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SETTLING COASTAL SWAMPLANDS IN SUMATRA
A CASE STUDY FOR INTEGRATED RESOURCE MANAGEMENT

by

Arthur J. Hanson and Koesoebiono
Environmental Research Training Project

1977

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by

Arthur J. Hanson[1] and Koesoebiono[2, 3]

I. INTRODUCTION

By 2000 Indonesia will have to feed a population of perhaps 250 million people -- 1.5 times the total present population of other countries in Southeast Asia. By that time Indonesia's population will rival the United States in numbers, although certainly not in consumption. At best income levels will be low, probably with a per capita GDP less than US $ 500 in 2000 by very optimistic estimates (Thee Kian-wie, 1975). At present 55% of the population is under 20 and opportunities for employment are limited. Yet a dilemma of development in Indonesia is the basic underutilization of its natural resources. More than 65% of the population is concentrated on less than 7% of Indonesia's area: Java, Madura and Bali. There are ecological reasons for this concentration of people, in particular the high fertility of many soils on Java. Only 1/3 of the irrigated ricefields, for which Indonesia is justly famous, are found off these three islands. Agricultural land of all sorts accounts for less than 5% of the total land area of the other islands. It has been estimated that at least 40 million ha of potentially productive agricultural land could be developed outside Java (World Bank, 1974). Thus government policy to bring more off-Java land into settled agricultural production seems very reasonable, given these statistics of land use and population growth.

Voluntary resettlement to lands off-Java was once seen as a solution to the population problems (Pelzer, 1945). Such a view can no longer be seriously entertained. Transmigration can help move people out of critical uplands, areas needed for other purposes (dam sites on Java) or areas threatened by volcanic action. The main justification, however, is not the large-scale relief of rural poverty on Java but a means for regional agricultural development, for increasing national food supply, and for employment of both migrant and settled workers. Budgets for transmigration have been increasing rapidly. The hope had been to move 250,000 families onto new farmland during the Second Five Year Plan 1974-1979. Although this goal will not be met, the ground

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[3] A condensed version of this paper will be published in Chia Lin Sien and Colin MacAndrews (eds). Developing Economies and the Environment: The Southeast Asian Experience. McGraw-Hill Publishers.

work is being laid for massive future efforts directed towards settlement in Sumatra, Kalimantan and Sulawesi.

Off Java many of the best areas are already under permanent cultivation either for upland estate crops or for food crops grown in relatively fertile river valleys. What remains, especially in Kalimantan and Sumatra, are 2 massive belts of relatively flat land. These are the peneplain zone of red-yellow podzolic soils and the coastal swampland soils generally composed of an acid sulphate clay soil overlain by peat (Driessen and Soepraptohardjo, 1974). The environmental management implications of development in either zone are considerable. In the uplands soil erosion and weed invasions need to be considered. The transformation to upland irrigated agriculture with use of agricultural chemicals is very likely to have an effect on downstream areas of the water basin. In the coastal swamps the system linkages to estuarine waters are a serious concern.

Furthermore traditional land rights add expense and uncertainty to any government-sponsored program to bring people into either uplands or the coastal zone. A fundamental question is whether long-term settlement and agricultural crop production can be maintained on these marginal lands or whether they should be kept for forestry grazing or other uses? Secondly, if the lands are settled, what are the optimum levels of production from the different possible balances of resources? This question is particularly relevant to the swamplands which have virgin forest cover and a rich fisheries in the surroundings. But the question is relevant to ask in the development of any new agricultural site where there are potential opportunities for animal husbandry, for fodder and wood production, for year-round cropping schedules and for labor and material inputs. Taken together these questions and observations suggest the need for integrated resource management strategies for area development, and for environmental protection of interconnected ecosystems. Approaches for developing such integrated, ecologically-based plans for resource management are still experimental (Dasmann et al., 1973). In developing countries the situation is most critical because choices are urgent and therefore often made without a full understanding of either options or optimality. The land development plans of Indonesia are a case in point. They are likely to be successful only if full use of the resource base can be brought about and sustained, since the useful productivity of individual resources is low and easily destroyed.

This article is a brief analysis of the problems faced in creating the integrated strategy necessary for multiple uses of one such unit -- a coastal swampland and estuary ecosystem in Southeast Sumatra.

Placing people onto potentially malarial deltaic areas, where the hazards of water fluctuation, poor road communication and unfamiliar soil environment would seem extreme, might be considered a strange decision. The decision is more understandable when population distribution in Southeast Asia is considered. Most people already live on or near deltas (Gourou, 1974) because these areas can be highly productive and have water readily available for wet rice cultivation (ECAFE, 1969). The expanse of mangrove and coastal peat swamp forest in Kalimantan and Sumatra (Figure 1) represents quite

