimantan (275,000 ha) also containing sizable tracts (see Polunin, 1983). Mangroves in Indonesia are frequently found near estuaries, seaward of tidal swamp forests and landward of seagrass beds. They seem best developed along sheltered coastlines with moderate to high tidal range and where freshwater and moderate sediment discharge persist.

Indonesia and adjacent countries also have the most diverse mangroves in terms of species richness (Polunin, 1983). Mangrove ecosystems vary in distribution and species diversity depending upon the frequency of tidal flooding, tidal range, exposure to waves, type of substrate (coralline or volcanic) and degree of freshwater influence; many different associations occur as distinct zones within wider and more complex mangroves.

The dominant plants in Indonesian mangroves are a variety of trees tolerant of marine salinities and able to root and grow in shallow marine brackish or fresh water areas. Although mangrove trees can tolerate fresh water environments, they are normally outcompeted there, and usually exist in marine or brackishwater areas.

Mangroves achieve great levels of productivity because of the nutrients contributed from fresh and brackish waters, sediment, and abundant leaf production. The leaves fall and collect on the protected submerged sediments and accumulate as leaf litter, supporting large detrital organism communities which break down the leaves and convert the energy used by the rest of the food chain, supporting a number of species of commerical and subsistence importance including: mangrove crab, shrimp (Penaeus), sergestid shrimps (Acetes), many fish (including mullet, milkfish, and baramundi), other crustaceans, scallops, cockles, clams, mussels, oysters, and other bivalve and gastropod mollusks, marine reptiles, mammals, birds, etc. The trees, including trunks, roots and leaf fall, provide much of the habitat for the attachment and shelter of associated aquatic species, and birds of many species roost and nest in mangroves. Mangroves also serve as nursery and spawning grounds for many aquatic species, including milkfish and prawns which are important in tambak culture. Organic energy produced in mangroves is often transported to open coastal waters by tidal currents, locally enriching pelagic and demersal fisheries.

Mangrove forests provide a variety of forest products including firewood, charcoal, wood for construction purposes, and honey. Mangrove resources are also used to manufacture textiles, tannin for leather preservation, food, drugs, beverages, household items, agricultural fertilizer, and paper products.

Management Practices and Effects. A number of studies have been conducted on mangroves in Indonesia and several are fairly comprehensive (Burbridge and Koesobiono, 1982; Soegiarto and Polunin 1982; Polunin, 1983). Burbridge (1983) provides a synopsis of conservation problems in tidal wetlands (including mangroves).

Practices detrimental to mangroves in Indonesia include: conversion to dry land and tambak areas (especially as components of fisheries and

transmigration programs); excessive harvesting of mangrove wood for fuel, poles, timber, and wood chip production; water diversion projects that can reduce freshwater (and nutrient) input; blockage or reduction of tidal circulation; sedimentation from upland sources; and pollution from domestic, petrochemical, and other industrial spills and discharges (extensive damage to mangroves occured after an oil tanker spill in the Straits of Malacca in 1975 (Polunin, 1983)).

The most pressing problems appear to be overharvest of mangrove wood products and conversion of mangroves, especially to tambak (see Burbridge 1983). Overexploitation often leads to colonization by less desirable species (Polunin, 1983). Often, tambak extensification projects are proposed and implemented without regard for the suitability of soils or the ecological consequences resulting from the loss of the mangroves. It is paradoxical that in some cases mangroves (which naturally provide stocks of milkfish fry and post larval shrimp for traditionally operated tambaks) are being converted to new tambaks that will reduce natural stocking to all tambaks and require greater levels of intensive management to maintain high tambak fishery production levels (see Polunin, 1983 and Collier et al., 1977).

Despite the official policy against tambak extensification into mangroves, our field visits revealed that this activity is occuring at all the locations we visited. Our visits to Ambon and Bali suggest that previous heavy exploitation of mangroves had significantly reduced the extent of mangrove there, and that replanting programs on both islands were proposed or in progress. The irony in the case of Bali is that the one large remaining mangrove forest, which according to informants is protected as a marine reserve, is now being slated for mangrove conversion to tambak by private interests, with the apparent cooperation of the local forestry office.

Our visit to South Sulawesi was particularly noteworthy: although the Governor strongly advocated a policy against tambak extensification into mangroves, the local fisheries office told us about a program advocating major conversion of mangroves to tambak. Along the shore of Teluk Bone, we observed a 20 ha tract of mangroves being burned, uprooted, and converted to tambak. Interviews with one of the workers revealed that a local government official had promised the worker the job of managing the tambak when he cleared the mangroves and dug the ponds. In return, the official was providing food to the worker and his family. Thus, a large mangrove area was in the process of being severely damaged without any money changing hands. Other interviews in the province revealed that tambak culture was becoming profitable and that many successful tambak operators on the west coast of the peninsula were selling their tambaks to develop new tambaks on the east coast, all reportedly with the blessing of the local forestry and fishery offices.

Another example of tambak conversion was brought to our attention during our field visit to Ambon. Interviews with the local fisheries office indicated that there are 100,000 ha of mangroves in the Aru Islands (southeast of Ambon) of which they feel "80,000 ha are potentially suitable for tambak." Other interviews revealed that the Transmigration Ministry is planning a large transmigration project in Aru, and that tambak extensification will be a major component of that project. Interviews with

university scientists revealed that the mangrove areas that could be damaged by tambak extensification there are located on carbonate soils, which are unsuitable for tambak culture. They further noted that existing and proposed transmigration projects have a central theme of rice and tambak culture, with little emphasis or consideration given to the suitability of the project sites for such uses or their ecological consequences. A prevailing but erroneous view among many advocates of mangrove conversion is that the swamps are wastelands with little value in comparison to "higher" uses such as tambak and rice culture.

3.1.8 Seagrass Beds

Although the Indonesian term rumput laut refers collectively to both submerged marine monocots (seagrasses) and to macroscopic benthic algae (seaweeds), the present discussion will concentrate on the former, which are the dominant plant forms on seagrass beds. However, marine macroscopic algae are common on many seagrass beds, including the sand-producing genera of green algae (*Halimeda, Neomeris*). Green, red, brown, or bluegreen algae are common on shallow coral reef flats and often occur in mangroves, estuaries, and even tambak.

Common seagrass genera in Indonesia include *Halodule*, *Halophila*, *Enhalus*, and *Thalassia*. As noted earlier, seagrass beds often occur landward of coral reefs where they are protected from heavy wave action and seaward of mangroves. When one or more of these productive ecosystems occur in proximity to one another, overall organic productivity and biological diversity are synergistically enhanced.

While there are few scientific studies on seagrass beds in Indonesia, the literature (Polunin, 1983; Salm, 1984) is adequate to document that seagrass diversity in Indonesia is the highest in the world. Our personal observations indicate that seagrass beds are very widespread in the archipelago.

Seagrasses have been characterized as being among the most productive of natural ecosystems, and many adult and juvenile species of fish and invertebrates spend portions of their lifecycles in seagrass beds, taking shelter or feeding. Important commercial and subsistence species include rabbitfish and goatfish (see Polunin, 1983); mullets were also reported. Edible invertebrates include crabs, shrimp, clams, and sea cucumbers. Other common invertebrates include sea stars, gastropods, and sometimes corals. Some of the common seaweeds in the beds are also edible. Since seagrass beds are in shallow, nearshore, and often accessible areas, they are popular fishing grounds in Indonesia. Seagrass beds are also important foraging grounds for dugongs (which are protected by Indonesian law) and herbivorous sea turtles.

Other important functions of seagrasses include stabilization of offshore sand reservoirs and regular transport of carbonate sand to dynamic beach systems nearer to shore. Seagrass beds may also serve as important areas for the collection of commercially important algal species, and may be particularly favorable for seaweed mariculture (e.g., *Eucheuma*).

Management Practices and Effects. Activities and practices that have the potential to disturb seagrasses include thermal pollution, heavy sedimentation, dredging (see Zieman, 1975; Penn, 1979), and overexploitation of economically valuable species. We visited many seagrass areas during our field work in Sumbawa and Pulau Rakit and observed excessive turbidity and sediment that appeared stressful to some seagrasses. Heavy coral collecting from reef flats on the coast of Bali may have caused minor disturbance to the inshore portions of seagrass beds, but the offshore zones were thriving in the area we visited.

Potential for ARD. With regard to ARD possibilities, seaweed culture may be feasible if designed properly to minimize disturbance to seagrass beds and associated coral communities.

3.1.9 Coral Reefs

Virtually all types of coral reefs are distributed throughout the Indonesian archipelago. We observed fringing reefs, patch reefs, pinnacles, deeper reef terraces, barrier reefs, and atolls during our field work. Although coral reefs have been extensively studied outside Indonesia, few ecological studies of Indonesian coral reefs have been completed (some important ones are, however, in progress). The recent IUCN/WWF inventory (Salm, 1984) catalogued important coral reef areas, many worthy of official protection, but the fauna and flora of reefs are still incompletely described, in part due to abundance and high species diversity (Stehli and Wells, 1971). Nevertheless, the importance of coral reefs in the archipelago probably approaches that of any other country, because of the great bathymetric diversity and distribution of shallow semi-protected seas in Indonesia.

Limited observations suggest that reef corals may be proportionately more abundant and coralline algae less abundant in the more transparent waters compared to other carbonate producing organism groups (mollusks, echinoderms, etc.). The exception occurs along the outer edge of reefs exposed to open ocean conditions where coralline algae may be more common (Umbgrove, 1929). The outer portions of reef flats and steep reef slopes are environments generally more favorable for reef corals and fishes; other invertebrates, fleshy algae, and sand deposits are generally more prevalent on inner reef flats or deeper sandy terraces and lagoons.

Coral reefs owe their great importance in the tropics to two factors. First, reef corals and other carbonate-secreting reef organisms are able to grow rapidly in shallow exposed seas to form biogenous wave-resistant reef structures, forming the substrate or habitat for most of the remaining organisms. The most rapidly growing carbonate-producing organisms, including reef corals, have evolved special symbiotic associations or adaptations to grow rapidly in warmer marine waters where there is abundant sunlight. Second, reefs are able to develop and achieve high levels of organic productivity and diversity in generally nutrient poor (and transparent) waters and maintain that productivity through efficient recycling of nutrients and organics. Because of these two factors, coral reefs thrive in environments that are suboptimal to other productive tropical ecosystems.

Conversely, environments that are less favorable to reefs include those near turbid waters, and with high rates of sedimentation and depressed salinities (such as river mouths and estuaries). Reef corals are less likely to settle on soft substrata and reefs in general are less developed or absent where sediments accumulate (in Indonesia, this occurs especially in the western half of the archipelago).

Aside from high organic productivity and diversity, coral reefs serve many other important functions in Indonesia. Most important is that coral reef fisheries provide for the subsistence needs of many coastal and inland communities throughout the archipelago. The important groups of finfish include rabbitfish, parrotfish, surgeonfish, snappers, groupers, goatfishes, jacks, sharks, rays, squirrelfish, priacanthids, eels, croakers, drums, grunts, and rudderfish. Invertebrates of subsistence importance in Indonesia include giant clams (Tridacna, Hippopus, etc.), trochus, green snail (Turbo), other mollusks, lobsters, many crabs and shrimps, many sea cucumbers (holothurians), sea urchins and green sea turtles. Also, edible seaweeds are collected or cultured on reef flats. Several of these species are commercially important, and were seen in marketplaces during our field visits.

Coral reefs also provide: protection from heavy wave action for beaches, coastal lands, seagrass, and mangrove systems; tourism and recreational use (especially sport diving); and subsistence use of coral rock and sand for construction. Coral reefs are important habitats for officially protected species, including marine turtles. Ornamental species such as mollusks, reef corals, and black corals are marketed as curios, and the aquarium fish trade is locally important (Salm, 1984; Polunin, 1983; and Burbridge, 1983). Lagoons and other waters protected by reefs facilitate local transportation and travel by small boats.

Management Practices and Effects. A number of practices have been detrimental to coral reefs in Indonesia. Sedimentation from upland soil erosion is perhaps the most significant and widespread impact, followed by the use of explosives to collect reef fish (Polunin, 1983), the use of poisons, coral rock collection from reef flats (Polunin, 1983; Soegiarto, 1983) and pollution. Nowhere during our diving surveys did we observe many large edible fish--which is evidence of both the subsistence and commercial fishery importance of reefs and a possible warning sign of heavy exploitation. The need for government involvement in coral reef management is discussed at length in a later section and in Burbridge (1983).

The burial and sedimentation of living reefs results from upland soil erosion which results from short-cycle swidden agriculture, deforestation and overgrazing by game and livestock, urbanization, public works projects, and possibly open pit mining. Although corals and other reef life can withstand moderate amounts of sediment for short periods, their productivity and abundance will significantly decline if they are subject to prolonged sedimentation and almost all species will die if buried under sediment. The authors observed sedimentation stress to corals in Ambon Bay. The recovery of reefs after the cessation of sedimentation is slow or non-existent. The variety of sources and the long distance between the sources of sediments and the reefs they affect complicate management and control. This problem offers the greatest challenge to conserving coral reefs and will require cooperation

from all sectors in terms of watershed management, reforestation, livestock and game management, use of long cycle swidden (particularly in arid areas), controls over excavation, mining and dredging, and management of storm water flows.

Dynamite fishing has been reported in the literature and was observed firsthand (injured floating fish, shattered coral) virtually everywhere we visited. In the affected areas, government officials and other informants were quick to point out that laws and regulations were passed to prohibit this practice, but were not being adequately enforced. Fishery officials and fishermen in the Ujung Pandang area alleged that the practice had been halted for several years, but were reluctant to discuss it. However, when we confronted our boat guide on the reefs of Ujung Pandang with a fish obviously injured by explosives, brought to his attention the muffled sound of explosions in the distance, and actually surprised two fishermen in the process of dynamiting a reef, the guide finally admitted that the practice was widespread. Although he claimed that the technique still caught fish repeatedly in the same areas, he took us to a reef that was razed to rubble by frequent blasts. Only a few small parrotfish were observed there feeding on filamentous algae that had colonized the dead coral. Our guide explained that small cartons are filled with explosives, the fuses lit, and the cartons tossed over the side so that they explode after reaching the bottom.

Maragos has observed the impacts of dynamite fishing and use of explosives on reefs in Polynesia and Micronesia. Although some fish float to the surface after the blasts, the great majority do not, and nonedible and edible species of fish and invertebrates alike are destroyed or injured. Thus, only a few of the injured or killed fish are actually collected. The blasts shatter the more fragile corals, reducing the colonies to rubble. Larger blasts produce shock waves that can crack and detach more massive heads from the substrate where the corals are then rolled around by waves and destroyed. Corals grow slowly and can take decades or more to recover completely, thus affecting species dependent upon viable coral. Dynamite fishing is particularly sinister because this destructive practice has long lasting often irreversible effects, occurs commonly on remote reefs (away from the authorities), and can cause conflicts with other fishermen. Reefs near a heavily populated fishing community offshore from Ujung Pandang showed no evidence of dynamite fishing. There, residents depend upon the reefs for subsistence and will protect them from outsiders. At the other extreme, evidence of dynamite fishing was seen off two remote islands (Pulau Pombi, north of Ambon, and Pulau Rakit off Sumbawa). One is now designated as a nature conservation area, but our observations showed that there are still residual effects of blasting done prior to official designation. Ironically, the other site is being proposed as a coral reserve.

Overexploitation of reef fisheries and the use of inappropriate techniques for exploiting reef resources is causing damage to many important coral reefs and declines in species of subsistence and commercial importance. A cycle of heavy fishing on a particular reef may cause stocks to decline to such low levels that explosives and poisons may be used in desperation, accelerating the destruction of additional reefs. The widespread practice of dynamiting reefs to obtain fish is a result of the inability of many fishermen to realize the consequences. Explosives are

apparently available from military and construction sources, judging from the widespread occurence of their use.

Heavy exploitation of live and dead reef corals for construction materials and live reef and precious (black) corals for the jewelry and curio trade can damage reef habitat, cause shoreline erosion, and result in declines in subsistence fisheries because of loss of coral habitat. We observed coral rock collection in Sulawesi, Bali, and Sumbawa, where the collected rock is later burned to lime and made into bricks for buildings. Evaluation and use of upland sites to obtain construction rock appear to be important remedial actions.

Pollution of reefs from agricultural chemicals and fertilizers, and from domestic, industrial and thermal effluents is probably also widespread, especially sewage discharge from larger urban areas. Indonesia apparently does not yet treat its sanitary wastes; inexpensive but effective options of wastewater treatment should be pursued in some cases. Threats are also possible from leaks and spills from refineries, tanker accidents, and open water release of bilge waters. Water quality control and other preventive measures may need to be pursued (Maragos et al., 1983a).

Potential for ARD. With regard to ARD on coral reefs, the development of seaweed mariculture on suitable inner reef flats is a distinct possibility. However, expanding commercial catch fisheries on coral reefs seems less important than reserving reef areas primarily for subsistence fisheries. The high number of species and the lower number of individuals per species (a characteristic of reef fisheries in general) argue against commercial marketability.

3.1.10 Pelagic and Demersal Ecosystems

These two ecosystems occur seaward of nearshore coastal ecosystems (for example, beyond the seaward limits of coral reefs, estuaries, etc.) where open ocean conditions and circulation have a predominant influence on the characteristics and composition of the water, substrate, and resident organisms. In general, a significant proportion of the pelagic and demersal stocks in the western half of the archipelago are distributed in shallower seas (overlying the Sunda Shelf).

The pelagic components include those planktonic and nektonic species living near the upper water surface or at mid-depth in the water column and not directly associated with the sea floor environment. The demersal components comprise the benthic and related demersal species living within, upon, or immediately above the sea floor that are directly dependent on or associated with the bottom environment. However, the flow of nutrients and organics from coastal ecosystems can enhance the productivity and composition of these two systems, particularly in Indonesia.

As with the other ecosystems discussed in this report, there are no clear boundaries between the two ecosystems (especially in shallow water such as offshore from estuaries) and normally there are zones of transition between the two. Also, most demersal or benthic species have planktonic larval forms that reside in the pelagic system during part of their life cycles. A good

recent overview of marine capture fisheries in Indonesia, including pelagic and demersal species, is found in Bailey et al. (in press). Information on the currents and bathymetry of Indonesian seas is found in Salm (1984a), Polunin (1983), and Wyrtki (1961).

Although these two systems are discussed together here, there are several practical reasons for distinguishing between them. First, the important fishery species characterizing the two systems are different, as are the fishing gear used for their capture. Second, the energy flow and feeding strategies of organisms within the two ecosystems are different. Most demersal systems occur in deep water below the thermocline and zone of active primary production by plants. Thus, food energy must be imported into the system, except in shallower water where some production by benthic algae and phytoplankton is possible. Many demersal species are deposit and detrital feeders, but a large number are also suspension feeders and carnivores; there are few herbivores. In contrast, phytoplankton productivity is the main source of organic productivity and is the basis for the pelagic food chain. Virtually all of this production occurs where light penetration is sufficient, above the thermocline. A greater proportion of the species are herbivores, phytoplankton, and suspension feeders, although carnivores are also important. Third, the pelagic ecosystem is more intimately connected with the shallower productive zones of water masses of adjacent seas and oceans due to tidal, geostrophic, and wind driven currents. As a consequence, many of the characteristic species are cosmopolitan and often migrate (or are carried) between different parts of oceans. In contrast, adults of demersal species are generally associated with or attached to specific bottom environments and often compete with one another for limited space on the sea floor. Also, organics, pollutants, and sediment can be carried downslope by turbidity currents or mudflows; thus, demersal environments are generally subject to greater influence from coastal environments. The composition of the fauna normally includes both cosmopolitan and regional species.

Pelagic and demersal ecosystems are of considerable importance to Indonesia because they are very productive in many areas, in part due to localized upwellings (where nutrient enriched deeper waters are carried into shallow water, stimulating phytoplankton growth) and influences from productive nearshore coastal areas. Major upwelling areas are mapped in Polunin (1983). In the productive areas, commercially important species occur in greater number and concentration, facilitating more efficient fishing activities. Demersal fisheries are particularly important off the crowded islands and the fertile inshore waters of Java and Sumatera, and large yields of shrimp and associated finfish are caught and consumed locally or are exported. As noted elswhere, demersal fisheries are more heavily exploited than pelagic fisheries in Indonesia, but there is great potential for the expansion of offshore pelagic fisheries.

Over twenty species of whales reside or migrate in the pelagic waters of Indonesia (Polunin, 1983).