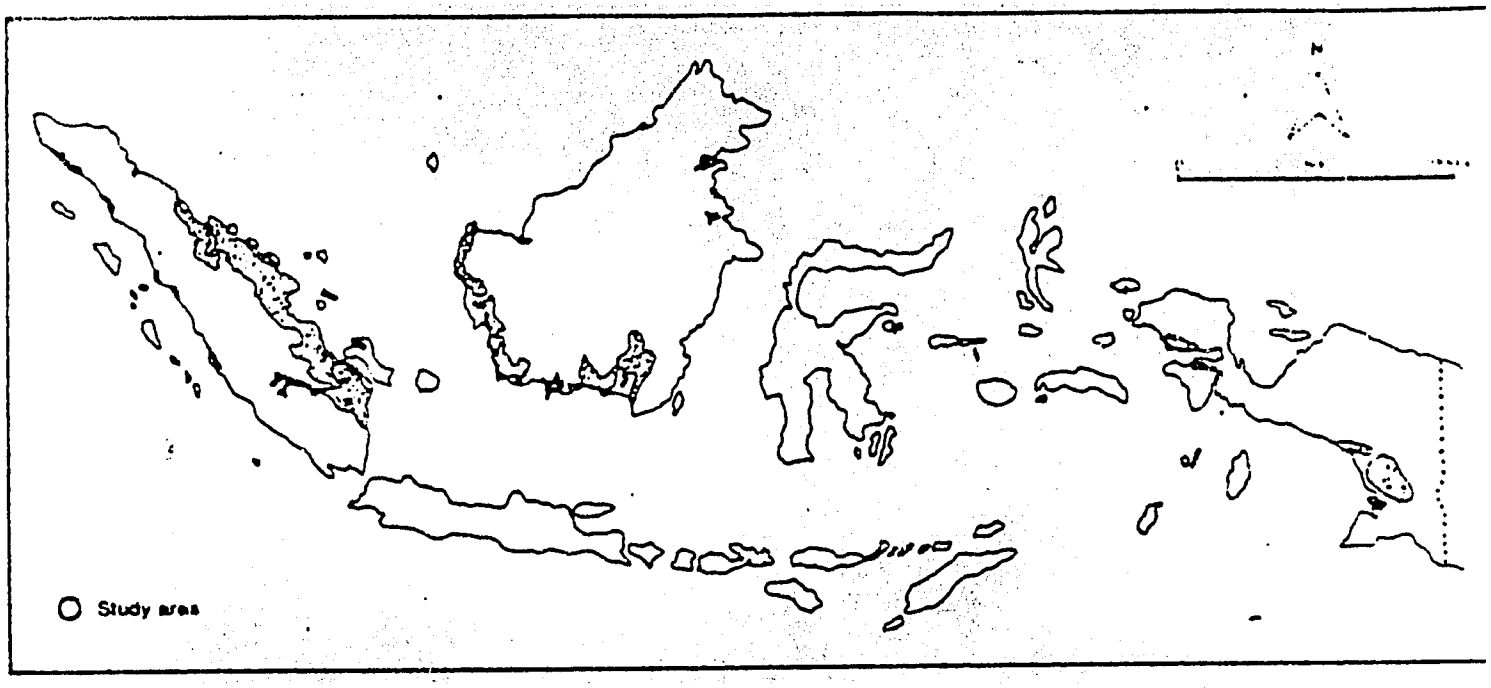


Figure 1. Major lowland organic soil swamp areas in Indonesia.

a different ecotype from the large alluvial plains of other areas, especially those on the North Coast of Java. Over the centuries planting techniques have evolved by Banjarese in South Kalimantan (van Wijk, 1951) to grow rice and coconuts on the domeshaped peatlands and on the alluvial levees along the river banks of the swamplands. In Sumatra members of coastal village resource management units (marga) have evolved a different balance of activities with somewhat less emphasis on agriculture and more on fisheries. Buginese migrants from Sulawesi have also displayed great adaptability to this wetland environment. They build long narrow drainage canals to the rivers and grow both rice and coconuts after cutting the forest. The temptation on the part of successive governments from the 1930's has been to hope that the swamplands could be converted to ricefields by Javanese and Balinese transmigrants. Various schemes were started but never fully completed for budgetary and political instability reasons. This situation changed with the initiation, between 1969 and 1974, of six substantial pilot projects in Sumatra and Kalimantan by the Ministry of Public Works and Electric Power (PUTL). About 32,000 ha of ricelands were opened and 8000 families settled.

On the basis of these trial efforts a program was announced in mid-1974 to open 1,000,000 ha of the total 5,000,000 ha of tidally-influenced wetlands now under swamp forest. The concept in development is to build canals that will provide limited drainage at low tide during wet season; high tide back-up of fresh river water in the canals onto the fields provides irrigation. The forest is to be cleared and small

villages (250 families each; 2 ha of land per family) created in the central areas of the delta. Unit development costs of $ 400 to $ 1000 per ha are considered relatively low since waterways are uncontrolled, no dams or roads are necessary and pumping systems are not envisioned. The basic aim is to achieve a single annual rice crop using high yielding varieties.