Management Practices and Effects. The practices that can adversely affect pelagic ecosystems include overfishing, coastal pollution (particularly toxic chemicals from industrial and domestic discharges), and

the threat of oil spills and pollution from accidents, discharge of bilge waters, drilling muds, oil transfer operations, etc. Demersal ecosystems, particularly those closer to shore, can be adversely affected by the same factors and are likely to be more sensitive to sedimentation from soil erosion, the discharge of mine tailings, other pollution and overharvesting.

3.2 COASTAL RESOURCES AND THEIR FUTURE DEMAND IN INDONESIA

3.2.1 The Significance of Coastal Land and Water Resources

The statistics relating to the concentration of Indonesia's population in Java, Madura and Bali (65% of total population, 7% of land area) are normally cited to present a contrast in development between these "inner islands" and the "outer islands" (see, for example, Hanson and Koesoebiono, 1979 and Djojohadikusumo, 1977). However, the fact that 60% of the population lives in what can be broadly defined as the "coastal" zone,* which also contains some 75% of Indonesia's medium sized cities (population over 100,000; see Biro Pusat Statistik, 1983), is generally overlooked.

It is no accident that the majority of Indonesians live in the relatively rich coastal environment of both the inner and outer islands. First, general soil maps of Indonesia indicate that throughout the archipelago, the better soils with favorable slopes are concentrated within the lower reaches of major watersheds in what can be broadly defined as coastal lowlands. In these areas, agriculture is generally developed at elevations between 7 and 25 m above sea level where population pressures are low to moderate. It is only where population pressures mount and land becomes relatively scarce that cultivation is pressed into upland areas with slopes in excess of 40% and areas below 7 m, such as tidal swamplands and other agriculturally marginal lands. Second, the natural productivity of estuaries and shallow coastal seas yield the major part of the capture fishery harvest and support the development of both aquaculture and mariculture.

The concentration of population in response to the location of the more valuable terrestrial resources is commonly cited as the major development problem in Indonesia. This, however, must be examined more carefully in regard to the relative ability of land and water resources to respond to development pressures.

A common feature of many development efforts is the promotion of agriculture, forestry, fisheries and other primary resource uses in the less populous outer islands. However, as is the case in the inner islands, the development potential of the outer islands' coastal environments has long been recognized by indigenous cultures and has resulted in the creation of both intensive forms of exploitation and sophisticated systems of multiple resource use. Further, those resources which may be underdeveloped require major investment to bring them into continuous production. In some cases, for example, hardwood production from lowland Dipterocarp forest, there are uniquely rich resource development options. However, where the conversion of

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* The U.S. Coastal Zone Management Act refers to the coastal zone as "the coastal waters (including the lands therein and thereunder) and adjacent shorelands (including the water therein and thereunder), strongly influenced by each other and in proximity to the shorelines(s)..."

natural systems such as forests to alternative development such as agriculture is attempted, the ability of those systems to sustain development is generally found to be low (Burbridge et al., 1981). There are often hidden costs involved in such conversions which are poorly perceived and which, if development is to be sustainable, require far more sophisticated management than is generally available.*

Therefore, we need to re-examine indicators such as population density and to focus more upon the assessment of how existing development can be made more productive. We also need to study the relative advantages of this option versus the extensification of development into more marginal lands.

In summary, due to the concentration of the more productive soils in coastal landforms, the great natural biological productivity associated with estuaries and nearshore waters, and their high natural energy subsidies, coastal areas offer significantly greater options for fulfilling development needs than any of the alternative land areas of Indonesia. These options will only be realized and sustained if appropriate management approaches and techniques are applied.

3.2.2 Population Growth and Demands for Coastal Resources

Indonesia's population is expected to reach between 216 and 222 million by the year 2000. This population growth will create pressures to intensify productive activity and to extend the development of natural resources to meet basic human needs. Due to the richness of their resources in comparison to upland areas, coastal areas will not only have to absorb the bulk of the increased population but will also have to produce a large proportion of the food and materials required to sustain the growing population.

The Future Demand for Agricultural Land. A rough estimate of the primary resources required to fulfill basic human needs can be gained by examining how land is now allocated to sustain the population. For example, in 1980 the population was estimated at 147.5 million people and the area of land given over to the production of food and other agricultural products was 36.2 million hectares, including agricultural settlements.** This means that approximately 0.237 hectares were required to meet the agricultural needs of

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* "Hidden costs" refers to: the rapid loss of soil fertility once the forest system is altered (the initial soil fertility must be replaced by increasing investment in fertilizers); the loss of sustained yields of forest products (this loss is generally discounted to zero, but in fact represents a "cost" that must be subtracted from the "benefits" calculated for agricultural conversion); increased soil erosion; alterations to the hydrologic regimes of watersheds, etc. (see Burbridge et al., 1981).

** Unless stated otherwise, the statistics given are derived from the 1983 Annual Statistics published by the Biro Pusat Statistik, Jakarta.

each Indonesian citizen at current levels of technological application.* The 1980 land requirement and the projected future population size can be used to give a rough idea of maximum agricultural land requirements in the year 2000, assuming current levels of technology are used.

216 million x 0.237 = 51.2 million hectares

This represents an increase of over 47% in the area currently required. It also means that the rate of expansion of agricultural land will need to be nearly 1 million hectares per year. It is reasonable to assume that new varieties of rice and other food crops will increase the yields that might be expected per hectare. However, the majority of the land that is available for agricultural expansion does not have the same fertility, favorable climate, drainage and other conditions that characterize the main areas of agricultural production today. The potential yields from most food crops on new lands can be expected to be lower than those of existing agricultural development. For example, some areas of tidal swampland that have been opened for transmigration are producing rice yields that are only one-fifth those of the best rice lands in Java. This is perhaps an extreme example; however, it does suggest that the above estimate of the additional land required for agriculture in the year 2000 is very optimistic. Instead of the additional 15.4 million hectares (51.2 minus 36.2) required to feed the population in the year 2000, it may be necessary to multiply that figure by a factor as much as 5 (15.4 x 5 or 77.0 million hectares).

The Future Demand for Fishery Products. Fishery products constitute an important source of protein in the diet of many Indonesians. In 1984 the average per capita consumption of fish products was estimated at 11 kg/year. The future demand for fishery products can be crudely estimated by multiplying the 1984 per capita consumption by the estimated population for the year 2000:
11 kg/person/year x 216 million people = 2.4 million tons.

The expected yields of marine and nearshore fishery harvest to meet future demand are difficult to predict. It has been suggested that certain areas are overfished while other areas (mainly in sparsely populated areas to the east) are largely undeveloped. For the purposes of this paper, it was assumed that future marine and nearshore open water capture harvests will be only 7% above existing levels.

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* In 1980 Indonesia was still importing substantial amounts of rice (2,011,700 tons) in order to feed its population. Since that year, imports of rice have fallen sharply due to improved crop yields per hectare. We have therefore assumed that improved management of the best agricultural soils will help to further reduce food imports. However, we simply do not know at this time precisely how productivity may increase or per capita consumption will change. It is unlikely that there will be a second "green revolution" and it would be unwise to rely too heavily on such technological innovations and to fail to conserve the soil with the greatest agricultural potential. With or without green revolutions, the best soils will always yield the greatest potential for feeding an expanding population.

It is anticipated that future demand will be met through tambak, freshwater fish ponds, cage culture in lakes, estuaries and nearshore waters, and paddy-cum-fish production. An estimate of the land/water area required to meet this demand by 2000 can be calculated by first subtracting the expected marine and nearshore open water capture harvest from the total demand.

Total demand in the year 2000	2.4 million tons
Expected marine and nearshore harvest*	1.5 million tons
Total non-capture demand	0.9 million tons

The productivity of these forms of fishery production varies considerably, from 33.5 tons/ha for cage culture to 0.36-0.6 tons/ha for tambaks. (The average productivity for all aquaculture/mariculture land uses is 0.69 tons/ha.)

A range of estimates of the total land required to meet the production demands for non-capture fisheries can be calculated by dividing future non-capture demand by productivity per hectare, as shown in Table 4.

If current levels of tambak productivity are maintained, .87 to 1.3 million hectares will be required in 2000 to meet expected non-capture demand. In 1980, the existing area of land in use for inland fishery production (including sawah) was 342,253 ha (gross). Thus, the .87-1.3 million hectares represents an approximate two and one half to four fold increase in land demand.

The actual land area that will be required for the expansion of aquaculture/mariculture will depend upon at least six factors:

(1) improvements in the productivity of the aquaculture/mariculture areas that have already been established;

(2) the quality of land/water areas available to support the expansion of aquaculture/mariculture;

(3) the emphasis given to different methods of production;

(4) the conservation, or even improvement, of marine and nearshore open water fishery harvests;

(5) the maintenance of environmental quality factors, such as water quality, that have a bearing upon sustained fishery development; and

(6) the relative price of fishery products.

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* This estimate may be too conservative. If a more optimistic estimate of 1.8 million tons (incorporating modest improvements in catch) is used, the contribution of inland and nearshore areas will be reduced to 0.6 million tons (see Table 4).

Table 4
Future Land Requirements for the Development of Aquaculture

Factors that could affect Land Demand	Total Demand in Year 2000 (million tons)	Expected Marine and Nearshore Harvest (million tons)	Expected Demand to Be Met from Non-Capture (million tons)	Productivity Per Hectare from Aquaculture and Mariculture (million tons/ha)	Total Land Required (thousand ha)
Current Levels					
Minimum	2.4	1.5	.9	.69	1300
Maximum	2.4	1.8	.6	.69	870
Increased Capture Yields	2.4	1.94*	.46	.69	666
Improved Aquaculture/ Mariculture (Tambak) Yields	2.4	1.5	.9	1.2	750
Increased Aquaculture/ Mariculture (Cage Culture) Yields	2.4	1.5	.9	33.5	27

*Assuming a 7.5% increase in haverst by the year 2000.

An alternative case would take into account the net benefits of improving the productive capacity of areas already in production. For example, if the average productivity of tambak could be increased to 1.2 tons per hectare (a modest amount in comparison with areas such as Taiwan), the future demand for increased domestic fishery products could be achieved by developing 0.75 million ha.

If all aquaculture/mariculture production could be met through cage culture, the additional production of inland fishery products required by the year 2000 could possibly be met by developing only an additional 26,866 ha of land.

These extreme estimates of the land required help to demonstrate the primary resource requirements of the inland fisheries sector related to population growth and the policy options that could be pursued. Because exercising different fishery policy options will have a direct influence upon future land demands, it is important to consider that adopting a strategy of improving the productive capacity of existing forms of fishery development could reduce overall land demands.

3.3 MAJOR COASTAL RESOURCE DEVELOPMENT AND MANAGEMENT PROBLEMS

Below, we examine some of the development problems that will arise when Indonesia attempts to expand her resource base to feed her growing population. These include the trend away from multiple resource use and toward more single-purpose use and the lack of integrated planning and management. This latter problem results in a bias toward sectoral development and the decreasing ability of Indonesia's coastal ecosystems to sustain development.

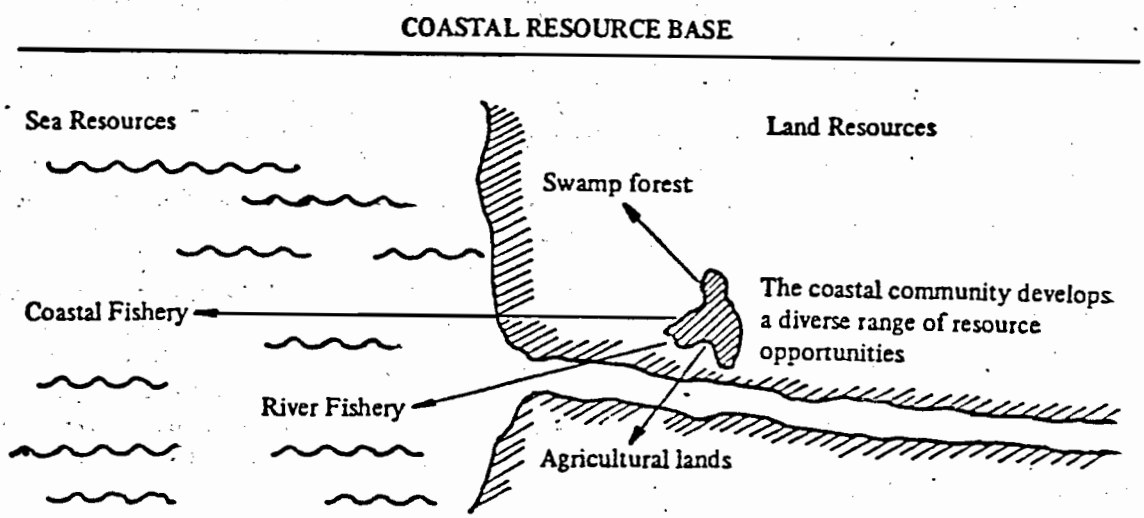
3.3.1 Transition in Coastal Resource Development

The concept of managing the forms and intensities of coastal resources utilization is by no means new. Traditional coastal societies have been forced to do this for centuries in order to survive. Although some resource opportunities may be poorly perceived, tradition and experience have provided basic guidelines as to what is feasible given a coastal nation's technology, economic wealth and socioeconomic perspective. Traditional forms of coastal resource development have evolved a multiple resource use strategy that exploits a series of resource opportunities over time. If one resource activity such as fishing is poor, there are other activities to fall back upon. Therefore, various elements of the resource base are combined to form resilient and sustainable forms of development that can adjust to fluctuations in biological cycles and withstand certain hazards. Figure 2 illustrates this approach.

However, with mounting population pressures, the growing shortage of land, and the desire for enhanced resource production, coastal areas are being viewed as sites for new or increased resource activity. This is resulting in a transition from multi-faceted traditional resource management practices to more intense single-purpose developments. This transition is resulting in mounting conflicts between single-purpose interests, a breakdown in the stability of traditional societies, and in many cases, the overexploitation of renewable resources.

Figure 2

Multiple Use Strategies Adopted by Traditional Coastal Societies



In essence, while the current transition toward single purpose sectoral development cannot be sustained in most of Indonesia's ecosystems, neither is it possible to merely mimic former traditional management practices in order to meet society's needs. If the ability of coastal resource systems to sustain mounting development pressures is to be conserved, Indonesia will need to adopt innovative approaches to coastal resources management that blend experience from other countries with Indonesian conditions.

3.3.2 Lack of Integrated Planning and Management

In 1976 the National Committee on the Environment, the National Institute of Oceanology, and the Bogor Agricultural University organized a series of seminars on coastal development. These seminars helped to highlight the importance of coastal resources, some of the problems being encountered in managing coastal development activities, and the need for cooperation between different sectoral agencies in promoting mutually beneficial resource development policies and management guidelines. A major product of the seminars was a handbook on coastal zone management that has subsequently been adopted by the Ministry of Population and the Environment. This handbook is potentially a useful management tool; however, the institutional and legal frameworks for applying it need to be strengthened.

Responsibility for the development and management of Indonesia's resources does not rest within a single agency. Rather, it lies in the hands of a series of government agencies whose activities are generally governed by the GBHN--The State Planning Guidelines. These guidelines are more statements of broad objectives than specific policies aimed at coordinating

the development of resources that can support a variety of different development related activities (e.g., production of domestic fuelwood, woodchip exports, reduction of coastal erosion and storm damage, and fisheries production).

Two broad categories of problems related to the development and management of coastal resources in Indonesia are discussed below. The first centers upon the emphasis on sectoral development programs and largely single purpose development projects. The second relates to the decreasing ability of coastal resource systems to sustain development. While these two broad problem categories are directly linked, it is useful to separate them to show the consequences that sectorally-oriented management frameworks can have upon a variety of related coastal resource systems.

Problems Related to the Current Bias toward Sectoral Development. As a result of the transition from traditional multi-use resource management to single purpose development, a series of sectoral pressures is being created for the development of specific resources. For example, forestry interests are seeking to exploit mangroves for woodchips, mineral companies are seeking concessions to dredge tin from mangrove areas, and agricultural agencies are looking to swamplands for new rice production areas.

These economic or resource-specific interests look at the coastal resource base from distinct and often incompatible viewpoints. The effects of one form of exploitation upon another form of activity and the cumulative effects of exploitation initiatives are seldom considered. In time, government departments and agencies are created to serve or align themselves with specific forms of resource development. For example, the Ministry of Forestry is staffed mainly by foresters interested in forest development and who, in many instances, have little knowledge of activities such as fisheries or mineral extraction.

When each of these sectorally oriented agencies or economic interests perceives that coastal areas may offer new development possibilities, a series of independent and often competing pressures for developing that resource base are created. As a result, conflicts can arise between individual economic activities and between the government agencies responsible for their development. Figure 3 illustrates this sectoral approach.

Four types of problems arise from the current emphasis on sectoral development: conflicting land demands, resource and inter-sectoral conflicts, intra-sectoral conflicts, and a lack of coordinated development planning. These problems and suggestions for their resolution are discussed below.

(1) Conflicting Land Demands

During 1983 ten major government agencies representing activities such as forestry and fisheries met to discuss future land demands. The forecasts of the land required by those agencies for their projects totaled more than 225 million hectares. These demands far exceed the actual land area of Indonesia (191 million hectares).

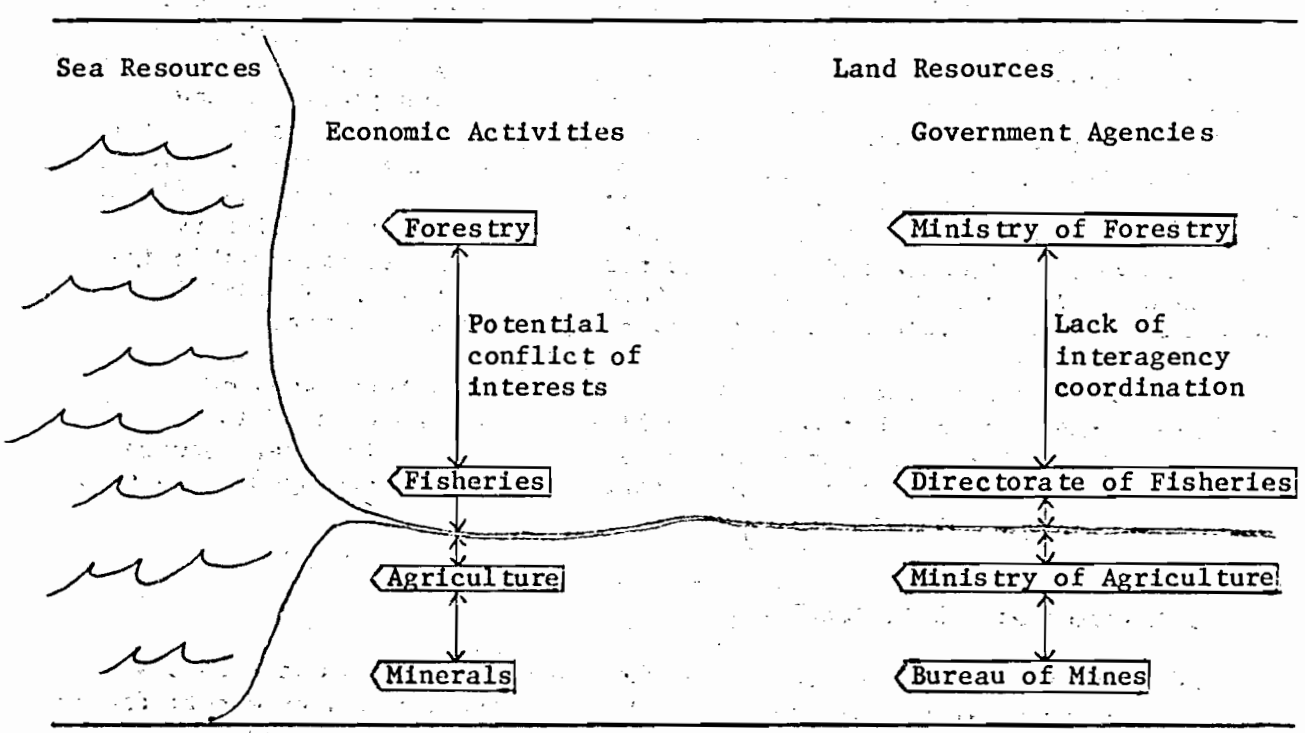
These estimates suggest that (a) single purpose land uses dominate assessments of land and water resource potential, (b) there is not sufficient land to meet demands based upon exclusive single purpose development, (c) multiple use concepts are the most logical alternative for fulfilling development objectives, and (d) increased emphasis upon improving the productivity of existing land and water uses will help to reduce the demand for more land.