Views on feasibility have been polarized and rarely completely analytical. Detailed ecological information and good economic inputs to conventional feasibility studies were lacking at the begining of the pilot developments. The tricky conditions for crop cultivation on tropical peat and acid sulphate soil conditions make some soil scientists skeptical of long-term stability. Pons and Driessen (1975) presented the following viewpoint in an Indonesian national soil science seminar :

Recent reclamation and use of both kinds of soil (peat and acid sulphate) for agricultural purposes has often produced disappointing results, the reclamations are abandoned and a worthless secondary vegetation turned the land into waste lands. Drastic measures such as clear felling of the forest vegetation, drainage and burning of vegetation and soil have consequences which were insufficiently understood up till now. Current agricultural management on these soils together with present reclamation methods are not suitable to increase or even maintain the physical and chemical fertility of these soils. With increasing technical facilities especially in the field of drainage, the danger of too radical interferences in the ecosystems also increases. Especially post-war reclamations show a relatively high incidence of Waste Land development. Pedological know how, knowledge of ecosystems and of the application of adapted agricultural practises ... [are] ... far behind the development of machinery for drainage and reclamation.

An FAO consultant (Brown, 1972) to the land and Water Resource Development Project in South Sumatra wrote that :

The soil types encountered in the "pasang surut" area must be considered only marginal for agricultural production and where the acid sulphate soils are present it will not be economically justified to invest the large sums of money for reclamation as there is a risk that there will only be a limited yield capacity for a considerable time and failures may be frequent ... In order to obtain complete water control it would seem that poldering would provide the best solution but the high cost of such works on these marginal soils is again prohibitive. Further investigations and studies are obviously highly necessary before large scale opening of these lands is attempted ...

Despite these negative comments the pilot projects have demonstrated that rice can be grown profitably on at least some of the tidally-influenced swamplands. The considered success of the pilot projects is not only this fact but also the demonstration that rice farming can begin quickly (PUTL, 1974) :

Unlike the conventional irrigation projects, the utilization of the tidal swamp reclamation area does not have to wait until the completion of the whole canal system. As soon as the intended land to be reclaimed [is] connected to a river by a canal the so-called leaching process is immediately at work. After the leaching process has lasted for 3 months, the area is ready for rice planting. To cite an example, a year after a project execution, one can enjoy the first rice crops.

This factor is crucially important for a country where complicated planning schemes are very likely to break down -- as has occurred in some attempts to create new irrigation systems. If settlers cannot be provided the promised inputs, they will abandon the land, become shifting cultivators or subsist at a very low level of productivity. The

specter of such failure has stalked some past Indonesian resettlement efforts and must be considered a central focus for tropical resource and environment studies (Janzen, 1973).

The wetland development is taking place at a time when a high level of interest exists in Indonesia for resource and environment analysis in project and regional planning. The Second Five Year Plan notes that development planning must take into account environmental factors and that resources must be managed on a sustained yield basis. Regional planning and more comprehensive project planning procedures are two general approaches being followed. Throughout the country regional planning units have been set up at the provincial and kabupaten (county) levels. Experimental regional planning analyses have been conducted for clusters of provinces. At the project level basic soil survey information is available before new lands are settled and, in some instances, a more broad-based set of inputs from climatologists, hydrologists and agronomists is available. While the quality of these inputs is variable, it may be argued that government planners move forward with fair knowledge of the natural resource base, although often without a firm concept of what costs (social, ecological and economics) are likely to be incurred in developing long-term productive resource use systems.

More recently a specific interest in ecology and environmental impact assessment has emerged. In part this is a response to the influence of foreign aid agencies which require such inputs. But it would be incorrect to attribute this reason as the major cause. There is a genuine concern among many government and university groups for minimizing environmental impacts of development and for improving degraded ecological situations. No matter how sincere this interest it will not be effective unless information can be transformed into workable interventions, and long-term regulation/management programs created. Those familiar with Indonesia might argue that: (1) North American style environmental impact assessments and adversary processes are not likely to be effective tools in a situation where agreement by consensus is highly valued, and where any factor creating a delay in the implementation of development plans may regarded as obstructive; (2) the understanding of tropical ecological processes is insufficient to adequately predict long-term environmental impacts; (3) the time frame of development is too rapid to allow experimental work which would answer critical questions concerning optimal patterns of environmental management; (4) the scope of present planning is too narrow and therefore planners are likely to overlook or ignore key problems and externalities of development; (5) despite the express interest of the government in pursuing only development plans which are environmentally sound, the actual decision-making and regulatory structure for resource and environment problems is fragmentary, while coordination among implementing agencies is sometimes lacking or ineffective. Unquestionably Indonesian decision makers must act on situations where there is greater uncertainty compared to counterparts in some other countries. They face decisions concerning traditional resource use practices that raise very basic moral issues and many dilemmas over what should be standards. To stall development plans for long periods is to invite

responsibility for failure in meeting objectives of economic growth.

The swampland development is one of the most significant environmental transformations likely to take place in Indonesia. It is one of the world's major experiments in marginal land utilization and a classic case for creating resource and environment strategies. The impetus for doing so has come directly from the major implementing agency, the Ministry of Public Works which initiated ecological studies and related resource survey and monitoring activities through several Indonesian university groups. The studies have focused on existing pilot project areas and surrounding landsand water. This paper, based on one of these studies, reviews key issues likely to result in the Delta Upang pilot project area on the Musi and Banyuasin Rivers of South Sumatra (IPB, 1975). The issues can be roughly classified as: concern for long-term stability of agricultural production; concern for stable, healthy human settlements; concern for potentially non-sustainable resource uses; and concern for environmental impacts in the coupled estuary-delta coastal zone. They are reviewed in the context of resource management strategy formulation and implementation. Environmental impact assessment is only an early stage in what must be a long-term effort to create an integrated resource management program for area development. The basic concept espoused is the absolute need for such a long-term program if detrimental charges are to be avoided in this innovative, but ecologically risky, effort for rural development.