(2) Resource and Inter-Sectoral Conflicts

The sectoral approach to development often results in a series of conflicting demands upon coastal resources and conflicting management guidelines and incentives. A good example is the current debate over the width of a "greenbelt" or zone of protected mangrove. In a move aimed at protecting estuarine and coastal fish stocks dependent upon mangrove, the Directorate General of Fisheries issued a policy instruction in 1976 stating that a "greenbelt" of mangrove should be established along all the nation's coastlines.* This instruction conflicts with the 50 meter wide belt of "protection forest" incorporated in the silvicultural regulations and attempts to assert authority over areas the former Directorate General of Forestry considered their responsibility. To resolve this conflict, the

Figure 3

Sectoral Approaches to Coastal Resources Development



* Instruction No. HI/4/2/18/1975, followed by Instruction No. E1/5/8/4/1976 issued to all provincial governors to set aside a 400 meter wide greenbelt of mangrove along their coastlines.

Minister of Agriculture instructed the Directorate Generals of Fisheries and Forestry to seek a compromise that would protect mangrove related fish stocks.* However, the issue is still being debated eight years later.** Even though a new Ministry of Forestry has been created, no satisfactory compromise has been reached. Further, even if a compromise is worked out between Fisheries and Forestry, it will not necessarily mean that a variety of other mangrove related activities will be protected or sustained.

The problems in this area lie in inaccurately acknowledging all of the direct and indirect uses of mangrove and other coastal resource systems. The inclusion of the interests of basically single purpose sectoral agencies can at best represent only a few such uses and many nonmarket values of mangrove will be ignored. These agencies may be well qualified to undertake their specific tasks of stimulating development; however, they are neither responsible nor equipped to incorporate the interests of other activities into their development objectives. As a result, conflicts can often only be resolved through some higher authority specifically instructing separate agencies to undertake discussions. This approach comes late in the development planning process and avoids neither conflicts nor environmental problems that reduce the economic viability of development activities.

The productivity of existing coastal uses is often depressed by conflicts arising from the negative effects of one form of development activity upon another. For example, a new port is being developed near Jakarta at Marunda to handle logs brought in from the outer islands for processing into secondary wood products. The port will be sited only a few hundred meters away from a planned tambak development area.

Inter-sectoral conflicts are often more complex and can involve a series of different sectoral activities. As noted, sedimentation is perhaps the major factor leading to the destruction of living coral reefs. To trace the causes of sedimentation, it is necessary to examine land practices and development activities within the watersheds upstream of the reefs. Within major watersheds, forestry, agriculture, road construction, urban development and a variety of other activities are affecting sedimentation rates. Thus, the conservation of reef fishstocks cannot be achieved through fishery practices alone. A concerted effort to reduce rates of erosion within the watershed is the only way in which the functional integrity of coastal resources can be maintained so that they can sustain development.

The sustained utilization of existing coastal resources requires management perspectives that reduce conflict. As in the case of the siltation of coral reefs, appropriate management perspectives may require attention to the linkages between different natural resource systems as well as individual forms of activity.

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* Instruction No. 13/INS/UN/7/1975.

** The Ministry of Forestry considers the production of forest products as the most valuable use of mangrove and is arguing for a narrow belt (50 m) to be set aside as a zone of protection. The Fisheries Department considers the role of mangrove in supporting fisheries to be of paramount value and is arguing for control of a larger area.

(3) Intra-Sectoral Conflicts

Apart from inter-sectoral conflicts over the allocation of coastal resources, coastal development problems are created by conflicting policies within agencies. A good example is the promotion of fish pond development in the Cilacap mangrove. Despite a policy aimed at preserving a "greenbelt" of mangrove around the coasts of Indonesia, the Fisheries Department is eager to increase shrimp exports through the construction of brackishwater ponds. In the Cilacap area, the mangrove already supports a mangrove-cum-fish production system utilizing canals interspersed with mangrove. This system would now be replaced with large open shrimp ponds that would reduce the area of mangrove.

This proposal not only contradicts the arguments put forward by the Directorate General of Fisheries concerning the value of mangrove in supporting coastal fishstocks, but it also displaces an existing fishery. That fishery is very productive* and meets domestic needs for fishery products and some exports of shrimp. By placing emphasis upon shrimp exports alone, the Fisheries Department may reduce both domestic food production and the ability of the Cilacap mangrove to support offshore shrimp harvest.**

(4) Lack of Coordinated Development Planning

From an examination of major donor agency projects and government programs, it is evident that current approaches to questions pertaining to the management of resources, such as those surrounding food requirements, focus upon production factors. Less attention is given to issues such as the improved management of existing development to fulfill projected demands or the identification of current and future constraints on production.

Where the characteristics of the resources base (soil, topography, water supply, etc.) are of direct significance to the supply of basic human needs, it is important to consider future pressures such as competition for fertile, level sites with a good water supply, that will result from different sectoral interests such as agriculture, fisheries or forestry. The resolution of potentially conflicting demands and the allocation of resources require a far more coordinated approach to environmental management than has been adopted to date.

It is clear that there is a political will to face the challenge of achieving sustainable forms of development. This, however, is frustrated by (a) a lack of clear articulation of the rate and scale of change that will result from the growth of population; (b) the lack of attention to the identification of existing and potential conflicts in demands for natural

* Aprilani (1985) has shown that mangrove-cum-fish culture systems can be very productive. He argues that the proposed conversion to large open water ponds will not necessarily improve the production of shrimp and may reduce wild shrimp capture due to damage to the mangrove ecosystem.

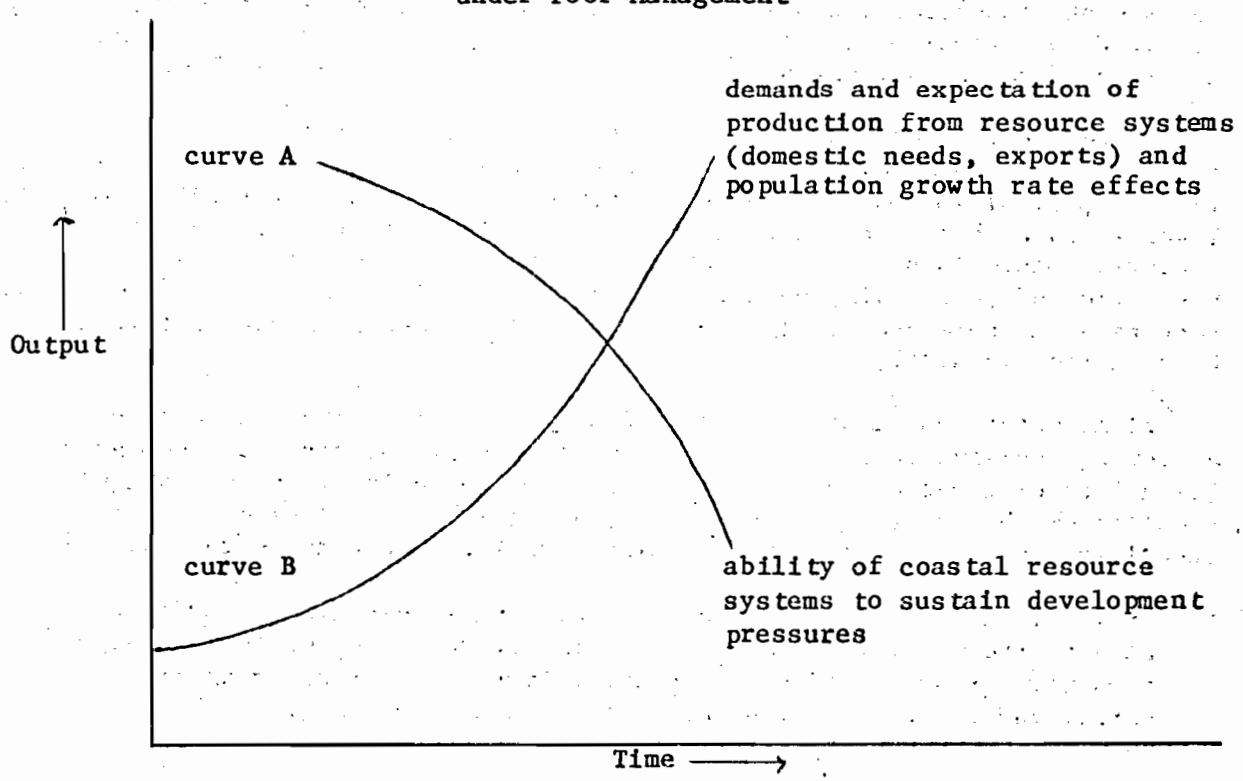
** Zalinge and Naamin (1977) suggest a strong correlation between offshore shrimp harvests and the area of mangrove in the Cilacap area.

resources such as water and land; (c) a common assumption that there are few limits to the ability of resources to support sectoral approaches to development and that money can always be found to overcome such limits; and (d) the absence of clear and practical guidelines for managing development in the short term. This is symptomatic of the broad objectives stated in national development guidelines, which often are not complemented by explicit policies to guide the allocation of resources among competing activities.

The Decreasing Ability of Coastal Resource Systems to Sustain Development. As a result of the failure to coordinate and integrate development policies and to regulate the exploitation of coastal resources, the ability of Indonesia's coastal resource systems to sustain development is being eroded. Figure 4 illustrates the problem of a fixed resource base where the ability to sustain development is being eroded by poor management (Curve A). Set against this declining resource base are increasing expectations of food and other forms of resource production (Curve B). The point where the two curves meet suggests the point in time that the resource base will fail to sustain development. Two of the major results of poor standards of coastal resource management, ecosystem stress and degradation, are discussed below.

Figure 4

The Ability of the Resource Base to Sustain Development under Poor Management



(1) Coastal Ecosystem Stress and Degradation

Coastal ecosystems in many regions of Indonesia are subject to mounting environmental stress. Stress occurs when the disturbance or use of natural resources leads to low or moderate negative environmental effects.

One major source of coastal ecosystem stress in Indonesia is pollution. The major sources of pollution are believed to be related to land based activities. These include increasing sediment loads in rivers and other waterways which result in increased turbidity and accelerated siltation, biocides from agricultural and forestry activities, oil spills and uncontrolled dumping, and domestic and industrial wastes (Soegiarto and Romimohtarto, 1984). Potential sources of significant pollution resulting from proposed developments include thermal wastes from power plants, increased industrial wastes (toxic materials and increased amounts of solid waste), and radioactive materials associated with nuclear power plants.

When environmental stress is severe and prolonged, an area's resource base suffers long-term, sometimes irreversible negative impacts, and the environment is said to be degraded. The degradation of coastal areas is closely coupled to the conversion (destruction) of tidal wetlands (tidal swamps, swamp forests, and mangroves) to alternative uses, and the subsequent destruction of coral reefs. The major activities leading to conversion are: the expansion of existing settlements; the location of new settlements (often associated with transmigration sites in tidal lands); the expansion of ports, airports, roads and other transportation and communication facilities; agricultural expansion, extensification of fishery activities, tourism and recreation; and the demand for industrial sites and/or raw materials to support secondary economic activities.

o Siltation

The dredging of channels, mineral extraction from shallow waters, and beach sand mining are contributing to siltation in coastal waters. Soil erosion in major watersheds is even more widespread and poses a more severe threat to coastal and marine ecosystems. For example, in Java, Soemarwoto (1974) monitored the silt levels in the waters of the Citarum River system and found a six-fold increase in silt loads between 1970 and 1972 (0.5% in 1970; 20.4% in 1972). Similar studies in other major Javanese watersheds suggest that rates of erosion and subsequent siltation are increasing (for example, see Ongkosongo, 1980). Our field studies and aerial observations also lead us to believe that in major river systems in the outer islands, erosion and siltation are significant factors to be considered in coastal development. Unfortunately, in at least one case (Palembang--the Musi River system), the regional fishery staff are not paying sufficent heed to the effects of upland management practices and their potential fishery resource management implications. A lack of perception of the linkages between upland and coastal ecosystems appears to be a common problem at the provincial and district levels.

o Cholorinated Hydrocarbons

The amount of pesticides and herbicides in use in Indonesia has probably increased considerably since 1958 as a result of efforts to intensify and

expand agriculture. Insecticide application in Java and Madura increased from 0.73 kg/liter/ha in 1974 to 1.33 in 1977 (Knox and Miyabara, 1984). These biocides eventually find their way downstream to estuarine and coastal areas; however, few studies document biocide concentration in Indonesia's aquatic habitats.

A study by Muluk et al. (1980) identified a number of interactions between agricultural and fishery management systems in the lower Citarum River basin, such as those occuring when pesticide residues from agricultural sprays entered fish ponds through the water system. Sutamihardja and Haeruman (1980) report significant concentrations of pesticides in the muds, waters and mangrove of the Cimanuk Delta. Because pesticides are not readily degraded and are known to be transported through the food chain, it can be assumed that pesticide residues are present in many aquatic species.

o Hydrocarbons-Petroleum Products

Oil production from offshore wells rose from nil in 1970 to some 30% of total production in 1977 (Soegiarto, 1984). Attendant with an overall increase in oil production is an increase in oil related industries in Indonesia. The effluents from these industries are not effectively treated or controlled and are often directly or indirectly discharged into rivers, estuaries and nearshore waters. An example of this was reported by Soegiarto and Romimohtarto (1984), where a petrochemical plant in Surabaya started operations and complaints were received from local fishpond operators concerning tainted fishery products in the vicinity of the effluent outfalls.

Both incremental additions of hydrocarbons and the potential effects of a major oil spill are causing concern to people managing coastal and marine environments. These concerns focus on five topics in Indonesia: physical disruption of shallow water habitats; damage to spawning areas of economic species; severe localized damage from oil spills, as in the cases of cage culture or brackishwater ponds; tainting of fish or fouling of fishing gear; and refinery wastes being dumped into fragile environments such as tidal swamps.

o Domestic and Industrial Wastes

There are no domestic sewage systems in Indonesia apart from local septic tanks. Where sewage is dumped into rivers, bays or shallow coastal waters, there are limits to the ability of those waters to assimilate wastes.

The effects of sewage and other organic materials on aquatic systems are complex. In general, when concentrations are too high, there can be corresponding and often negative changes in species diversity and productivity. Public health problems may arise from disease vectors (e.g., typhoid virus) in which fishery products may form part of a pathogen/food chain and water quality can be significantly reduced.

Heavy metals associated with industrial effluent disposal are a source of mounting concern. For example, Jakarta Bay is subject to high concentrations of heavy metals in both the water column and in sediments (Sutamihardja, pers. comm., 1983). Heavy metals such as lead, mercury and copper can be

extremely toxic and examples of mercury poisoning related to tainted fish (Minamata disease) have been reported in Japan. A 1982 report by the Minister of Population and the Environment indicates that among some 75 types of industry found in or near Jakarta, 15 were known to produce wastewater effluents containing toxic and carcinogenic heavy metals.

Together, domestic and industrial wastes affect not only the natural functions and productivity of coastal systems but can also make the available harvest unsuitable and in some cases hazardous for human consumption. Many aquatic environments in Indonesia are approaching the stage where further waste materials cannot be assimilated, particularly in areas where there are both major population concentrations and/or industrial development (Soegiarto and Romimohtarto, 1984).

(2) Examples of Stress and Degradation in Indonesia

Section 3.1 described the nature and significance of human activities and their impacts on Indonesia's major coastal ecosystems, including degradation. Below, we highlight three of these ecosystems where documented institutional and management problems have led to a substantial reduction in productivity and value.

o Tidal Swamp Forests

The Indonesian government has projected major development of these lands for tidally irrigated rice fields associated with the transmigration program. After committing vast areas and billions of dollars of loan funds to these fragile and generally agriculturally marginal lands, it is not certain that their use for agriculture can be sustained. Reports are circulating of decreasing rice yields, accelerating management costs, and deteriorating soil and water conditions. Research undertaken by the Institute Pertanian Bogor and the Center for Environmental Studies at Palembang indicates that in the tidal swamplands of Sumatera, yields of unhulled rice from some transmigration sites may have fallen to 1.5 tons per hectare, which is less than one-fifth the yields from non-swampland irrigated padi in Java (Koesoebiono, 1983, pers. comm.). Declining yields may be related to increased acid sulfate conditions in the soils and the consequent reduced rates of release from fertilizer applications. The recent workshops held by the Research Group on Agroecosystems (Kepas, 1983) cite tidal swampland transmigration schemes where rice yields have been very low and where land has been abandoned.

Apart from the marginal nature of these lands for agricultural development, development planners have consistently failed to evaluate the impact upon fresh water, and estuarine and coastal fish stocks resulting from conversion to agriculture. To date, there have been no definitive studies to determine what the nature and scale of the impact upon fisheries may be. It is reasonable to expect that a major alteration to these systems will alter nutrient cycling, increase acid drainage, and reduce spawning and nursery areas. In addition, the commercial value of the swamp forest is generally discounted to zero when assessing the benefits of natural ecosystems. However, the long-term sustained yield of timber from these areas is substantial and equates with that of many upland forest areas (Burbridge et

al., 1981). These values, when incorporated into an expanded economic analysis, suggest that agriculture should be directed to rehabilitated alang-alang (Imperata cylindrica) grasslands.

o Mangroves

Mangrove areas are cited in different contexts as either worthless swamps or as highly valued natural ecosystems supporting a variety of economic activities. Even where their value in supporting fisheries in their natural state is recognized by agencies such as the Directorate General of Fisheries, mangroves are cited by those same agencies as prime locations for replacement by fishponds. At this time, the GOI plans to open up 30,000 hectares of fishponds, many of which will be in mangroves.

Current policies concerning mangrove management are not leading to the conservation of these resource systems as the basis for sustained development. Apart from questionable estimates of the extent and areal distribution of mangroves, the rate of loss of these areas is often obscured by piecemeal, small scale erosion of both the areal extent and viability of the mangrove habitat. In all areas we visited, mangroves were heavily exploited for fuelwood and large tracts had either been reclaimed for fishponds, saltponds or other uses and many were subject to pollution or interference in freshwater flows or tidal flushing. It was a rare occasion when we found a relatively undisturbed mangrove area.

The current condition of mangroves is a reflection of both controls over local utilization and often single purpose development policies. For example, the leasing arrangements concerning mangrove have been radically altered from an essentially provincial base to a central government base. As a result, all leases over 100 hectares must now be allocated by the Ministry of Forestry. This shift was carried out in order to promote foreign investment in forestry development: 13 major companies now hold leases for some 55% of the country's total mangrove area. These companies are mainly extracting mangrove wood chips based upon a clear cut strip system of silviculture. There were indications that this system is not leading to the regeneration of the desired Rhizophora spp.; instead, less commercially valuable species are replacing the harvested mangrove (Burbridge and Koesoebiono, 1984).

Research on the utilization of mangrove for uses such as traditional charcoal production, modern woodchip production, and conversion to fishponds based upon current FAO guidelines in nearby Malaysia has shown that, of the three alternatives, only a 30 year rotational cycle of mangrove charcoal production is sustainable (Gong et al., 1984). These results suggest that neither current forestry policies favoring large scale wood chip production nor the conversion of mangrove to fishponds promote sustainable development.

Repelita IV's targets advocate the increasing export of fisheries products to improve Indonesia's foreign exchange position. In the past, prawn exports have been one of the most lucrative and important fisheries exports, and tambak culture is an important means of producing prawns. It should not be surprising that economic trends have been leading towards a major program of tambak extensification (as well as intensification). In

this context, the full range of values of mangroves is not being included within the implementation of Repelita IV policies for the next five years. In short, mangroves are, at present, expendable. Despite another Repelita IV objective to better control the utilization and management of fisheries resources, the conversion of mangroves to tambak and transmigration areas is one of the most critical environmental problems facing the country, and has tremendous implications regarding the sustainability of other aquatic resources. The widespread destruction of mangroves is also a problem in nearby Malaysia (Gong and Ong, 1983) and perhaps in other ASEAN countries (Knox and Miyabara, 1984).

Although the establishment of nature reserves has led to greater protection of some valuable tracts of mangroves, the extent of the program and enforcement to protect resources are inadequate. As discussed earlier, there are institutional problems and disagreement associated with the establishment of a buffer zone or "green belt" concept to protect mangroves. Clearly, a range of management strategies is needed for mangrove conservation.

o Coral Reefs

The serious degradation now occurring to coral reefs in Indonesia is the result of overexploitation, destructive fishing techniques, sedimentation, various forms of pollution, and mining/harvesting activities. At present, there are no integrated or effective programs to control or manage these activities or their consequences. Because of their environmental and economic value for fisheries, erosion prevention, and tourist potential, coral reef management should be among Indonesia's highest conservation priorities.