II. STUDY AREA AND RESOURCE DEVELOPMENT

Resource Base

A series of mangrove and freshwater swamp forest-covered deltas, the Musi-Banyuasin coastal lands (Figure 1 and 2) are bounded by three channels of the Musi River and the higher salinity Banyuasin estuary and river. The Musi is the largest river in the province of South Sumatra, draining 5.7 million ha of both upland and lowland areas. The Banyuasin river has a predominately lowland drainage of about 1.5 million ha. The vast swamplands in and around the lowland portions of these river basins form part of what is considered to be the largest and most valuable remaining forest unit in South-east Sumatra, the Palembang swamp forest complex. These forests are considered suitable for sustained yield production from the freshwater swamp hardwoods and from the mangrove species (for pulp and charcoal) according to Dixon (1973). During the early 1970's a large part of the forest area was divided into concessions by the central government. Cutover areas, if there is no further management or replanting, eventually return to swamp forest, but with a lower value species such as gelam (Melaleuca leucadendron).

Swampland forests are distributed in very distinctive patterns imposed by the conditions of salinity, tidal levels and peculiar geomorphology of coastal peatlands (Anderson, 1964; Andriesse, 1974). Agricultural patterns (rice, coconut, and home gardens) have evolved in relation to these constraints and thus also tend to follow natural boundaries. The patterns for all forest types and areas opened for agriculture are shown in Figure 2. Land opening over the past 6 years has proceeded very rapidly (Sobur et al., 1975) as a result of an influx of Buginese farmers, the transmigration project on Delta Upang, logging and large forest fires. The local settlers farm the levee and backswamp alluvial soil while the Buginese clear fields on either side of a narrow (< 2 m) and shallow (1 m) canal dug up to 9 km from the river bank to the delta interior. The Buginese have access to the peat soils, which reach a thickness of about 80 cm in the center of the delta.

The mangrove forest is of special interest because it accurately delineates the saline and freshwater soil boundaries. It is managed on a sustained yield basis for several products by local settlers: nipah (Nipa fruticans) leaves, nibong (Oncosperma tigillaria) poles and Rhizophora plus some other mangrove woods. Mangrove forests are generally considered a vital link for estuarine fisheries (Odum and Heald, 1972; MacNae, 1974). In the study area, tidal creeks in the swamps are rich in the larvae of both marine and freshwater migratory shrimp, supporting the concept of its use as a fishery nursery area.

In the water habitats (which include most of the delta land surface at least for part of the year) sharp gradients in water quality occur wherever there is mixing of blackwater swamp drainage, mainstream river flow and salt water. The resulting distribution patterns of fish and shrimp species are complex and linked to specific levels of salinity. The estuary serves as a nursery area and breeding ground for many

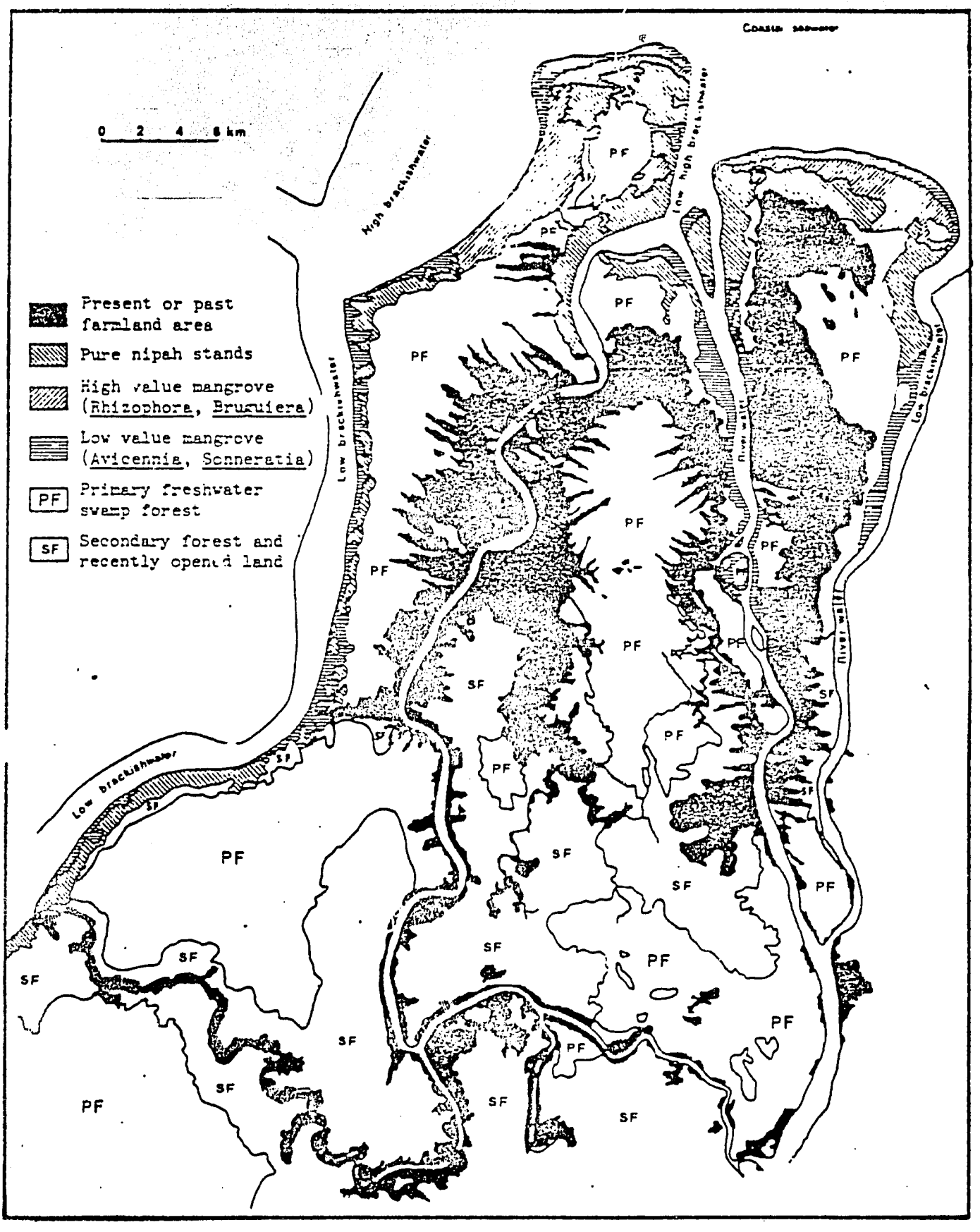


Figure 2. Land use and salinity zones in Musi-Banyuasin coastal zone 1973-1975.

species, thus concentrating fishing opportunities for both juvenile and adult forms. Fishing is an important income source for the local residents, accounting for about 1/3 of total family income. In 1974, according to provincial government statistics, there were 2440 full-time and 4475 part-time fishermen among the 31,000 inhabitants living in the 5 long-established margas.

The offshore region of the study area is the northwestern mouth of the Bangka Straits. The gradual extension of the deltas into these shallow waters has been calculated at 100 to 200 m per year as an average over the past 8 to 10 centuries (Obdeyn, 1941; Tjia, et al., 1968), although a 1969-1975 comparison from aerial photographs revealed a maximum of 30 m per year (Chambers and Sobur, 1977). The local instabilities of shoreline are complex; some areas are eroding while others accrete, and river channels to the upstream port of Palembang require maintenance dredging that can be very costly (on the order of a million dollars per year to maintain the offshore channel into the Musi River). Villages said to have formerly been close to the sea are now far inland. Some areas, however, stabilize and probably have changed little over a period of 100 to 200 years.

Resource Use Rights

Under adat law (van Royen, 1927) the rights for land and water resource uses traditionally have been vested in the contiguously located marga units (a central village plus smaller satellite villages and a large area of lands, river, estuarine and coastal waters). Land and forest exploitation rights are leased -- not sold -- by the marga. Fishery rights to specific river areas or fixed traps are also leased at annual auctions. Adat law continues to be an important element of control in resource use. However, timber leases fall under provincial government control. Also, transmigrants are given full ownership of the land they settle once the areas have been ceded from marga control. In contrast, the Buginese settlers, invited to the area by marga councils, have only the right of land usage.

Development Plans and Decisions

The existing and planned transmigrant settlement areas are shown in Figure 3. The choice of Upang Delta as an initial settlement site was motivated by the presence of a major river and an adequate tidal elevation; a large primary forest area, but reasonable overall size of the delta unit; and accessibility to markets. The Upang agricultural and settlement areas were designated following a soil survey in 1969 (IPB, 1969). Areas with indications of brackish water surface soils or peat layers less than 30 cm were excluded. In addition PUTL designers designated a 0.5 to 1 km green belt of trees along all shores. Over the time period 1969 to 1973 the Bugis settlers authorized to open land by the marga council actually opened as much forest area as the government program in Delta Upang. Their capabilities for rapid forest removal and canal construction have been demonstrated in all the major deltas except