The GOI recognizes the need for coral reef management, but given the complexity and extent of reef degradation, major economic and technical assistance to shift the use of reef resources to a less destructive and more multiple use strategy will be required. The management and control programs will necessitate a variety of different techniques and emphases because of the constrasting nature of the source of the problems and their possible solutions. For example, to eliminate or reduce the destruction of reef habitat from explosives (and poisons), greater enforcement and penalties for unauthorized use and sale or distribution of explosives would be particularly important. Education on the consequences of dynamiting and training in alternative fishing practices and vocations may also help reverse existing trends.

Aside from their many other valuable functions in Indonesia, reefs provide vital sources of animal protein for many people. A concerted government-backed coral reef management plan is needed in Indonesia to sustain subsistence, artisanal or small scale fisheries and other important functions. Management options should also consider controlling access to certain reefs, encouraging seasonal use, and discouraging large scale commercial exploitation.

Studies using remote sensing techniques should be considered to identify problems areas (sources of pollution and sediment). Other studies should focus on documenting the extent of damage, effect on fisheries, rates of

recovery and identification of remedial actions. Burbridge (1983) gives details on the application of remote sensing techniques to coral reefs.

(3) Conclusions

Because of the interrelationships that exist among Indonesia's coastal ecosystems, national policy guidelines and local controls implemented in accordance with those guidelines are critical factors for promoting the sustained development of these resource systems. At both levels, major improvements are needed to refine policies and to impress upon the public and officials alike the need to promote conservation. Even though they are fragile, these ecosystems offer great potential for fulfilling future development objectives. Therefore, sectoral assessments of resource utility will need to be enhanced to incorporate many more of the pecuniary and environmental values to society represented by these systems. Except for activities such as ports or power stations that cannot be developed without radical alterations to coastal areas (however, these projects can be sited to reduce or avoid adverse impacts), the greatest economic returns from coastal resource development will lie in skillfully managed, multiple-use activities based on natural resource systems.

Further, many environmental problems could be reduced by improving the definition of the boundaries for economic analysis and project evaluation. For example, a project to convert mangrove should have analytical boundaries broad enough to include the expected benefits or costs that occur offsite (e.g., changes in coastal fish catch resulting from the conversion of the mangrove-based breeding areas inland, or storm damage following the destruction of the mangrove buffer function).

4. COASTAL RESOURCES MANAGEMENT AND ITS ROLE IN AQUATIC RESOURCES DEVELOPMENT

4.1 THE NEED FOR COASTAL RESOURCES MANAGEMENT

Given that: (1) it is not possible to meet the land and water demands forecast by the various sectoral agencies, (2) conflicts between sectoral forms of development need to be rectified, and (3) the management of any single coastal resource is largely influenced by bio-physical conditions extending over a series of related ecosystems, a broader framework than is now provided is required to guide the allocation and development of coastal resources. Coastal resources management can provide this framework.

When considering coastal resources management as a development approach for Indonesia, it is important to keep in mind the following points:

- The future demand for land uses will be directly affected by the level of control exersized over the conversion of land. For example, if 10 hectares of first-quality agricultural land in Java are developed for highways, housing or factories, up to 50 hectares of land in the outer islands may be needed to replace the lost production from these 10 hectares. Unless good agricultural lands are protected, the need to expand agriculture in the year 2000 will be greatly increased. Much of the land best able to support intensified agriculture is in coastal areas.

- Natural resources must be safeguarded as part of the effort to increase the productive capacity of existing land/water uses.

- It will be very important to identify factors (e.g., water quality or siltation) in areas distant from the coast that will influence potential coastal development options. These factors must then be incorporated in the calculation of future land demands. This will help clarify both the intersectoral impacts of poor management and the cumulative effect of these factors upon the productivity of existing activities. It will also assist in defining the management units (e.g., watersheds) that are necessary to promote the sustainable development of aquatic resources.

- By placing emphasis upon improving the information that is available on marine and nearshore fish stocks, it will be possible to more accurately assess their potential for development. More accurate estimates of potential open water fishery harvests will help to improve the estimates of future land requirements for aquaculture/mariculture and will promote the cost-effective development of these activities.

- Because forestry, agriculture and fisheries practices are dependent on the quality of limited land and water resources, there are bound to be

areas where these activities will be in competition. It is important to identify such areas so that priority can be given to resolving potential conflicts before they arise.

- The integration of compatable land use activities and the segregation of non-compatable uses are fundamental elements of land use allocation policy. With increasing pressures upon scarce land resources, the identification of compatable, multiple use activities and the spatial and temporal allocation of lands suitable for these mixed uses may take precedence over allocating the same lands to single purpose uses. It is therefore critically important to consider how coastal and aquatic resources development can be managed to promote complementary, sustainable, multiple-purpose land use strategies.

4.2 COASTAL RESOURCES MANAGEMENT AS A COMPLEMENT TO AQUATIC RESOURCES DEVELOPMENT

Coastal resources management provides a logical framework for implementing improved approaches to integrating and managing aquatic resources development activities. The need for a broader framework for evaluating the factors that condition ARD has been identified by Bailey et al. (1985).

Because the supply of and demand for coastal resources varies widely both within and among the regions of Indonesia, government actions on the use of those resources can also vary widely. This can lead to conflicts both within one level of government (e.g., Forestry and Fisheries at the national level) and between levels of government (e.g. provincial vs. national agencies). Thus, it is helpful to evaluate all of the resources that coastal areas can offer, in addition to their aquatic resources, when resource development plans are being formulated. Below, we illustrate some of the important factors at play in coastal regions and highlight the need for an integrated approach to their development. These factors include:

- the market factors associated with different fishery commodities;
- the areal distribution of major coastal and associated ecosystems;
- major development and management initiatives; and
- factors that cause either internal stress within individual ecosystems or that have a potential cumulative effect upon the coastal and marine resource base within major market areas.

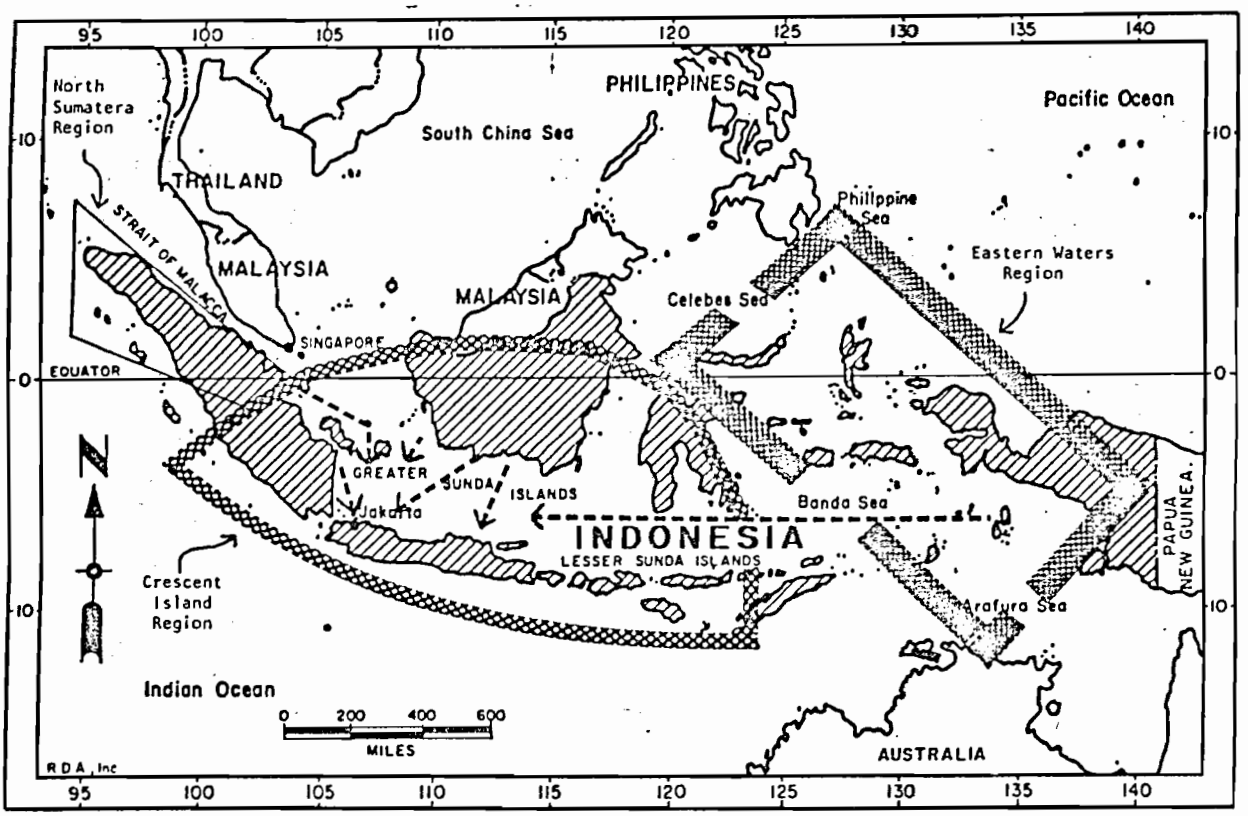
The interrelationships that exist among these factors are illustrated below.

First, the three major fisheries markets operating in the archipelago (the "crescent," North Sumatera, and eastern waters regions illustrated in Figure 5) create different demands for aquatic resources. In turn, these demands influence the resource exploitation strategies that are adopted and the choice of aquatic resources used to meet demand. For example, the international market for shrimp led to increased trawling pressures in major

shrimp capture areas of the Java Sea and Malacca Straits. When trawling pressures became a concern to artisanal fishermen, trawling was banned in these waters. The ban then caused shrimp export investors to alter their strategy and cultivate shrimp in tambaks. While the shift from the exploitation of wild stocks to cultivation fulfills demand, it is causing a major change in the areal distribution and quality of mangroves in Java and Sulawesi, is leading to major changes in land tenure, and may well cause a series of negative environmental impacts associated with the destruction of mangroves.

Figure 5

Major Fisheries Market Regions in Indonesia. After Bailey et al. (1985).



Second, the cumulative effect of uncontrolled development in response to market preferences and government policies is causing competition for scarce resources and is leading to mounting problems of externalities (bio-physical water pollution or erosion-siltation, economic reduction of milk fish fry due to clearance of mangroves, etc.). These problems increase costs, reduce development options, and reduce the ability of coastal resource systems to sustain development. Thus, there is a need to examine the effects of the different sectoral policies that cause these phenomena and to assess the long term effects of current initiatives. Activities that need to be examined in terms of individual and synergistic effects are:

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- Transmigration (upland, tidal swampland, and fisheries related projects).

- Upland watershed management (erosion, changes in hydrologic regimes).

- Population growth and migration.

- Donor assistance for major agriculture, fisheries, forestry and similar development projects. Many of these assistance programs (transmigration, irrigation, tambak extensification, commodity based programs) are causing considerable changes in coastal ecosystems.

- Government policies to promote rice (tidal swampland reclamation), shrimp exports (tambak extensification-mangrove reduction), and mangrove wood chip production (resulting in changes in species and raising questions of long term viability).

- Lack of policies or effective controls to protect high quality agricultural land, to conserve marine habitats, and to maintain the functional integrity of coastal resource systems (pollution control including sedimentation, mangrove management, and tidal swamp forest conservation).

Third, a lack of integrated planning and management is leading to a reduction of development options. Policies that emphasize commodities such as export-quality shrimp tend to promote the simplification of complex resource systems to a single function, commodity related resource base. The oversimplication of such production systems increases their vulnerability to natural hazards (storm, floods, disease) and to markets shifts, which in turn increases the risk of catastrophic financial failure. The medium-term irreversibility of actions such as mangrove clearance for tambak extensification reduces alternative development options and represents the investment of scarce resource capital in high risk ventures. The questions of the equitability of such ventures in terms of access to resource opportunities, distribution of benefits and costs, and the socio-economic impact of potential failures are also of concern when resource use is simplified.

Each of the three market regions has its own distinct combinations of the above factors which, in essence, represent the management milieu within which aquatic resource development projects will be instituted. If we take the market area based in Java (the crescent region described by Bailey et al, 1985) as a case in point, we see the following factors at play:

- The Java Sea, common to each of the island groups within the crescent, is subject to a series of major uses and/or environmental stresses, including:

  -- it is the focus of major trading routes between the islands of the archipelago;

  -- it is the site of major oil production and oil shipment routes and has the potential for a major marine oil spill;

-- it is the area of major shrimp/finfish capture fishing;

-- it is experiencing increasing sediment loads in sea water due to the clearance of upland forests, industrial wastes, human wastes, and shifts in hydrologic cycles (and thus freshwater flows from major river systems); and

-- it is the scene of major coral reef destruction (Bali, South Sulawesi) and extensive mangrove forest conversion.

- The crescent area contains Indonesia's major population concentrations and is the locus of major transmigration programs (South Sumatera, South and Southeast Kalimantan, Sulawesi).

- The majority of the best agricultural soils as well as major swamplands are found within the crescent.

- The cresent area has the greatest concentration of secondary and tertiary industrial/commercial development.

- A large part of all donor assistance funds and projects is directed to areas within the crescent.

This list could be extended; however, it provides sufficent information to illustrate the influences upon aquatic resources development exerted by the web of economic activities, population pressures, and competition for limited resources.

Because of the GOI's policy promoting the creation of sustainable forms of aquatic resources development, it would seem prudent to adopt a broader CRM perspective for ARD projects. Thus, a proposal has been formulated that links aquatic resource development options to the coastal and marine resource systems that would best sustain the development of those options. The options for program development are presented in the companion volume to this report (Baily et al., 1985). However, it is useful to sketch out the primary components of those options as a basis for further discussion of the feasibility of promoting broader CRM-ARD programs.

The principal components of a combined CRM-ARD program cited by Bailey et al. are:

1. Marine Fisheries

Stock assessment of currently unexploited species
Applied socio-economic research
Market policy analysis, with emphasis on inter-island trade
Quality control of shrimp processing for export
Installation of ice plants in appropriate locations

2. Aquaculture Development

Rice-cum-fish culture development in Sumatera
Research and *Pengasius* cage culture (Sumatera)

Giant freshwater prawn development (Sumatera)
Small-scale shrimp hatchery development at tambak intensification site (Java, South Sulawesi)

3. Education and Training in Aquatic Sciences

Small grants program
Short courses for fisheries faculty development
Equipping new laboratories at Bogor National University
Provision of support (including a faculty participant) to Universitas Hasanudin (UNHAS)
Institution building through inter-institutional cooperation at Ambon

4. Coastal Resources Management and Development

Policy, technical, and training assistance to the Ministry for Population and the Environment
Cross-sectoral resources management and development at the provincial level (perhaps in South Sulawesi)

The adoption of a broad CRM-ARD approach presents a number of options for shifting towards development planning involving a series of national and provincial agencies and a series of project areas and representative resource systems. While this approach involves added complexity, sustainable forms of intensified ARD development can only be achieved through improvements in current standards of CRM.

The GOI thus has an important choice to make between pursuing a basic commodity-based ARD approach or developing new multiple use strategies for ARD based on improved coastal resource management practices. We believe this second option will do more to safegurard individual ARD activities and will provide a demonstration of how to manage and maintain future development options.

The broader CRM-ARD option poses a series of challenges that need to be considered, namely:

- More government agencies would be involved, making programming more complex.
- A sustained effort will be required to achieve successful results.
- More integrated planning and management of program activities, as well as increased utilization of the successful CRM-ARD methodologies of other countries, will be necessary.
- Funds will be needed to support the CRM-ARD option. Due to the severity of the stresses now leading to the degradation of Indonesia's coastal resources, a major effort will be required to improve both central government policies and management procedures and to develop demonstration projects at the regional level where ARD projects would be undertaken.

The necessary pieces of an embryonic CRM framework exist in Indonesia. The challenge is to put into operation the GOI's normative policy objectives. In the next section, we outline the activities of the Indonesian ministries and provincial institutions that would formulate and implement CRM-ARD projects.

4.3 THE GOVERNMENTAL CONTEXT FOR DEVELOPING A COASTAL RESOURCES MANAGEMENT INITIATIVE IN INDONESIA

4.3.1 National Policy

The Peoples' Consultative Assembly of the Republic of Indonesia (MPR) has, since 1971, been responsible for the formulation of national development policies. These policies form the State Policy Guidelines (GBHN) and are embodied in the Five Year Development Plans (Repelitas), providing the broad policy framework and specific objectives for the management of the "living environment and natural resources."

The current GBHN (1983-1988) sets out the following broad development objectives in the Third Five Year Plan (Repelita III, 1979-1984):

- the mobilization of human resources to complement the "abundant" natural resource capital for national development (Chapter II);
- the exploitation of natural resources in a manner that will not destroy the living environment and that provides the basis for sustainable development and the promotion of human welfare (Chapter III); and
- a series of specific objectives related to resource management, including:
  - -- improve resource assessment;
  - -- apply appropriate forms of technology;
  - -- integrate development efforts between sectors of the economy and within regions;
  - -- rehabilitate natural resources damaged through poor management and adopt improved management approaches to river basins, forests and other land and water resources; and
  - -- improve the use of coastal areas, territorial waters and national air space (Chapter IV).

Based upon the current GBHN, the new Fourth Five Year Plan (Repelita IV, 1984-1989) provides specific directives concerning the utilization of natural resources, including:

- development should be sustainable in terms of the ability of the natural resource system/environment to respond to individual and cumulative development pressures;

- o no individual form of utilization should degrade another natural resource development opportunity; and

- o future development options must be maintained (Chapter II).

The general objective of the natural resource development and environmental policies is to safeguard public welfare. To this end, ecosystem concepts are emphasized as tools to be used in reducing environmental stress and preventing harmful effects resulting from development. By pursuing this objective, it is hoped to reverse current trends in resource degradation and to provide a strong basis for long term development during Repelita V. This is referred to by Emil Salim, the Minister for Population and the Environment, as the "take off point" where Indonesia's development efforts will be self-sustaining.

Repelita IV also makes specific reference to the significance of coastal resources. Mangrove, coral reefs and other coastal ecosystems are cited as the most productive parts of the Indonesian territorial waters (including the 200 mile limit and the Exclusive Economic Zone). Recognition is also given to the linkages between upland management practices and coastal resources. Particular attention is paid to the role of forest protection in maintaining hydrological regimes in river systems, estuaries and associated coastal ecosystems. A point which is implied, but not specifically stated, is that the control of erosion will reduce rates of estuarine siltation and in turn will reduce the stress imposed on coral reef communities.

4.3.2 Sectoral Line Agency Development Principles

The national environmental and natural resource development criteria are meant to apply to policies promoted by the different line agencies. For example, agricultural development covering agricultural foodstuffs, fisheries, and estate crops--whether it entails intensification, extensification, diversification or rehabilitation--must be carried out in a manner that promotes the maintenance of environmental quality. Similarly, the activities of line agencies like the Ministry of Forestry are governed by long-term natural resource management guidelines. These guidelines include reforestation, regreening and the conversion of forests to other uses.

Rehabilitating lands degraded through inappropriate, non-sustainable forms of use (critical lands or tanah kritis) is a major element of national policies. A policy of increasing the public's awareness of environmental concerns is also promoted by line agencies to help reduce activities that run contrary to the public welfare.

4.3.3 Provincial Levels' Emphasis

As part of the efforts under Repelita IV to improve the management of renewable resources, the government has established Environmental Study Centers (PSLs) at provincial universities and the Bureaus for Population and the Environment (BKLHs) as part of the provincial government structure. The PSLs are to provide the information and technological support for the establishment of environmental management procedures and frameworks. The recently-established BKLHs are to advise the Governors and the Provincial

Regional Development Planning Offices (Bappedas) on the implementation of environmental concepts and regulations and help to integrate sectoral initiatives into provincial development plans.

The Bappedas formulate regional plans for the implementation of national objectives, policies and guidelines. In pursuing this function, they are being instructed to incorporate environmental considerations in the development planning process.

Ideally, the PSLs, BKLHs and Bappedas would cooperate in integrating environmental assessment procedures into the development planning process. In reality, this will be a slow process due to a severe shortage of regional staff with adequate implementation skills. It is therefore likely that sectoral development policies and plans will filter down to the regional level and will not be critically assessed in terms of the ability of the regional resource bases to sustain development. The recent field trips brought several good examples to light of PSLs with no real facilities, and inadequate manpower or operating budgets; BKLHs with no staff trained in environmental assessment or resource management; and Bappeda staff with little knowledge of physical or economic planning and almost no skills in integrating sectoral development into regional plans.

4.3.4 Implementation Problems at the National, Provincial and Local Levels

Conceptually, the State Policy Guidelines and Five Year Plans present a very comprehensive series of statements concerning the management of development. There is, however, a major gulf between policy prescriptions and the implementation of those policies.