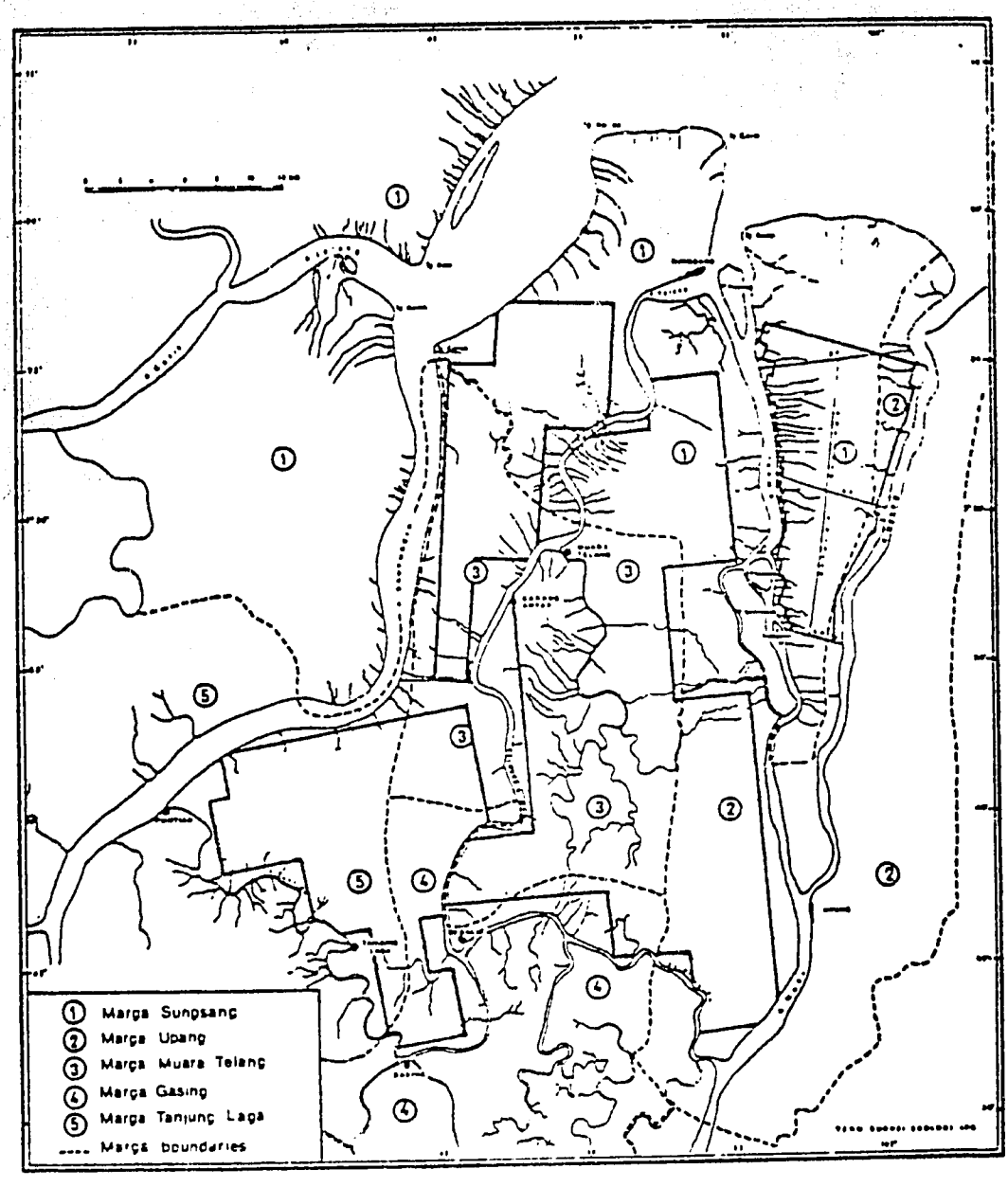


Figure 3. Traditional marga (dashed line) and transmigration area boundaries (heavy line).

for the Puntian delta, where they have not been granted settlement permission by the local marga. In all some 20,000 Bugis are estimated to have migrated to the study area since 1964 (Kuntjoro, personal communication). The various settlement activities will expand population density to between 150 and 200 persons/km^2.

In typical fashion for the coastal zone, there are activities and plans, besides those for agricultural development, capable of creating major environmental changes.

The forest uses could be divided into options for brackishwater swamp exploitation. If mangrove were cut for a Palembang pulp mill, as suggested by the Sumatra Regional Planning Study (1976), virtually all its high value wood would be required. Left to traditional uses the mangrove is likely to be harvested on a sustained yield basis, although not at optimal return levels. On the other hand, the disappearance of the remaining primary freshwater forest lands, at least from the study area, seems almost inevitable. The vast area of surrounding swamp forest is under forest concession and under consideration for eventual clearing as part of the ricefield expansion program. There have been no comparative studies on economic return from the two options.

Fisheries development options are still hypothetical since no firm plans have been put forward by government agencies. There is sufficient interest on aquaculture and fishery intensification programs that development plans are likely to emerge over the next several years. Three cold storage plants in Palembang process and export high value shrimp and fish. They have special boats which directly contact coastal fishermen for their catches of high value sea shrimp (Penaeus) and river prawns (Macrobrachium).

The study area is strategically located because the city of Palembang, 90 km upstream on the Musi River, is the major agricultural trading center and industrial city of southern Sumatra. It is the port city for most of Indonesia's fertilizer output and the location of a large oil refinery which serves Java. The extensive bar (4 m deep) at the Musi River mouth and sediment deposition in the river are serious constraints to ocean freighter navigation. Thus there are plans for massive dredging, development of new channels and a new coastal port (possibly with a road to Palembang). The transport planning is proceeding more or less independently of the agricultural development activities. The possible alterations to the area from these development activities are shown in Figure 4. The pivotal decision is whether a new coastal port should be constructed. This possibility is under review at present (Frankel, 1976). With or without a new port, frequent river and estuarine dredging is essential.