The failure to implement policies and to regulate development are cited in Repelita IV as problems that must be redressed. Together with problems of population distribution and the geographic spread of natural resources, the failure to implement existing development policies and regulations are blamed for deteriorating environmental conditions in Sumatera, Kalimantan, Sulawesi and the lesser Sunda Islands (Nusa Tenggara). Specific reference is also made in Repelita IV to the shortage of skilled manpower, lack of materials, and low levels of participation in soil conservation and pollution control efforts.

The field work undertaken by Bailey et al. (1985) illustrates problems of attitude and lack of government enforcement of existing regulations. Often, the reason given was that "if such regulations are enforced the local population will be impoverished." While it is easy to sympathize with this logic, lack of enforcement is leading to accelerating rates of damage to critical environmental systems. A simple example is the failure to control explosive fishing on coral reefs. By not controlling the destructive activities of a minority, the welfare of the majority is impoverished.

The theme of social participation in environmental management is repeatedly stressed. Public awareness of environmental issues is emphasized because awareness levels are considered too low to motivate self supporting efforts for the improvement of environmental management.

4.3.5 Specific Measures to Improve Implementation

Given that implementation problems exist and are recognized by the national government, policies and measures to promote the implementation of environmental management are set forth in Repelita IV. Specific attention is being given to:

- reducing population growth, redistributing population and improving the quality of settlement planning;
- increasing basic knowledge of the capacities of natural resource systems to respond to development pressures;
- developing natural energy sources to regulate resource utilization and to promote conservation and protection in areas required to maintain ecosystem functions;
- integrating development in watersheds;
- promoting marine conservation areas and measures to limit catches while increasing marine fishery production and aquaculture;
- reducing marine pollution through the implementation of an oil spill contingency plan;
- offsetting damage to mangrove forests important to shrimp and finfish breeding areas through reforestation and afforestation;
- protecting areas allocated to development through the protection of the ecosystem that supports a specific area or form of development activity;
- applying environmental impact analyses to existing policies and activities including: the use of fertilizers and pesticides, the construction of large scale reservoirs, coastal development/conversion of natural habitats, conversion of natural forests into agricultural land and plantations, and the development of large scale agro-industries;
- reducing or avoiding the conversion of primary forest at transmigration sites and focusing on the rehabilitation of *Imperata cylindrica* grasslands for resettlement projects;
- reducing damage to production and protection forests through shifting cultivation, fires, mining operations, road construction and the development of other infrastructures;
- increasing control over hazardous waste production and disposal;
- building institutions through developing better laws and regulations and setting performance standards. Specific emphasis is given to Environmental Law No. 4 (1982), where new regulations will be promulgated that can be applied at both national and regional levels.

Priority will be given to provisions covering the lay-out of towns and villages, utilization of natural resources, standardizing environmental regulations, standardizing waste management criteria, environmental impact assessment, regulation of hazardous waste disposal, use of marine dumping areas, development of self-reliant community institutions, and the application of environmental standards/information in development planning; and

- o developing manpower through professional technical training for development planners and more specialized environmental management training at the university level. Both forms of training will be closely associated with the PSLs.

4.3.6 Other Legal Instruments Related to Coastal Resource Initiatives

The formulation of resource allocation and land use policies will be critical elements of any initiatives to manage coastal areas on a sustainable development basis. Law Number 5 (The Law on Agrarian Affairs, 1960) calls for a centralized land policy to overcome problems created by a maze of local codes and to rectify problems of land ownership left over from the colonial period. This law attempted to put into practice Article 33, point 3 of the Indonesian Constitution which states that land, water and all other natural resources are managed by the state for the benefit of mankind. Law number 5 is potentially a powerful tool for improving resource allocation procedures. Article 2 of this law gives the GOI the right to formulate land use policies and Articles 14 and 15 give powers to allocate land to meet basic needs such as agriculture, settlements, infrastructure, etc.

The Five Year Plans provide the GOI with a mechanism for generating broad land use objectives (e.g., sustainable development) and determining priorities for development that the major line agencies translate into programs and projects. In turn, they are adopted by provincial governments as the basis of their development plans. However, the application of land allocation procedures comes at a low level in the hierarchy of authority: the Daerah Tingkat II (sub-provincial level) deals with land allocation.

Two unresolved problems make the task of meeting the objective of sustainable development very difficult to achieve. The first concerns the lack of emphasis on the strategic value of land and water resources. A variety of land classification systems have been adopted by individual government agencies, but they are seldom compatible with one another, are based mainly on physical features, and do not contain relevant information on the socio-economic factors required for good land allocation policies and land use plans. This problem is recognized in Presidential Instruction 1-76, which directs departments with large land holdings to coordinate their policies and activities in the public interest. However, as in the case of the mangrove greenbelt, conflicting views between departments acting in "the public interest" can take a long time to be resolved because there are no unified and clearly articulated policies and priorities for the allocation of land/water resources.

The second problem is that there is no effective control over lands held in private ownership. Claims to adat (traditional) rights of access to lands

also tend to inhibit the creation of strategic land/resource allocation policies.

4.3.7 Key Institutions for Coastal Resources Management

Ministry of Population and the Environment (KLH). Minister Emil Salim has provided leadership in bringing coastal resources management issues to the fore and has actively promoted intersectoral discussions to resolve coastal development conflicts. The strength of KLH lies in Salim and the respect that the President, other ministers, department heads and non-governmental bodies have for him. As a State Minister, he has no vested interest in development as do the ministers leading sectoral line agencies (Forestry, Agriculture, Public Works, etc.). He can, therefore, concentrate on issues and problems and through the coordinating role of his agency, bring representatives from all coastal related agencies together to seek commonly agreed upon policies and solutions to problems.

Within ASEAN, Salim plays a major role in promoting environmental assessment and resource management. He has consistently urged his fellow ASEAN ministers to strengthen marine conservation and to cooperate in seeking common solutions to marine and coastal problems. At the recent ASEAN meeting in Bangkok, Salim was elected as the first spokesman for the combined ASEAN representatives. This puts him in a very good position to disseminate CRM-ARD approaches to other countries in the region.

Salim is currently establishing an interagency committee for coastal resources management in Indonesia which will bring together people from universities and government agencies. The committee has the potential for developing strong working links between departments and influencing agencies such as Bappenas, which control the allocation of funds on specific coastal resources. The achievements of this committee will depend largely upon the strength of the members who will be appointed. If the appointees have power and influence, it will be possible to make major policy improvements and to exert the political pressure to have them implemented. The committee could also serve to coordinate provincial CRM projects if strong linkages can be forged between the committee and the provincial governor, Bupati (Kabupaten) and Dinas (provincial service) heads.

It should, however, be remembered that Salim is the pivotal character in the Indonesian CRM initiative. Should he leave KLH to take up another appointment, there is probably nobody at KLH who has his strength or standing in government circles.

Ministry of Science and Technology (BPPT). Minister Habibie has been actively promoting the application of scientific research and new technologies in coastal areas and has been lobbying for the support of ASEAN nations in marine resource management. Habibie is also the head of the Agency for the Application of Technology for Development (PPPT) and has just inaugurated the Academy of Sciences. The Academy and the National Research Council will assess priority areas for research and will provide mechanisms for bringing scientific and technological manpower together to address specific issues. The implementation of research will, however, remain with the Indonesian Institute of Science (LIPI). For all practical purposes,

research on policy or technical issues relating to ARD or CRM will be channeled through LIPI and the National Oceanographic Institute (LON). Both these groups will have an influence on the conduct of coastal development and should be considered as potential contributors to a CRM initiative.

Habibie has a deputy—Achmad Satari (former Rector of the National University at Bogor (IPB)) in charge of a group on natural resources. The work being carried out by this group centers on specific projects such as the development of sago for alcohol production. There is little evidence that this group is concerned with broader coastal resource management issues.

The World Bank is launching a US $100 million loan project with Habibie for scientific and technological manpower training. These funds will attract a large number of people and could drain active, ambitious staff away from agencies such as KLH which do not have such funding programs. If Salim could obtain additional training funds, it would help to offset any potential siphoning off of his staff and could also provide inducement to get more qualified people to work in his ministry.

Ministry of Interior (Dalam Negeri). Although this agency has no specific commodity or other resource development interest in coastal areas, it is the parent institution for the Bappedas. The Bappedas and their district level offices (Bapemkas) are responsible for planning and implementing national policies. These agencies could play a pivotal role in a CRM initiative.

There are two further agencies within Dalam Negeri that are of importance in coastal management. The first is Agraria, which is responsible for surveying and land use mapping, land use planning (tata guna tanah), and the registration of land holdings and ownership. This agency is instrumental in regional planning and development and will play a key role in questions of coastal land use regulation, disputes over riparian rights, and monitoring changes in land use. The cooperation of this group would be essential to the success of any proposed CRM initiatives.

Dr. I Made Sandy, the Director of Tata Guna Tanah, expressed interest in and support for a CRM initiative during discussions with the authors. He is already acting as an advisor to Emil Salim on coastal mapping and planning questions.

The second agency is Bakosurtanal, the National Resource Surveys and Mapping Agency. Bakosurtanal was established with the assistance of the World Bank. Some US $23 million (World Bank and Indonesian funds) have been invested in very sophisticated equipment to analyze resources and to create a geographic information system and mapping facilities using remote sensing information.

Due to a shortage of training funds in the original loan agreement, the facility has never operated at its potential capacity. There have also been management problems in terms of delegation of responsibility. These have been futher complicated by the recent death of Professor Kardono (Gajah Mada University, Geography), the deputy director in charge of remote sensing interpretation.

Despite these difficulties, the agency has very good equipment for the analysis of aerial photography and satellite imagery and for information storage, retrieval and mapping. It provides a valuable resource for the inventory, mapping and continuous monitoring of coastal resources. For example, Bokosurtanal could initiate or assist appropriate ministries in conducting studies to monitor the distribution of mangrove, coral, fish ponds and other vegetation or land use types and the dynamics of how that distribution is changing in response to development effects.

Ministry of Energy and Mines. This agency is responsible for managing mineral extraction in coastal areas and plays a part in decisions on power plant location. At present, there are few effective guidelines on coastal (beach and shallow water) mining operations and the impacts of power plants (thermal discharges, for example).

Ministry of Agriculture. This ministry is actively involved in coastal land reclaimation for agriculture. As the home of the Directorate General for Fisheries, it also plays a major role in the development of aquatic resources. There is strong evidence of this ministry's concern for the conservation of mangrove habitats; however, it is also implementing plans to convert mangrove to fishponds. There thus appears to be a lack of leadership, political will, coordination of activities, or integrated planning of coastal resource development within the ministry.

Ministry of Forestry. This ministry is responsible for the management of coastal swamp and mangrove forests. Although silviculture regulations have been developed for both these forest types, there is strong evidence to suggest that current management practices are not leading to their sustained utilization.

It is very difficult to assess the potential support for CRM within this very powerful ministry. Mangrove resources provide a very small part of its total revenues but perhaps account for significant administrative costs. In addition, many of the benefits from mangrove management fall outside the ministry's economic sphere, as in the case of their value for fisheries conservation. It is questionable whether Forestry is prepared to devote any significant portion of its manpower or management funds to a broader concept of mangrove/coastal resource management.

On the other hand, the ministry is responsible for nature conservation including marine reserves. Although it is receiving technical support from the World Wildlife Fund and IUCN, the Nature Conservation Section (FHPA) is staffed by foresters, only one of whom can swim and who knows anything about marine ecosystems.

Public Works (PU). This ministry is responsible for irrigation, drainage projects (tidal swamplands being a major example), land clearance (transmigration sites), wastewater treatment, public water supplies, and other construction and engineering activities in coastal areas. Public Works has a team of environmental engineering advisors and computer based information management and mapping facilities. Several environmental and resource evaluation consulting groups work for PU and from discussions with members of these firms, it appears that PU is responsive to suggestions for

the improvement of engineering procedures and techniques that can promote better standards of coastal development.

Ministry of Communications. Responsible for land, sea and air communications, this ministry is active in port/harbor planning and development, and controls ferry operations. Although it uses PU for the actual construction of projects, it is a key ministry to consider in terms of policy toward integrating coastal development and implementing improved design criteria for individual projects. A subagency--the Agency for Meteorology and Geophysics--provides a very important source of coastal climatic information.

Ministry of Education. Although this ministry is not involved in development per se, it has a major role in manpower training and education, and is also administratively responsible for the environmental study centers located at the provincial universities. Minister Salim has actively sought the support of the Minister of Education to allow the PSLs to assist his ministry. Any training funds or direct support to PSLs under a proposed CRM project would have to go through the Ministry of Education.

National Oceanographic Institute (LON) - Lembaga Oceanologi National. LON is primarily a research institution; it is not directly involved in the management of coastal resources. However, in its role as an advisory body to various ministries, it has developed management assessments and expertise. LON also plays a key role in coordinating marine and coastal research carried out by the PSLs. It also helps to train staff at the PSLs in specialized areas such as monitoring pollution.

LON has been very effective in obtaining funds from the Ministry of Forestry for research on mangroves. Thus, it has circumvented the problem of the major part of all mangrove research funds being given to Forestry by Bappenas.

Environmental Study Centers (PSLs) at Provincial Universities. The original environmental study center at the Institute Pertanian Bogor (IPB) was set up as the result of an Indonesian initiative to bring people from different disciplines together to examine environmental problems associated with the development process. Since the inception of the IPB center, interdisciplinary research has been encouraged at a number of provincial universities. Minister Salim, in cooperation with the Minister of Education, has actively supported these centers and seen them as a vital source of technical assistance, manpower training and information derived from applied research.

Although over 30 centers have been encouraged to develop, very few have any facilities, research funds or permanent staffing arrangements. Nevertheless, given support and encouragement, these centers can flourish and in turn provide badly needed support for planning and development efforts in their respective regions.

Eleven centers have been identified as having skills and interests related to coastal resource development. These are:

1. Bogor Agricultural University--watershed ecology, tidal agro-forestry and estuarine ecology;

2. Diponegoro University, Semarang--ocean and mangrove ecology;

3. Surabaya Institute of Technology--coastal settlement and industrial ecology;

4. Udayana University--island ecology, parks and tourism;

5. University of North Sumatera, Medan--coastal ecology, Malacca Straits management, grasslands and forestry;

6. Riau University, Pekanbaru--swamps, island and plains ecology;

7. Sriwidjaya University, Palembang--tidal swamp ecology;

8. Hasanuddin University, Ujung Pandang--lake and coastal ecology;

9. Pattimura University, Ambon--ocean ecology;

10. Jenderal Sudirman University, Purwokerto--coastal and brackishwater ecology;

11. Sam Ratulangi University, Manado--coastal, ocean and island ecology.

The development of these centers varies markedly. The centers at Bogor, Ujung Pandang, Ambon, Semarang and Medan may well be the best equipped and have more experienced staff. Others, such as Udayana, have well motivated leaders but lack even basic facilities, reference materials or funds.

In both the field work and during interviews, we attempted to assess the capabilities of these centers. Repeatedly, Bogor, Ujung Pandang and Ambon were mentioned as centers that would be suitable partners to Bappeda and BKLH groups as part of a CRM initiative in their respective regions.

These bureaus vary greatly due to a shortage of staff with skills in population and/or resource and environmental matters. In time, they will be required to make a significant contribution to provincial development policy, the enforcement of policies and regulations, and monitoring the response of land and water resources to development pressures. We anticipate that training to increase BKLH manpower skills related to CRM-ARD would be a component of any provincial CRM-ARD initiative.

4.4 FRAMEWORK FOR DEVELOPING A COASTAL RESOURCES MANAGEMENT INITIATIVE IN INDONESIA

In order to develop a coastal resources management initiative that focuses on the sustained development of aquatic resources, a number of measures could be undertaken. First, Indonesia can evolve an innovative approach to CRM that blends experience from abroad with its own bio-physical, economic and socio-cultural conditions. Second, we suggest how resource allocation policies could be improved at the national level, primarily

through the Ministry of Population and the Environment. Third, a plan is presented for developing demonstration projects and improving coordination at the provincial level.

4.4.1 Incorporating Other Countries' Experience in Coastal Resources Management

In this section, we draw from our observations on the conduct of CRM in a number of countries that may be of assistance to Indonesia. Interested readers can refer to a very comprehensive review of coastal resources management policies in both developed and developing countries that has been prepared by Dr. Jens Sorensen (1984) as part of an expanded information base project.

Coastal Zone Versus Coastal Resource Management. Where there is a strong separation of powers between the central government and provincial authorities (e.g., Canada, USA), attempts to define a uniform coastal zone have largely failed. Because provincial/state governments have been concerned that central government-sponsored coastal management initiatives would mean the loss of local decision making, there has been both great variability in the definitions adopted for state coastal zones (USA) and attempts to restrict special initiatives to a narrow "shoreline management" area (Canada). In response to both the time wasted in defining a coastal zone and resistance to the adoption of a broad coastal zone for management purposes, emphasis is now placed upon coastal resources management. The shift to managing resource systems (coral, barrier beaches, estuaries) helps to avoid political conflicts and assists in promoting joint governmental efforts to manage resource systems that overlay more than one administrative area.

Land Use Planning Controls. In countries with a very strong national government and delegated authority at the provincial and local levels, national plans and their regional subsets tend to guide coastal development. The presence of well established land use planning procedures helps in the implementation of those plans; however, they neither form a substitute nor guarantee a strong framework for coastal resources management.

In developed countries such as Great Britain, reliance on land use control procedures provides an inadequate base for coastal resource management. Such controls work well for urban related development; however, agriculture, fisheries, forestry and other natural resource development activities are not subject to planning controls and remain the responsibility of sectoral line agencies.

Scotland has developed a coastal conservation strategy to deal with North Sea oil and gas which is based upon the preservation of areas of great landscape value. However, it lacks any concept of the functional utility of coastal resources and the interaction between land and water systems. The control of coastal development remains a part of the town planning systems.

The adoption of land use controls is necessary to ensure that individual development initiatives conform with management plans and to help conserve highly productive lands from innappropriate forms of development. However,

for such controls to be effective, it is necessary to formulate clear policies that define how they should be applied to resources such as first quality agricultural lands.

Transferability of Coastal Resources Management Concepts, Procedures and Techniques. A series of seminars held between 1979 and 1981 on "Resource Use and Management in the Coastal Zones of the Asian Humid Tropics" brought to light world-wide efforts to develop long-term coastal management programs. Scientists and professional managers from each of the participating countries (Australia, Bangladesh, China, Indonesia, Japan, Malaysia, the Pacific Islands, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and U.S.A.) presented papers on coastal resources; typologies of human ecosystems in coastal areas, perceptions and definitions of the coastal zone, resource use and management, administrative arrangements, and problems and recommendations. Each of these analyses illustrated management problems similar to many areas of the world. There were, however, very marked differences between the countries concerning the perception of the utility of coastal resource opportunities, administrative frameworks for organizing, controlling and developing resources, and the stage to which coastal resource management initiatives had been developed.

A good deal of thought was devoted to appropriate frameworks for coastal management. Due to the early advances that the United States had made in promoting its Coastal Zone Management Act, this act and its provisions formed a conceptual basis for discussion. However, there were perceived limitations to the US-CZM framework's applicability to the individual countries and to the tropical environment.

A central consideration was the construction of the act based upon the separation of powers between the federal and state levels of government. This separation is not characteristic of most Asian societies, which have strong traditional institutions and laws (margas and adat law in Indonesia). Therefore, each country proposed the establishment of appropriate institutional arrangements to promote coastal resources development incorporating: guidance for public and private investment; the integration of sectoral development interests; the formulation and implementation of national, regional and local development plans; and monitoring the course of development to continually assess the performance of plans and implementation procedures. To these ends, the concept of a fixed coastal zone was considered of less importance than gaining a clear understanding of how coastal resource systems function and what factors are critical in terms of managing development.

Caution was also expressed concerning the transfer of coastal management concepts from temperate regions to tropical ecosystems. The principal differences between these ecosystems are:

- Floristic and faunal diversity is greater in tropical areas. For example, much of the seminal work on mangrove management has been derived from areas such as Florida where the mangrove habitat has a much smaller diversity and range than Indonesia. The same is true of seagrasses and coral reefs.

- Major seasonal variations are lacking in tropical areas. The absence of major variations in sunlight allows primary production to remain relatively stable throughout the year in tropical regions. Monsoonal conditions may well influence nutrient flows and the salinity of coastal environments; however, little is known about such influences.

- Little is known about the tolerance of tropical terrestrial and aquatic ecosystems to perturbations. Both terrestrial and aquatic systems in Malaysia are termed "fragile" by Furtado et al. (1981). Terrestrial systems are susceptible to degeneration of soil fertility, and to increased erosion and laterization owing to poor management. Tropical aquatic ecosystems are noted as being particularly susceptible to thermal pollution. It is thought that, owing to high water temperatures, most aquatic organisms are living near their upper lethal limits. However, high water temperatures favor the rapid breakdown of pollutants, possibly making aquatic ecosystems relatively resilient.

- There are large differences in the behavior of bio-physical parameters in the aquatic habitats of tropical and temperate coastal zones. Thus, the criteria and standards defined for temperate aquatic habitats should be applied with utmost caution in the tropics. Johannes and Betzer (1975) give a comprehensive summary of physical and chemical characteristics, community structures and biological functions in shallow tropical marine ecosystems versus their temperate zone counterparts at comparable depths.

These factors form important considerations in the design of any coastal resource management initiative because of the manpower, funds and time required to provide even basic management information. For example, a team member recently visited Thailand, where staff at the Phuket Marine Biological Station estimate that there are at most 100 trained scientists in Thailand available to examine coastal resources. These scientists face the task of creating a basic inventory of coastal flora and fauna. While such work has been underway for more than 100 years in Europe, it has barely begun in Thailand.

Experience in Thailand and the Philippines. The Philippines has one of the most advanced programs in Asia for integrated research and management of coastal resources. Even with its sophisticated system, the Philippines still has unresolved problems that are common to all coastal nations. An important problem is that no single agency is given complete jurisdiction, which leads to inter-agency conflicts. Because the evolution of a management policy depends upon the consensus of agreements between agencies (at present, there are no regulations compelling agency compliance in the Philippeans), the different goals and development objectives of various agencies will have to be reconciled. This process will be hampered by a lack of understanding of coastal resource values and the limits to which those resource systems can be pressed.

Anderson (1978) and Juliano (1978) both cite the conflict between fishpond expansion and mangrove conservation as an example of policy conflicts between economic and environmental goals in the Philippines. The

Bureau of Fisheries and Aquatic Resources wishes to expand capture fisheries and aquaculture there. Presidential Decree No. 705 (1975) directs that all mangrove areas controlled by the Bureau of Forest Development that are not needed for coastal protection be turned over to the Bureau of Fisheries and Aquatic Resources for conversion to fishponds (Anderson, 1978). This policy ignores the role of mangroves in nutrient exchange, primary production and support of coastal fisheries. The policy also goes against the Ministry of Natural Resources "Mangrove Committee's" 1977 recommendations that "the remaining mangroves may now have reached the critical limit to support breeding and nutrient needs of coastal fisheries...fishpond development can avoid utilization of mangrove-covered swamplands...expansion can be confined to swamplands without mangrove cover." Juliano (1978) observes that fishpond production can be increased through better management without expansion into mangrove areas. Nevertheless, licenses are continuing to be granted for clearing mangroves for aquaculture expansion (Anderson, 1978).

Conflicts in management priorities for mangrove areas can also arise in the case of high value minerals such as tin. The economic pressure to dredge mangrove areas for tin can outweigh consideration of the damage to coastal mangrove systems. For example, at one site in Thailand, yields of 60 kg of tin were obtained in .16 ha, which represents a value of US $64,100/ha. With rehabilitation of mangrove areas possible at $106/ha, no objection was seen to the mining (National Research Council of Thailand, 1977; Adulvidhaya et al., 1978). These figures can be disputed, however, if external costs caused by increased turbidity, siltation, loss of fuelwood, or decreases in primary biological activity are imposed upon other potential uses. However, owing to the difficulties of placing a value on these costs, in identifying all those persons who may be harmed by the mining activity, or in placing monetary values on the integrity of resource systems, mining will probably continue to appear of benefit to the nation.

Thailand has adopted a coastal zone management framework based upon the U.S. Coastal Zone Management Act of 1972. A special office of Coastal Land Development has been established within the Ministry of Agriculture and Cooperatives. With the assistance of the Thailand Institute for Scientific and Technological Research, which provides technical advice on coastal planning, the Office has produced a Master Plan for Coastal Zone Management, a series of nine regional plans, and twelve of twenty-five provincial coastal development plans.

These plans are a major advance in coastal zone management. However, the lack of coordination among different departments concerned with coastal resource use remains a major constraint to coastal management. This is partly due to the very strong top-down approach where major agencies continue to plan in isolation and do not feel compelled to comply with any paper plans. It is also due to the provincial authorities working without the benefit of detailed management concepts, procedures or effective controls over national agencies.

Thailand did not include the section of the U.S. act that provides for federal agency consistency with state coastal zone management plans once these plans have been approved at the federal level. The provision of funds to implement programs at the state level following approval is also absent in Thailand.

The lesson to be learned from both the Philippines and Thailand is that the creation of good information and plans without a consensus of opinion, agreement between national agencies, authority for resolving problems, and funds for enforcement will not lead to conflict resolution or wise management.

Applicability of the U.S. Coastal Zone Management Act (CMZ). The major difference between U.S. and Indonesian development policies and initiatives to improve coastal resources management lies in the division of power and responsibilities between the central and provincial levels of government. In Indonesia, provincial governors are political appointees and there is little practical separation of power between a central government office and its provincial level department. The provincial Bappedas take a strong role in actually planning for and implementing the national policies promoted by the various sectoral agencies. Further, this level of government serves as a channel to feed information up to central government departments, acting as both a reporting mechanism on the feasibility of meeting national goals and as an early warning system to indicate region-specific problems that require national action. The provincial level is therefore the most practical level at which to work (as is the case in the U.S.) to improve the integration of development initiatives in coastal districts.

It would make a great deal of sense to apply some of the major principles of the US-CZM Act to Indonesia's coastal resources initiatives. This would include federal compliance with approved state/provincial coastal resource management plans, the central government's provision of technical assistance in planning and management to the provincial authorities, and the provision of financial assistance (incentives) to operate coastal zone resource management plans that are being adequately enforced by the provinces.

Conclusions. Technical assistance will be required to help in developing both central government and provincial coastal resources initiatives. Experience in the development and implementation of the CZM Act and subsequent resource management activities would provide a source of relevant technical expertise and support in the formulation of policies, improved institutional arrangements, manpower training (domestic and abroad), planning, implementation and monitoring. However, caution would be necessary in choosing people who had experience in humid tropical coastal areas to provide the necessary support.

In formulating aquatic resources development projects and a complementary coastal resources management strategy, the coordinating role of the Ministry of Population and the Environment would be a key element in resolving sectoral conflicts and in seeking a consensus on policies. Attention could thus be given to strengthening KLH initiatives, obtaining expert advice for the Minister on coastal resources management, coordinating the provision of international support and technical assistance for ARD projects, and concentrating on manpower development and institution building as part of a broader CRM initiative.

Providing advice to provincial authorities, where day to day decisions concerning the allocation of coastal resources are made, is also urgently needed due to the shortage of trained manpower and the need for more integrated planning and resource management. Improving on the experience of

CRM in Thailand and the Philippines and adopting the best concepts, procedures and legal instruments from the U.S. and other developed countries are necessary if sound guidance is to be provided at the national and regional levels.

4.4.2 Improving National Resource Allocation Policies Related to Coastal Resources

The strategic resource allocation policies needed to achieve sustainable development include a system of priorities for making land/water resources available at the right time and for the right purpose. The Ministry of Population and the Environment is the only government agency that has the skills and, under the terms of the Environmental Management Act of 1982, the opportunity to promote such a system. Article 18 allows the Minister to create an institutional mechanism to manage the living environment. The implied mechanism is the coordination of sectoral development activities. It is not necessary to build up a major bureaucracy to do this.

Although the Ministry has little executive power, its coordination role is a powerful mechanism and the sectoral agencies look to the Ministry for practical advice on how to improve development. The basic elements of the Ministry's coordinating role are: (1) providing information on what ought to be done to meet the State Planning Guidelines and objectives of Repelita IV, (2) encouraging the line agencies, the Bappedas and BKLHs to enforce regulations, and (3) providing technical specifications for judging whether development conforms with policies. During discussions with Ministry staff, two points were stressed. First, the Ministry cited its need to provide better environmental management guidelines to sectoral agencies. Second, the staff stressed that they could make significant improvements in the process of coordinating development if they had better advice on CRM. They consider that implementing policies and enforcing regulations and standards depend very much upon the quality of the advice they can offer.

The Minister of Population and the Environment is currently exploring ways to actively promote a special program for coastal resources management. First, he has appointed a junior minister (Dr. Herman Haeruman) and a special assistant (Mr. Henk Uktolseya) for the coastal zone. Second, the Minister is seeking the support of nine Environmental Study Centers (USU, URIAU, UNSRI, UNHAS, UNSPAT, UNPAD, IPB, UNDIP, and UDAYANA) at regional universities to advise him on coastal resources management. A major feature of these centers is their interdisciplinary approach to environmental management and resource development. These efforts could be greatly enhanced by the presence of a full-time CRM-ARD expert who could advise the Minister and who could call in other specialists to help train staff members. Third, he is in the process of setting up a standing committee of representatives from the different government agencies to explore current problems and recommend ways to improve future coastal development policy and management efforts.

Using the system of standing committees, five steps could be taken to strengthen the Ministry's coordination and integration of coastal development.

- First, standardize resource evaluation and classification procedures.

- Second, improve forecasting procedures for estimating future land requirements with technical assistance from a body such as the Biro Statistics or a task force composed of foreign advisors working with LIPI.

- Third, formulate national resource allocation procedures and priorities of resource use which would be generated and agreed upon by the national CRM committee. These procedures and priorities would employ CRM approaches, environmental assessment procedures, regional planning procedures, and land use controls to be used as basic tools for program development at the agency level and implementation at the provincial level.

- Fourth, create a multi-disciplinary team within the Ministry incorporating skills from agencies, research institutes, and other bodies involved with resource development and management (e.g. Fisheries, Agriculture, Forestry, PSLs, LON, LBN, PPA). This team, which could be formed by expanding the membership of the present "coastal zone advisory team" working under Dr. Haeruman, would be given a strong manadate to promote sustainable coastal resources development based upon optimizing multiple-use opportunities. The team would act as a task force to advise the Minister and the national CRM committee on resource development issues, provide technical advice, and create linkages between KLH and specialist resource expertise in the government agencies, donor agencies, and private commercial and industrial concerns. It would also function as a link between entities such as PPA or the BKLHs which are creating management plans for specific coastal ecosystems, and the Ministry as the coordinating body. This would improve the flow of information and help to coordinate coastal resource allocation and management activities undertaken by the sectoral agencies. The task force could also provide advice on resource allocation and management to line agencies, provincial authorities, the BKLHs and private concerns.

- Fifth, GOI Environmental Management Act of 1982 provides the authority for drafting new legislation to create broad control over public and private lands to ensure that land allocation and utilization adhere to new policies and priorities. As is the case of existing legislation, control does not mean that land ownership and use rights will be changed. Rather, they will only be affected in that land owners must comply with environmental laws directed at maintaining public welfare. New legislation could focus on both procedural and substantive policies to guide development and ensure that a full range of development options and their consequences are evaluated and communicated before decisions are made and resources are committed.

4.4.3 Developing Provincial-Level Pilot Projects in Coastal Resources Management

National-level initiatives to promote improved policies and procedures for coastal resources development and management have been instituted in Thailand and the Philippines and are being encouraged in Sri Lanka, Malaysia and Taiwan. While they offer the potential for significant long term

benefits, they also require a great deal of effort and time to formalize and put into operation. Thus, there is a good case for complementing a national CRM-ARD effort by developing provincial-level demonstration projects. If successful projects can be developed, they can, as has been demonstrated in the establishment of the Environmental Study Centers (PSLs), be used as models for rapid application to other areas.

The most appropriate site for a project at the provincial level would be one where there are representative coastal resource systems, a strong governor interested in CRM-ARD, and a strong Bappeda representing a coastal region. In the governmental hierarchy of Indonesia, the Bappeda (part of the Ministry of the Interior) is the provincial/regional body that coordinates development. The Bappeda is responsible to the regional governor and operates as a two-way channel, translating government policy into development plans and serving as a conduit for information from the local level to the relevant national agencies.

Some Bappedas have a full complement of well trained planning staff; most do not. Even where the planning staff are of good calibre, it is most unlikely that any of them will have been exposed to coastal resource management concepts, frameworks, procedures or techniques. It would therefore be sensible for them to follow the lead of the Minister of Population and the Environment in using the PSLs for advice, applied research and manpower training.

Local Bureaus for Population and the Environment (BKLH), which were established in the Office of the Governor to advise on population questions and environmental management, should also be included in the demonstration projects. Unfortunately, these bureaus are inadequately staffed and generally have few people with enough expertise to advise on environmental management issues. They will, however, be increasingly called upon to deal with issues such as coastal management.

Together, the Bappeda, PSL of the provincial university and the BKLH would form a logical nucleus for a demonstration project. However, they would need strong technical support to help them develop a program. A full time coastal management expert would be required to help promote both CRM and to support the integration of ARD efforts. The expert could also serve as a communications conduit between the national and provincial levels.

5. RECOMMENDATIONS

As the result of our study of the problems and future of Indonesia's aquatic and coastal resources, and our assessment of the infrastructure that determines their development, we make recommendations in two major areas. First, in order to make sound decisions on the utilization of natural resources, the environmental assessment procedures currently used in Indonesia must be improved. Second, we recommend that coastal resources management initiatives be incorporated into the aquatic resources development projects underway or planned in Indonesia. In the discussion of these two areas, we present a brief background on the major problems that led to our recommendations, objectives of the programs proposed to deal with these problems, and specific program recommendations.

5.1 CONCEPTUAL APPROACHES

There are essentially two levels of approaches to improve the basis and quality of the decisions made on natural resource utilization. Ideally, both should be used concurrently. One focuses on the evaluation of individual project proposals on a case-by-case basis; the other involves an integrated cumulative evaluation of all demands for resources within a broader region, and allocates resources, policies and decisions that maximize multiple and sustainable use. The former will be referred to as improved environmental assessment (EA) procedures and the latter as improved CRM procedures. These two approaches share a number of objectives:

- establishing improved procedures for promoting development and conservation, which stress the evaluation of alternatives before development decisions are made;
- establishing substantive guidelines that help direct development efforts to avoid the unneccessary destruction of coastal resources;
- providing support for research on critical problems;
- training and staffing of environmental advisors and coordinators in the government;
- providing support for the regional environmental study centers in terms of grants, equipment, references, supplemental staff, and research;
- improving communication of policies and procedures, using a variety of media and techniques (workshops, remote sensing, publications, computer networks and hotlines);
- providing education and training for environmental scientists (who will serve as trainers for other technical staff) and managers (the decision makers in the "line" ministries and regional planning bodies (Bappedas) that make most of the important resource decisions); and

- improving the flow of environmental policies generated at the national level and their consistent execution and enforcement at the provincial (state), kabupaten (county), and kecamatan (village) levels.

The establishment of improved natural resource decision making in Indonesia can be facilitated through:

- obtaining support for technical advisors who would work with counterparts in the GOI to provide on-the-job training (e.g., helping to define and assign research priorities, and helping to manage environmental studies and assessments);
- sponsoring coastal resources inventories that map important resources and their uses and functions;
- developing project-specific development plans and the tools for their implementation;
- revising laws, regulations, and organization of agencies or departments;
- developing and managing workshops and training courses;
- publishing and disseminating research and accomplishments; and
- acquiring important equipment (field monitoring, remote sensing, computer software and hardware, etc.)

Ultimately, it will be the GOI's responsibility to implement these improved procedures. Improved CRM policies, procedures and techniques and improved EA procedures for use on a project-by-project basis can greatly improve the quality of decisions and reduce the unnecessary loss or degradation of resources.

5.2 ENVIRONMENTAL ASSESSMENT

5.2.1 Background

The problems with existing GOI EA procedures are that many single-purpose or sectoral programs or projects advocated by line ministries (or their provincial or local counterparts) are potentially and unnecessarily damaging to natural resources. This occurs because decisions on the details of a specific alternative are frequently made before an environmental assessment (EA) is prepared, leading to the preparation of the EA to justify the alternative. Often, EAs are not prepared at all. Conflicts and disputes between ministries or subordinate equivalents then arise, leading to delayed and/or poor decisions.

5.2.2 Objectives

The goals of environmental assessment procedures should focus on ensuring that environmental planning and coordination are initiated at the earliest possible time (when the project's problems and needs are

specified). Furthermore, EAs that consider a full range of alternatives should be prepared before the lead or sponsoring agency makes its decision. In this manner, the agency can benefit from the advice and information provided by reviewers and consider their comments prior to making a decision. Because the reviewing agencies will be contributing to a future decision rather than reacting to a decision already made, conflicts and disputes between agencies should be reduced. Finally, the evaluation of a full range of alternatives would allow informed decisions based upon the pros and cons of all options, which should improve the quality of the decisions.

5.2.3 Recommendations

Two recommendations are made here for EA. One deals with the preparation of a specific EA in accordance with U.S. procedures. The other deals with improvements to existing GOI procedures for the preparation and coordination of environmental assessments and statements.

Local PSLs (environmental study centers) should be provided with funding to conduct environmental studies and prepare preliminary EAs based on U.S. environmental assessments, but in accordance with the environmental laws and regulations of Indonesia. This task could serve as important on-the-job training for the PSLs, encourage the use of the EA process, ensure that all environmental effects and development alternatives are taken into account, and develop a model to be adopted by PSL counterparts in the GOI.

A preliminary EA for a future ARD-CRM project is outlined in Appendix C, using the U.S. format, based upon the recommendations of the Bailey et al. report (1985). Of the projects proposed by Bailey, only the construction of shrimp hatcheries near mangroves has the potential to produce severe adverse environmental effects by indirectly stimulating the conversion of mangroves to tambaks. However, the decision to consider hatcheries in the context of a South Sulawesi CRM implementation project should lead to decisions involving a full evaluation of alternatives, including no action.

Specific recommendations for improved EA procedures that could be used by the Government of Indonesia are summarized below and in Table 5:

- KLH should prepare implementing regulations for the Environmental Management Act of Indonesia.

- The KEPAS Agroecosystems Network and work group concept should be expanded to include other ecosystems with environmental problems and research needs (mangroves, aquaculture, bio-physical relationships, etc.).

- The KEPAS network should conduct a workshop on the environmental and socioeconomic consequences of ARD intensification in Indonesia.

Table 5

Outline of Recommendations for Improved GOI Environmental Assessment Procedures

1. Have senior technical advisor work with the Ministry of Population and the Environment to prepare implementing regulations for the Environmental Management Act (EMA):

   o Assign an advisor to work with counterparts in the Ministry to draft proposed revisions to the implementing regulations.

   o Give greater stress to the process of environmental planning and coordination than to the written product.

   -- Encourage line agencies to identify problems, needs and opportunities for projects at the earliest stage and prepare public notices for distribution.

   -- Encourage line agencies to work up a full range of possible alternatives to achieve the desired results, ensuring the assignment of an environmental specialist to each specific project and early coordination with other line agencies to scope the EA.

   -- Have EAs prepared and coordinated before the line agency makes a decision on the selected alternative.

   o Encourage the establishment of GOI environmental coordinators within each national ministry. These coordinators will maintain close contact with the Ministry of Population and the Environment and with subordinate provincial and kabupaten planning and environmental staffs.

2. Encourage maximum participation by the environmental study centers (PSLs) in the study and preparation of preliminary EAs:

   o Direct grants or contracts for studies and EA preparation to capable and willing PSLs.

   o Encourage the purchase of essential equipment and reference materials.

   o Encourage the hiring of specialists, on an as-needed basis, to supplement existing PSL staffs in the conduct of specific environmental programs.

3. Work with selected provinces and kabupatens (especially where future ARD projects may be located) to develop environmental staff and planning capabilities. They would have the following major responsibilities:

   o Coordinate the planning and development of coastal resource management programs as they become established (see the recommendations on CRM for more details).

Table 5 (continued)

- o Coordinate the responsibility for conducting studies and preparing environmental assessments and statements for specific development projects.
- o Develop routine funding procedures as necessary from the provincial and national ministries to support PSL involvement in the environmental study and assessment of specific projects.

5.3 COASTAL RESOURCES MANAGEMENT

5.3.1 Background

The principal problem with existing CRM in Indonesia is that a central integrated and coordinated program has not yet been established, although the basic legislation has been passed, the lead ministry identified (Population and the Environment) and a coordinating committee among the ministries has been proposed. At present, the single purpose sectoral projects advocated by one line ministry (or subordinate counterparts at the provincial or kabupaten level) do not consider the adverse environmental effects on other coastal resources; further, these projects can conflict with the programs of their counterpart agencies. As a consequence, uninformed decision making results, coastal use options are unnecessarily compromised, and resources are lost.