Figure 5 summarizes 20 resource use options for the area, including the activities outlined above. This interaction matrix identifies potential complementaries and conflicts between each pair of resource use options. What emerges from this identification of likely options is a set of very expensive infrastructure options and other central government plans which will overshadow the traditional resource use activities managed by the marga. Full development of the transmigration option will cost at least $ 30 million dolars for the basic canals and settlement. For continued use of the Musi River as a sea-freighter route, capital dredging expenditures of more than $ 6 million dollars were projected for 1976. These costs are small in comparison to the 100 million dollars or more which would be required if a road were built to a proposed port in the seaward basin of the Banyuasin River. In contrast to these very expensive infrastructure developments the returns from various existing activities seem relatively small. For example, the value of fish landings is likely under $ 500,000 per year.

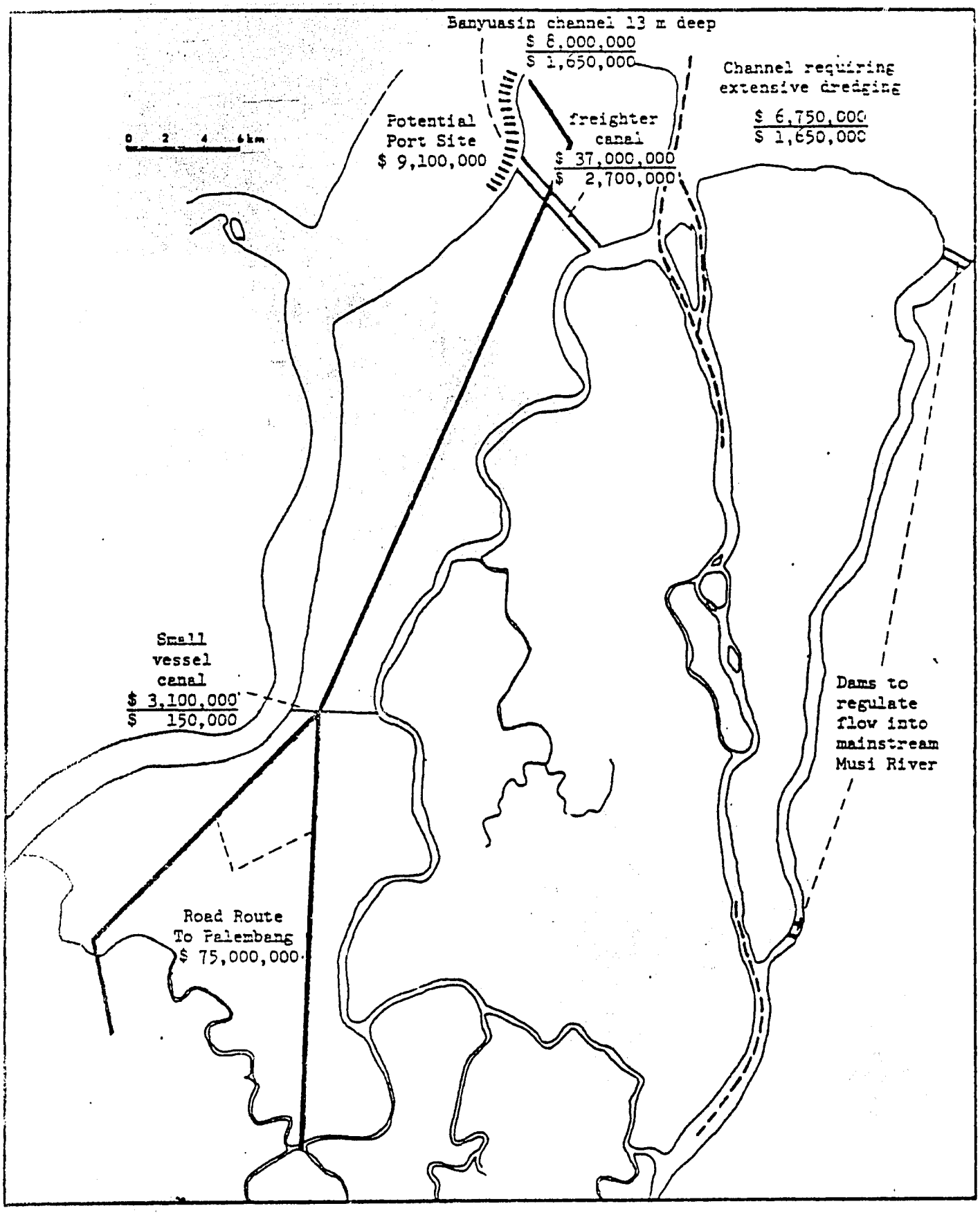


Figure 4. Transportation-related infrastructure development under consideration. Where available annual maintenance estimates are provided (lower line) as well as capital investment (upper line or single line). Source : E. G. Frankel (1976).