5.3.2 Objectives

The goals of a CRM program would be to provide the framework for resolving conflicts among single purpose proposals in a specific region, by evaluating their consequences on other activities and evaluating a full range of alternatives that maximize multiple uses that are both sustainable and compatible, and that minimize unnecessary foreclosures of options or losses of coastal resources. Such projects should also be aimed at promoting both economic development and the conservation of coastal resources. Long range plans for the future allocation of resources should also be developed. CRM will require national, provincial, and to a lesser extent, international components to maximize benefits and develop a workable and effective program at all the necessary levels.

5.3.3 Recommendations

Below, we present recommendations for an aquatic resources development (ARD) project that incorporates CRM at both the national and provincial levels. Such a project must be responsive to the need to improve the management of the coastal resource system so that it will sustain any individual project activity and promote the development and conservation of coastal resources.

The following general components would be included in the program:

- o Decision making process components established. The GOI's decision making process should be divided into phases: 1) problems, goals, and

development objectives should be identified; 2) alternatives that address problems and goals (including designs, sites, etc.) should be specified; 3) inventory of resources and their uses that would be affected by coastal resources development; 4) technical feasibility, environmental effects, and economic costs and benefits should be outlined in a review document (e.g., an EA); 5) a coordinating mechanism with other relevant government agencies should be established; and 6) the lead agency should choose the alternative to be developed and take the measures necessary to protect the affected coastal resources.

- Policy and plan formulation. The GOI should coordinate with conservation and development agencies to refine existing policies, develop new ones, and develop implementation procedures (regulations). Once an integrated national plan and process for implementing it are adopted, they would filter down to the provincial level.

- Training, manpower development and education. On the-job training, workshops, courses, etc. should be provided for key administrative and technical officials of important agencies.

- Research and development. Priorities would be set and research conducted at the national and provincial levels to acquire information upon which to estimate the impacts of future conservation and development efforts. The information, including coastal resources inventories, would in turn guide decisions on future CRM.

- Pilot-level implementation. After specific regional plans and processes are established, pilot CRM projects would be initiated at the provincial and lower levels.

- Dissemination of information. Reports and other products of research, training, and CRM progress would be published and widely disseminated to maximize the transfer of technology to provinces not directly serviced by the program.

- Periodic adjustment of program goals. Based on the lessons learned from these and other projects, the program's goals and direction would have to be adjusted.

- International initiatives. These efforts would emphasize cooperation in research, development and training, particularly on common and migratory resources and aspects of the program that are applicable or transferable to other nations.

While all of the above components would be a part of both national and provincial initiatives, most of the actual management and decision making would occur at the provincial level, and most of the important policies and guidance would be developed and monitored at the national level. The above components would also serve as the general sequence for program evolution.

For the overall project outlined in Appendix C, most of the level of effort and investment would be placed within the aquaculture and fisheries development sectors; this would require the support of a CRM policy advisor in KLH and a provincial CRM advisor in the Bappeda of South Sulawesi. Although aquaculture and fisheries development and research is being proposed in several other provinces, the scope of a possible role for CRM is reduced in these locations because most of the recommended ARD initiatives are small and do not justify an additional full time CRM coordinator.

The scope of the ARD program recommended by Bailey et al. (1985) suggests that it could be easily integrated into a larger CRM project. Such a larger project would increase the dimensions and utility of the intiative. More of Indonesia's coastal resources would benefit from the project and the project's products could be more quickly and effectively transferred to the rest of the country. Finally, a larger and more diverse CRM project would be considerably more useful to other nations including those in ASEAN. Table 6 presents a sample framework of a major CRM initiative.

Table 6

Example of the Steps for Implementing
a Major Coastal Resources Management Project
in Indonesia

Year One:

1. Establish central CRM coordinator in the GOI.

2. Initiate a series of policy studies to determine major CRM-ARD issues that need to be addressed in order to establish sustainable development.

3. Prepare national CRM plan to support sustainable development of aquatic resources and other coastal goods and services.

4. Initiate regional and national research on coastal issues of critical importance (LON, in cooperation with PSLs and other universities). For example, remote sensing analyses could be conducted on the dynamics of coastal resource use including: mangroves, coral reefs, turtles, sedimentation etc.

5. Complete, supplement and verify the IUCN coastal resource inventory.

6. Select regional sites.

7. Assign four or five regional coordinators in important CRM provinces.

Year Two

1. Establish counterpart coordinators in regions to implement regional CRM plans.

2. Coordinate national CRM plan with all provinces, kabupatens, PSLs, line ministeries, and provincial Dinas.

3. Complete national implementing regulations, CRM, manual, and revise national CRM laws as necessary.

4. Adopt and implement the national CRM plan.

5. Complete CRM plans in selected provinces, including coordination and adoption.

6. Continue and complete highest priority research on CRM, including regional and national inventories of important coastal resources and their values and uses.

7. Establish additional national research priorities for critical CRM issues and sponsor studies, with heavy involvement of PSLs, as necessary.

Years Three and Four

1. Coordinate the products of national and provincial CRM planning with the provinces not selected for CRM projects (publications, workshops, media, training, education, and use of KLH data processing center).

2. Sponsor additional provincial CRM intiatives.

3. Complete all first phase research of national significance and recommend additional management policies.

4. Hold training workshops for potential provincial and kabupaten CRM coordinators in provinces where CRM implementation projects are not sponsored.

5. Implement CRM plans in the selected provinces, including additional research, regulations, staffing, training, etc.

Years Four and Five

1. Establish regional CRM coordinators in the remaining provinces.

2. Present workshops and publications on the results of all previous efforts to be distributed to remaining provinces; BKLHs and PSLs.

3. Encourage remaining kabupatens to establish CRM plans and to staff offices with qualified advisors.

4. Fund remaining PSLs to acquire equipment, references, and staff to conduct research and assist in CRM plan development.

Table 6 (continued)

Years Five through Seven

1. Complete all provincial CRM plans and implement them.

2. Encourage expansion of kabupaten CRM planning initiatives.

3. Hold a national workshop to discuss results of the first four to six years:
   - o identify additional R&D priorities;
   - o present proposed revisions to CRM policies;
   - o revise existing national laws and regulations; and
   - o publish and distribute proceedings of workshop.

4. Establish CRM plans or procedures in as many kabupatens as possible, but especially those of critical significance to CRM.

5. Develop detailed implementation model and manual for use in other ASEAN and comparable countries, based upon success and lessons learned.

Program Actions and Components: National Level. Below, we highlight the basic framework for GOI actions on coastal resources management. At the end of this list of recommendations, we present an example of some of the problems and issues that could be addressed at the national level (Table 7).

1. Work with the KLH to support its mandate to coordinate development and to promote sustainable forms of resource use. One way of helping to accomplish this would be to place a CRM-ARD specialist in KLH as an advisor to Minister Salim. This specialist would help improve CRM policies and coordination procedures, and through the CRM Committee, provide coordination between the CRM-ARD activities at the provincial level (for example, see Figure 6).

2. Promote a rigorous and thorough review of CRM issues, policies and institutions to provide a better understanding of what needs to be done to promote CRM as a means of creating sustainable development under Repelita V.

3. Specific activities and actions would be guided by the following goals:

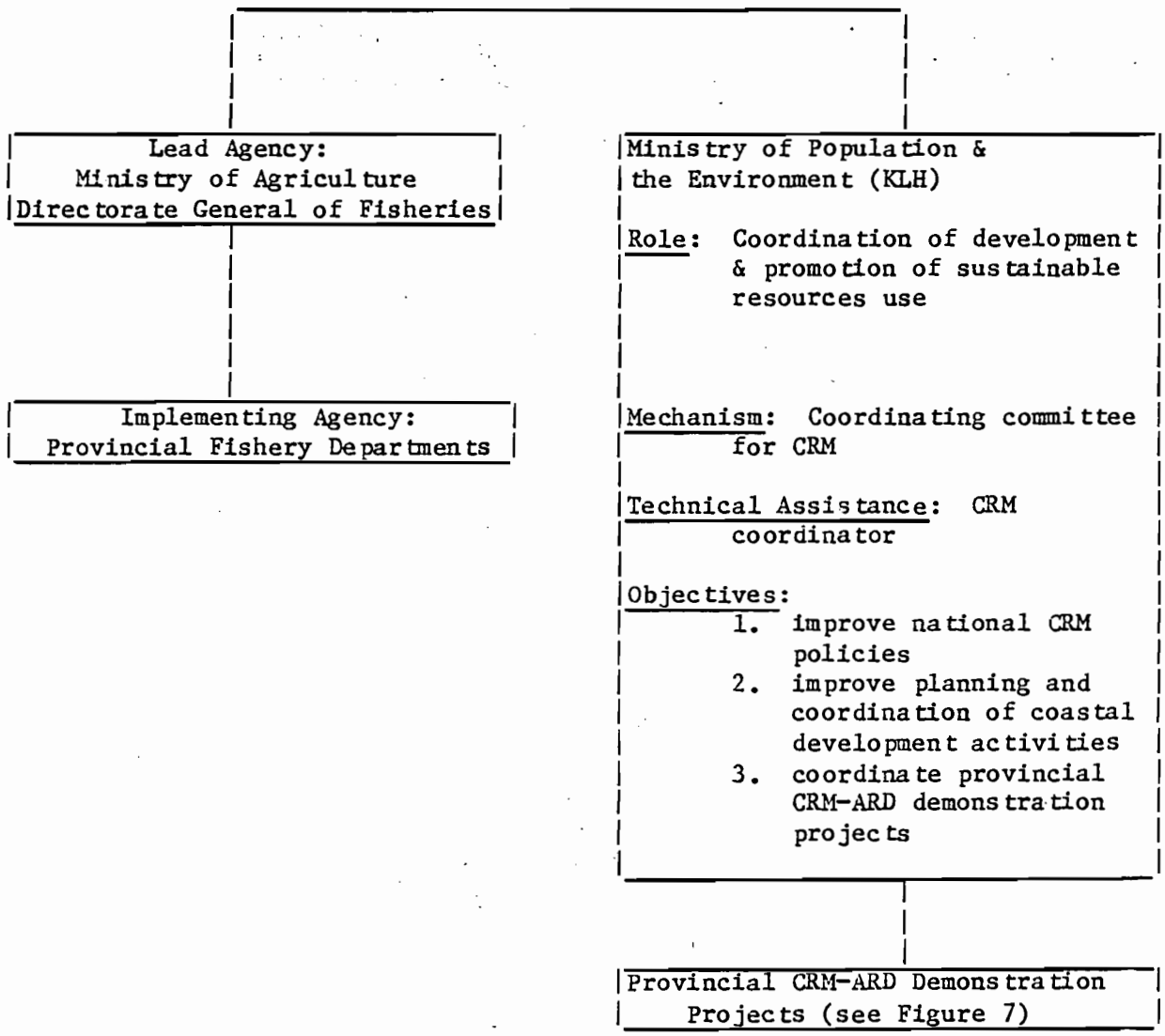
   - o identify and reduce coastal resource use conflicts;

   - o identify major development conflicts in coastal areas;

   - o analyze these conflicts to isolate: common problems that might be eased through the implementation of other alternatives, or if necessary, through arbitration between the parties/activities involved; problems that are common to a variety of activities but that may be the result of activities elsewhere (e.g., upstream water pollution, reducing fish yields in tambaks) and can only be rectified by central government action; and activities that cannot be sustained in coastal areas but can be located elsewhere.

Figure 6

National Level Framework for Instituiting a CRM-ARD Initiative



4. Use the analysis of current conflicts to identify potential conflicts that can be avoided by using improved resource allocation procedures; controls over the form, scale and intensity of permitted development; or the selection of alternatives that avoid conflicts altogether.

5. Devise resource allocation priorities and management guidelines in cooperation with the agencies responsible for specific resource development and management activities (e.g., the Ministries of Agriculture (including Fisheries), Forestry (including PHPA Nature Conservation), Tourism, Industry, Public Works and Transmigration). The deputy ministers and appropriate heads of subagencies (e.g. PPA) could be invited to participate in a working or standing conference to develop the system of priorities and management guidelines and then to review these during each of the five years of Repelita.

Below we highlight steps that could be taken by the GOI to improve its CRM procedures in the following specific areas: policy formulation, project design and implementation, information availability, forecasting procedures for future coastal land requirements, and manpower training.

Table 7

Examples of Coastal Resources Issues of National Importance and How They Could be Addressed in a CRM Project

Mangrove Management Issues of Critical Importance

- Document the national extent of the problem, including status of mangroves and rates of conversion for specific regions.
- Document the importance of mangroves to a number of other ecosystems, and their economic value in supporting aquatic resources production, or the production of timber, fuel wood, wood chips, etc.
- Explore the feasibility of using alternative sites for transmigration and tambak.
- Strengthen national policy on conservation of mangroves.

Coral Reef Management Issues of Critical Importance

- Document the extent and ecological impacts of coral mining and collection activities. Explore alternative sites and actions.
- Document the extent to which explosives and other inappropriate techniques are used for fishing on coral reefs, and conduct long term studies on the impacts.
- Encourage reform and control the availability of poisons and explosives to fishermen; provide education and training in new occupations and fishing techniques.
- Identify areas where coral reef fisheries are being heavily exploited and where alternative fisheries resource and livelihoods are needed to discourage overfishing and use of illegal methods.
- Enforce laws more stringently and confiscate boats and fishing gear associated with illegal methods. These actions get violators off the reefs and pursuing other livelihoods, and set an example for other potential violators.
- Develop national policy and management requirements for the conservation of coral reefs to ensure sustained subsistence and commercial uses. Implement and enforce policies in selected provinces (e.g., South Sulawesi).

Table 7 (continued)

Heavy Exploitation of Sea Turtles for Meat, Ceremonial Use and Shell Ornaments

- o Conduct a national research program to document the extent of turtle exploitation in areas requiring immediate attention (including Bali, Ujung Pandang, Ambon, etc.).
- o Verify the accuracy of IUCN inventories of turtle nesting sites and areas proposed for conservation or park status.
- o Establish a national policy against the collection of eggs and egg bearing females at nesting beaches. Afford nesting areas official protected status.
- o Investigate the feasibility of promoting fisheries development in Bali to provide a source of meat that will be competitive with the price of turtle meat for use in ceremonies.
- o Conduct training and workshops with Hindu clergy to encourage them to exercise leadership and advise their religious followers to use other sources of meat for ceremonies.
- o Provide technical management guidance to turtle farms and propagation projects in Bali and elsewhere in the country. Develop comprehensive manuals for the management of turtle propagation and conservation programs.
- o Contact and cooperate with the tourism industry to explain the negative indirect impacts of tourism to turtles. Advise, educate, or if necessary, regulate visitor industry activities to discourage tourism activities that are detrimental to turtles.
- o Publish a pamphlet for distribution to tourists in order to promote a conservation ethic for marine turtles.
- o Develop and enforce regulations to protect turtles that are already afforded official protected status.

Short Cycle Swidden/Slash and Burn Agriculture and Range Management

- o Develop the framework for a comprehensive watershed management program to reduce soil erosion and sedimentation to coastal ecosystems resulting from agricultural, deforestation, and livestock management practices.
- o Establish pilot projects where watershed uses are currently having major environmental and economic impacts.

Improvements in Policy Formulation, Project Design and Implementation

1. The Ministry of Finance and Bappenas could coordinate efforts to promote the improved economic evaluation of development projects by setting analysis criteria that require the inclusion of off-site and nonmarket factors. This will lead to the inclusion of environmental/economic externalities which are generally ignored (Djayadiningrat et al., 1983).

This single action will do more to improve the quality of design and implementation of projects and long-term sustained development than a long list of environmental laws and regulations. Therefore, it should receive immediate ministerial attention.

2. Update and promote the adoption of the KLH's Coastal Zone Management, Coral Reef, and Mangrove Area Management handbooks, and regional and other handbooks, as tools for project planning by central government agencies and regional and local government bodies such as the Bappedas, BKLHs, and Bapenkas.

3. Draw up a list of key environmental considerations and procedures for project planning to be circulated to Ministeries, Bappedas, BKLHs and other groups. This list should be used as a planning tool in assessing the effects of projects.

Improvements in the Information Available for Coastal Resource Evaluation, Allocation and Management

1. Compile an information base that will provide an accurate assessment of the ability of coastal resource systems to sustain development. Apart from basic information on land areas, vegetation types, soils and other bio-physical factors, information is required to help define: the current use of these systems, ownership, existing plans for their development, socioeconomc activities and environmental impacts. This combined inventory will allow the current state of resource systems to be defined, which in turn will assist in highlighting the key management constraints and appropriate steps necessary to enhance resource production on a sustainable basis.

For example, using a topographic map, a series of transparent overlays containing information (such as information on soils) could help define the development potential or constraints for different coastal lands.

2. Use maps and written reports from Agraria, Tata Guna Tanah, as a means of defining current land utilization and the basic potential for intensification or expansion of existing activities and for the development of new activities. This source of information would be a valuable tool for defining areas for future development as well as problem areas where land use controls should be used to protect agricultural lands. Table 8 highlights examples of some of the significant resource issues that have already been identified at the provincial level. The annual reports prepared by the Bappedas and the research reports of PSLs would be a useful source of regional or area problem-specific information.

Table 8

Examples of Major Provincial Resource Issues that Could be Addressed as Part of CRM Regional Demonstration Projects

South Sulawesi

- Mangrove management, especially conservation and protection from conversion.
- Tambak extensification and intensification (including shrimp hatcheries).
- Coral reef management, especially protection from overharvesting, poisons, dynamite and aquarium fish trade (Ujung Pandang).
- Turtle harvesting and marketing practices and possible controls.
- Use and conservation of remote underutilized marine fisheries.
- Feasibility of fish, cage, and seaweed mariculture.

Maluku

- Improved technical evaluation and planning for transmigration projects (Aru).
- mangrove conversion and tambak extensification policies.
- Coral reef management with emphasis on regulating use of explosives, poisons.
- Watershed management of selected agroecosystems (e.g., Ambon Bay).
- Restoration of mangroves and feasibility of seaweed culture and other mariculture (Ambon Bay).
- Expanded use and conservation of underutilized marine fisheries.

Bali

- Integrated turtle management and conservation.
- Coral reef management, with emphasis on mining, harvesting of ornamental species, and use of explosives.
- Mangrove restoration and protection of the few remaining swamps.
- Shoreline management and beach erosion from construction and resort beaches.
- Expansion of successful seaweed culture.
- Expanded education and interpretive programs for tourists at selected parks or reserves to conserve sea turtles.

Sumatera or Kalimantan

- Conservation of tidal swamp forests.
- Conservation of mangroves.
- Freshwater aquaculture development projects.
- Stock assessment off coasts where tidal swamp forests have been converted to tranmigration areas and comparison to fisheries stocks off undisturbed coasts.
- Assessment and documentation of fishery resources in tidal swamp forests.

3. After problem and potential development areas have been identified in the coastal regions, these areas can be more clearly examined using specific information on soils, water resources, slope, population, etc. to define their suitability for different forms and intensity of use.

4. Attention should be given to assessing the quality, the level of detail, and the geographic coverage of the information available and also updating this information.

5. Having collected and analyzed the available information, missing information can be identified and research priorities can be assigned for obtaining it. These priorities can be based in part on the Coastal Management Handbook, Mangrove Area Management Handbook, the Coral Reef Handbook, environmental assessments, and the Bappenas "Blue Book." This last source provides useful information on future research projects.

6. Consideration should be given to how Bappenas allocates research funds nationally for coastal resources. For example, the bulk of the money available for research on mangroves ecosystems is channelled to the Ministry of Forestry.

7. These information needs should then be made known to donor agencies for consideration for assistance. The forthcoming USAID project on coastal management, for example, would be able to provide information on coastal development information needs. The UNESCO programs on mangrove and coral reefs would also be potential sources of assistance.

8. All of this information should be collected and put into a format that is compatible with the information processing center facilities at KLH. KLH might consider obtaining further assistance in disseminating information to agencies and provinces where there will be no CRM-ARD demonstration projects.

9. A point to keep in mind is the intention of KLH to give its limited number of personal computers to PSLs. KLH is willing to give priority to PSLs in the CRM-ARD demonstration project areas.

Improving Forecasting Procedures and Techniques for Future Land Requirements in Coastal Areas

1. In association with the improvement of coastal resource information, work should begin now on improving the forecasts of land requirements for activities that are directly dependent upon the functions of coastal resource systems.

2. Emphasis should be given to identifying and quantifying:

- the area required;
- specific resource conditions (soils, slope, elevation, water quality and quantity) necessary to support individual land uses;
- compatible forms of land use;

- multiple use possibilities and appropriate management arrangements (seasonal use, spatial or temporal segregation, intercropping, intensities of use/extraction, etc.);

- non-compatible uses; and

- alternative resource systems that could be utilized for non-compatible uses and the resulting costs or benefits.

3. Once many of the short-term activities have been started, attention should be given to the formulation of a longer term planning framework for coastal areas. Two different approaches are advocated in this report.

The first approach concerns the formulation and implementation of national land use policies, procedures, and controls to protect coastal land and water resources. Ideally, this should be an integral part of a national CRM policy, where strict controls are exercised over the conversion of good quality agricultural lands, watershed protection zones, fishponds and other important land uses. If manpower and other constraints are viewed realistically, the full development of national CRM policies, land use plans, and effective development controls will take ten to fifteen years.

4. Due to the great importance of coastal resource systems, priority should be given to developing improved land use policies and development controls for:

- mangroves;
- coral reefs;
- riverine and estuarine areas;
- watershed protection;
- tidal swamp forests;
- marine/coastal conservation areas;
- coastal agriculture and, where possible, high quality agricultural lands either already developed or with potential for intensification, diversification and agricultural settlement;
- conserving coastal forested lands (production, protection and nature conservation);
- seagrass; and
- beaches of importance to birds, turtles, tourism, and recreation.

The second approach is directed more toward development in the "outer islands" and is oriented toward the use of resource information to define areas that would be suitable either for activities directly dependent upon coastal resource systems (agriculture, forestry, fisheries, etc.) or for settlement, roads and the location of other infrastructure such as irrigation dams. The development of these areas would be facilitated by basic investment in infrastructure, social facilities and services to "prime the pump," and to attract people to settle the areas. The objectives of this approach are to maximize the use of human initiatives, energy, and skills to develop coastal opportunities in accordance with basic coastal development guidelines; to reduce the time, manpower and capital required to achieve the development of agricultural and other activities; and to free scarce manpower skills for the adaptive management of coastal resources.

The adaptive management of resources is a pragmatic approach to adopt when dealing with tropical ecosystems, where both information and development experience are limited. By focusing the available manpower skills on adapting plans to suit longer term management objectives, it is possible to rectify mistakes and to incorporate new data and experience into successive planning efforts. This approach offers the best chance of accelerating development and creating a management framework for promoting sustainable forms of development.

Manpower Training

1. There is a general shortage of people trained in resource management. This is particularly true of coastal zone management, which is essentially an interdisciplinary approach to development planning. There are, perhaps, only a handful of people trained in coastal management in Indonesia. In our discussions with PHPA, for example, it was revealed that the marine conservation planning staff are primarily foresters and there is only one person among them who has any real knowledge of coral reefs.

2. Increased emphasis should be placed on manpower training in order to create a nucleus of staff to support KLH and its linkages with other ministries. These staff should be trained in activities related to coastal areas such as fisheries, agriculture, forestry, nature conservation, physical planning, and resource economics. They should be given further training in inter-disciplinary approaches to resource management.

3. Funds should be sought to send people to the PSL Bogor and the Magister Program in resource management, and to overseas universities with training programs in coastal management (e.g., Asia Institute of Technology, East-West Center, Hawaii, Biotrop). Also, it may be possible to organize a training program that provides scholarships for study abroad. UNESCO is another possible source of funds for regional training (mangrove, coral reefs and coastal management). CIDA (the Canadian AID group) is also prepared to support CRM training initiatives if it is seen as a priority of KLH.

Program Actions and Components: Provincial Level

1. Use the Indonesian regional market distribution model in Bailey et al. (1985) and modify it to include major factors that condition how coastal resource systems are developed in response to market preferences. The model can then be used to define geographic areas for consideration as ARD/CRM foci.

2. We suggest that South Sulawesi be considered as the first choice for a focus of action at the provincial level. This is based upon the following criteria:

- There is strong support from the Governor for a series of ARD themes including coral reef fisheries management, tambak improvement, and small scale hatcheries. The Governor is also seeking advice on coastal resource development issues such as mangrove conversion, coral reef mining, and explosive fishing.

- There is a reasonably strong Bappeda in this province and the provincial university has good faculties with skills appropriate to both ARD and CRM. The university-based PSL is already involved in marine studies and has been identified as a potential beneficiary under the Canada-Indonesia Environmental Manpower Development Project. The Canadian project managers consider an ARD-CRM project appropriate to South Sulawesi.

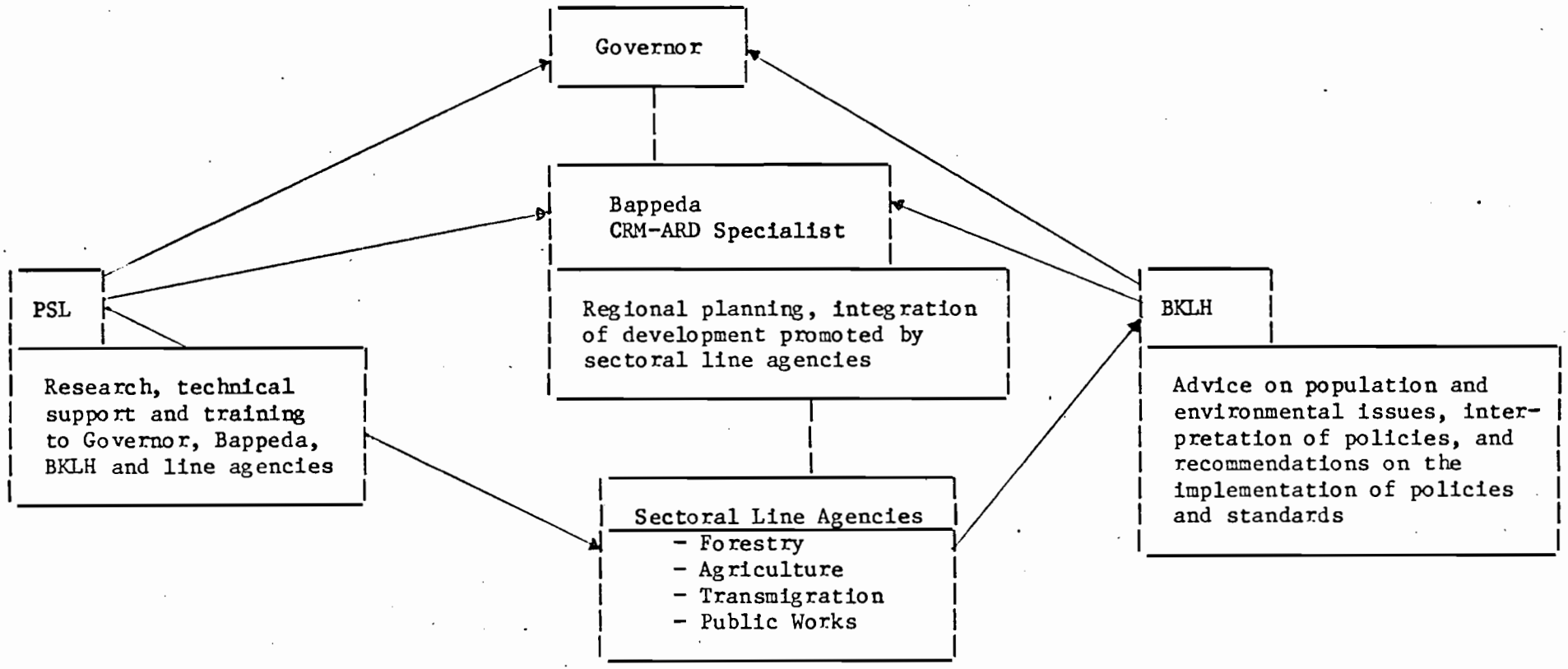
- The BKLH in South Sulawesi has been established; however, we did not have the opportunity to evaluate its manpower capabilities.

- South Sulawesi has a series of coastal resource systems (coral, mangrove, tambaks) which we consider as local targets for individual aquatic resource development projects.

3. Place a CRM-ARD specialist in the Bappeda to institute CRM policies, procedures and techniques. This specialist would provide on-the-job training to Bappeda and BKLH staff, set up short courses with the help of the PSL, and provide short term technical assistance. He or she would also assist in the coordination of sectoral and private development initiatives through advising the BKLH, Bappeda and the Governor's office. BKLH's anticipated relationships with other agencies in this CRM project are displayed in Figure 7.

Figure 7

Provincial Level Framework for Implementing CRM-ARD Projects



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APPENDIX A

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APPENDIX C

PRELIMINARY ENVIRONMENTAL ASSESSMENT FOR PROPOSED AQUATIC RESOURCES DEVELOPMENT PROJECTS IN INDONESIA

C.1 SUMMARY

This preliminary environmental assessment (EA) discusses the likely environmental consequences of the aquatic resources development projects proposed by Bailey et al. (1985) and suggests the scope of work for a full environmental assessment, including supporting studies. A change in the magnitude, nature, or location of the proposed projects prior to final project design could result in changes in the environmental consequences and the need to revise the EA.

Many of the proposed projects will have no adverse environmental impacts, and all but one of the remaining projects can be designed in a manner to avoid significant adverse impacts. Only one of these projects, the proposed development of small-scale shrimp hatcheries for tambak intensification, has the possibility of resulting in significant adverse impacts. The primary impacts of this project would be indirect impacts to mangroves, estuaries, and perhaps other important ecological systems, by stimulating tambak extensification into these ecosystems. The adverse effects of hatchery development, however, can be reduced through carefully planning the sizing and siting of hatcheries so that their "service areas" can be effectively confined to existing tambaks. Proposed improvements to environmental assessment procedures and the implementation of a coastal resources management program are suggested to ensure that such projects avoid or mitigate adverse environmental impacts.

C.2 ARD ALTERNATIVES

Bailey et al. recommend a program with four major components: (1) marine fisheries, (2) aquaculture development, (3) education and training, and (4) coastal resources management and development. None of the measures proposed for the last two components will result in physical alteration or adverse impacts to the environment.

The specific items recommended for marine fisheries include: stock assessment of unexploited species, socioeconomic research, market and policy analysis, quality control of shrimp processing, and the installation of ice plants. Of these, only stock assessment and ice plant installation will have any measurable effect on the environment; however, the primary impacts are expected to be minor.

The specific items recommended for aquaculture development include: rice cum fish culture in Sumatera, research and Pangasius (catfish) cage culture in rivers, giant freshwater prawn (Macrobrachium) development in Sumatera, and small-scale shrimp hatchery development as a part of tambak intensification in Java and South Sulawesi. With the exception of shrimp hatchery development, all the aquaculture activities are expected to result in only minor adverse primary impacts because overall, the proposed projects are primarily research and development efforts and no major exploitation of any fishery stocks or species is being advocated.

The adverse environmental impacts that could result from shrimp hatchery development are given in Section C.3. The remainder of this section discusses the rationale for developing such a project and for site selection.

C.2.1 Purpose and Need for the Proposed Action

A major constraint to increasing shrimp yields and productivity in existing tambaks is the limited availability of post larval shrimp stock. In most cases, post larval shrimp are recruited in ponds with the tide. However, natural or wild shrimp stocks can account for only 10-20% of the total present demand for stocking existing tambaks (Bailey et al., 1985). As a consequence, shrimp yields in the ponds are low and hatcheries offer one of the few feasible prospects for substantially satisfying existing demand for shrimp stock.

There are other alternatives to improve shrimp production in tambaks (see Bailey et al. 1985 for a discussion), including improved pond design and maintenance, improved water quality, supplemental feeding, and fertilization. In addition, the survivorship of existing post larval shrimp stock could be enhanced through improvements in techniques to catch, handle, hold, and transport shrimp stock from collection sites to ponds. Some existing procedures are relatively crude and result in high shrimp mortality, even before the shrimp reach the ponds. Clearly, some of the mortality is avoidable, and improved survival could lead to increased shrimp production.

However, Bailey et al. feel that all of these measures collectively will do little towards closing the gap between available stock and demand. They see hatcheries as the only long term solution. On the other hand, their site visits to government and private fish hatcheries revealed that they are operating well below design capacity and are not making a meaningful contribution to satisfying major demand for post larval shrimp. Hence, the strategic development of small scale hatcheries is being emphasized, particularly developing and transfering the technology for proper hatchery design and operation that will maximize the production of post larval shrimp. The team selected Java and South Sulawesi as sites for shrimp hatcheries because they have large areas of existing tambaks which would benefit from increased shrimp yields. Java has few mangroves or other coastal ecosystems that would be threatened by hatcheries, and the careful siting of hatcheries in South Sulawesi could also reduce the threat of tambak extensification there.

C.2.2 Description of the Affected Environment

A brief description is given here of the environment of South Sulawesi, the only region where the proposed ARD development activities could lead to significant negative environmental impacts. Only the major coastal resources of the region are described.

The dominant physiographic features of the province include the 1) elongated peninsula stretching north to south and constituting the major land mass of the province, 2) the mountainous interior and extensive coastal plains of the peninsula, 3) the deep ocean waters (Makassar Strait) to the west, 4) the large inland gulf (Teluk Bone) to the east of the peninsula, and 5) the large port and urban center at Ujung Pandang near the southern tip of the peninsula.

South Sulawesi is a major rice producing region in the Celebes, and has the largest concentration of tambaks in Indonesia outside of Java. Most of the tambaks are found along the peninsula's west coast, but there are plans for expanding tambak areas and production along the east coast. Mineral extraction (especially nickel mining) and forestry are important industries in the northern part of the province. Other important ecological resources include considerable mangrove swamps along the east coast and off Pare Pare (west coast), large estuaries at the head of Teluk Bone, and river estuaries scattered along the entire coast. Perhaps the largest coral reef fishery in Indonesia is located in the shallow seas within 80 km of Ujung Pandang, and thousands of people depend upon this fishery for food protein.

The province's major pelagic fisheries include Caesio spp (fusiliers) and Cypselurus (flying fish) along most of the west coast, and skipjack (Katsuwanus) along the entire coast. In addition, the ornamental or aquarium fish trade is important on the coral reefs off Ujung Pandang and the area is important for many subsistence invertebrates including scallops, green snail (Turbo), giant clams (Tridacniidae), trochus (Trochus), horned helmetshell (Casiss), and beche-du-mer (Holothuriidae). Invertebrates are also collected in several other west coast regions. Near the village of Palopo, at the northern end of Teluk Bone, are important estuarine fisheries and a variety of invertebrates including clams, cockles, helmetshells, scallops, trochus, and greensnail. Important demersal shrimp fisheries (Penaeus) occur offshore along most of the coast of the province. Ujung Pandang and the offshore southern islands are major centers for sea turtle (Chelonia, Caretia, Dermochelys) capture and many of the turtles are shipped to Bali. The fry of milkfish, an important domestic food and tambak species, are collected in large numbers along the entire west coast and most of the east coast. Major potential seaweed harvest areas are found around the entire coast of the province. The mangrove crab (Scylla serrata) is caught in large numbers in many of the mangroves of the province. Most of the pelagic fish catch is landed during the few months of wet weather when runoff and riverine flow presumably stimulate marine productivity along the coasts and attract feeding pelagic species. A major habitat for the dugong is reported to occur along the entire west coast and the southern offshore islands of the province. Several seabird species have large populations in the province during certain seasons, including lesser frigate birds off Ujung Pandang and several migratory shorebirds off the south tip of the peninsula.

The Indonesian government recognizes the importance of many of the ecological resources and areas in the province, and has proposed preserves off Ujung Pandang to protect the coral reefs, and in Palopo to protect swamps and forests. A terrestrial reserve bordering Teluk Bone is sited in Polewali. The IUCN/WWF inventory (Salm, 1984) recommends additional areas for protection including the pelagic fisheries along the entire coast of the province, the southern islands off the peninsula, and coral reefs off Ujung Pandang, Sinjai (east coast in Teluk Bone) and Jalang. In addition, the threat of tambak extensification along the east coast merits additional protection for the extensive mangrove forests there.

C.3 ENVIRONMENTAL CONSEQUENCES

The adverse environmental impacts from the proposed shrimp hatchery development can be categorized as either direct or indirect. The direct impacts are those associated with the construction of hatcheries. These include ground disturbance at the hatchery sites leading to possible damage or destruction of historical and archaeological resources and the remote chance of damage to rare vegetation. However, these impacts are expected to be minor due to the small size of the hatcheries and the probable location of at least some hatcheries near urban areas. If any direct impacts occur, they can be mitigated by archaeological and botanical reconnaissance surveys at candidate hatchery sites likely to harbor significant resources. Hatcheries could then be redesigned or resited to avoid possible disturbance to resources.

The indirect impacts of small scale hatchery development are associated with the successful operation and expansion of post larval shrimp production. Increased production and reliable sources of shrimp stock could stimulate the development of additional hatcheries and/or the extensification of tambaks outside of the "service area" of the hatcheries. A major tendency for tambak extensification has been to expand into mangrove areas, particularly in South Sulawesi, as we observed during our field visits. Extensification results in the conversion of the mangrove to tambak by clearing, burning, and uprooting mangroves, and constructing the walls, gates and floors of the new ponds. The conversion results in the elimination of the beneficial uses of mangroves, including sustainable production of fuel and construction wood; mangrove crab, blood cockle and scallop yields; estuarine and mangrove finfish harvests; energy and nutrient export to coastal waters; sediment and nutrient retention; shoreline stabilization; hydrological functions including water filtration and fresh water retention; and potential larval, juvenile and nursery grounds for many species of commercial or subsistence significance (including milkfish and penaeid shrimp, the most important species grown in the tambaks). Aside from the mangroves themselves, estuaries and seagrass beds could also be threatened by tambak extensification. Bailey et al. recognized the possible adverse implications of shrimp hatchery development on important coastal ecosystems, especially tambak extensification into mangroves. Thus, the goal of a hatchery program was specifically focused on increasing productivity within existing tambaks (tambak intensification) and not tambak extensification.

The primary measure to reduce or avoid impacts from the development of small scale hatcheries is to site hatcheries away from important coastal resources. The development of hatcheries will need to be carefully evaluated on a case-by-case basis; perhaps as a part of improved environmental assessment and coastal resource management (CRM) initiatives, or avoided altogether until the province and the country as a whole can afford greater protection for mangrove and other ecosystems that are now threatened by tambak extensification. The CRM approach has the advantage of permitting hatchery development within additional areas, but under certain protective conditions.

Limiting the maximum size and charter of new hatcheries are other measures that could be used to reduce adverse environmental impacts. Hatchery size limitations would help to preclude the use of shrimp stock outside existing tambak areas because of high local demand. Also, new hatcheries could be approved on the condition that they service only existing tambaks or specific service areas. However, this would be difficult to administer and enforce.

While controlling the location, size and charter of new hatcheries can help to reduce pressures to expand the area under tambak, measures to improve the planning and management of mangrove will still be required. Greater control needs to be established over the unauthorized conversion of mangrove. However, an even more fundamental issue is the conservation of mangrove of critical importance to mainteneance of the coastal and riverine fish stocks. Measures such as mangrove "green belt," buffer zones and reserves can only be effective if they are carefully chosen and their use is regulated. This requires official commitment, financing and manpower. To be really effective, the value of the cost of such measures needs to be clearly demonstrated to the agencies concerned. To date we know of no concerted effort to establish the rationale for mangrove management to protect their multiple use potential for sustainable development.

C.4 RECOMMENDATIONS AND CONCLUSIONS

The recommendations and conclusion apply to the expanded environmental studies and assessment should accompany the more detailed subsequent phases of project planning and design.

- Each new small scale hatchery project should require a full environmental assessment to ensure that no significant indirect or direct impacts occur to important ecosystems.

- A coastal resources management (CRM) component with at least some focus on South Sulawesi should be established to help promote appropriate hatchery development and protect important ecosystems. This could be accomplished by establishing a planning process and providing resources to inventory suitable sites and establish controls. A CRM component could also address a number of other significant coastal resource problems in this province, especially the need for coral reef and sea turtle conservation (see tables 7 and 8 in the text).

- All new hatchery sites in rural areas should be evaluated and if necessary, surveyed by professionals at a reconnaissance level for historical, archaeological, and botanical resources in order to avoid adverse effects to such resources from ground disturbance.

- The Environmental Study Centers should be encouraged and sponsored to participate in or conduct the environmental assessments and supporting studies for proposed hatchery development projects. If necessary, they should be provided with technical assistance and training to allow them to fulfill this role.