Compatibility of Options
(numbers correspond to resource use)

S Supplemental or complementary
M Mutually exclusive
C Competitive or harmful

	Resource Use Options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Peat soil and levee land use	1. Existing multiple use (coconut, rice cultivation)																			
	2. Swamp forest management	C																		
	3. Agricultural development project non-transmigration	S	C																	
	4. Transmigration agricultural development	S	C	S																
Mangrove use	5. Traditional uses (firewood, building materials)	S	–	S	S															
	6. Conservation reserve area	–	–	–	–	M/C														
	7. Harvest for pulp	–	S	–	–	S	M													
	8. Fishponds	–	–	S	S	C	M	M												
	9. Agricultural development	–	–	S	S	C	M	M	S/C											
Fisheries	10. Traditional techniques/entrants	S	–	S	–	S	M	S	S	S										
	11. Improved gear	–	–	–	–	–	–	–	S	C	S/C									
	12. Motorized vessels	–	–	–	–	–	–	–	C	–	S/C	S								
	13. Aquaculture	–	–	S	S	S/C	S/C	–	S	–	S	–	–							
	14. Transmigrant entrants	–	–	–	S	–	–	–	S	S/C	S/C	S	S	S						
Shipping and road transport	15. Musi channel maintenance dredging	C	–	–	–	C	C	–	C	–	–	–	–	C	–					
	16. Musi channel deepening	C	–	–	–	C	C	–	C	S	–	–	–	C	–	S				
	17. Banyuasin channel/cross-delta canals	S/C	–	S/C	S/C	C	C	–	C	S/C	–	–	–	–	S	S	–			
	18. New coastal port	–	–	–	–	C	C	–	C	C	C	–	–	C	–	S	S	S		
	19. Road or railroad to coastal port	S/C	C	S/C	S/C	–	C	S	S/C	S/C	–	–	–	S/C	–	–	–	S	S	
	20. Barges to coastal port	–	–	–	–	C	C	–	C	–	C	–	–	–	–	S	S	S	S	M

Figure 5. Coastal zone resource use compatability matrix.

The marga receives very little direct financial assistance for development activities so that locally-sponsored agricultural development or other activities must come from earnings obtained by lease of lands or fishing sites and royalties from locally-authorized forest cutting. However, as noted, marga initiated land opening is not inconsequential compared to government transmigration efforts. Moreover, the marga is the only single agency with control over all 3 primary resource uses (agriculture, forestry and fisheries). The dualism of adat and national law prevails so that marga and central government sometimes simultaneously pursue independent goals in the same area, as in the case of Buginese land development and transmigration settlement.

To provide some perspective on decisions likely to influence the Musi-Banyuasin coastal zone a list of important choices is provided in Table 1. Operationally, it may be predicted that the critical decisions will focus on forestry, water management, agriculture, fisheries, human settlement and public health, waterway development and maintenance, road transportation and habitat conservation. The agencies involved in the decision process could include all of those shown in Figure 6. It is characteristic of Indonesian decision-making to involve multiple agencies, with poorly defined channels of control. Hence it is often difficult to identify exactly when, where and how decisions occur. Often the process is gradual as concensus is reached. The four major executing agencies for the tidal land activities (PUTL, Interior, Transmigration, Agriculture) work on a committee basis under the leadership of PUTL. This Ministry offers the closest model to a national land and water resource development agency but it is important to note that no agency has overall coordinating responsibility for the range of decisions described.

Interdepartmental Coordinating Committee

National Committee on the Environment

National Committee on Resource Inventory

Study Group on Pollution
(Oil and Gas Research Institute)

Indonesian Man and Biosphere Committee

Research

State Minister for Research

Departmental Research Institutes and Research Coordinating Centers:
e.g. PUTL - Water Engineering
Agriculture - Soil Research;
Central Agricultural Research;
Inland Fisheries Research

BAKOSURTANAL (National Mapping Unit)

National Institute of Science (LIPI)
Institutes:
e.g. National Oceanological Institute
National Biological Institute

Universities:
e.g. Bogor Agricultural University
Bandung Institute of Technology
Sriwijaya Provincial University

Regional Planning

Ministry of Public Works Directorate of City and Regional Planning

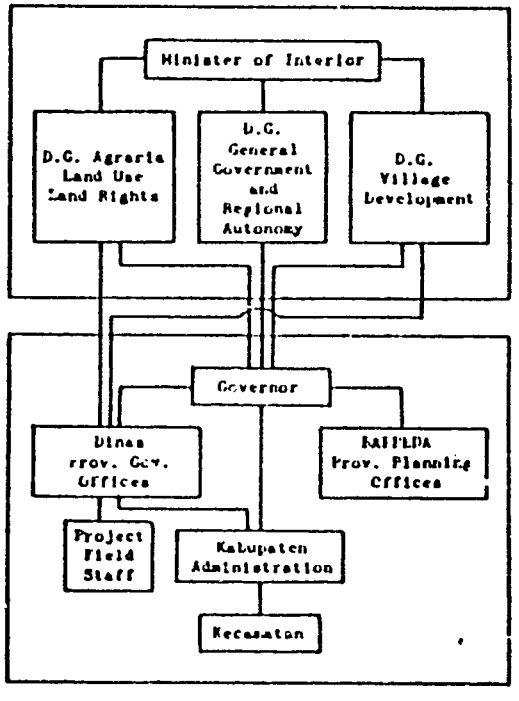
COORDINATING, CONSULTATIVE, AND RESEARCH INPUTS

Division	Bureau
Economy	Agriculture and Irrigation
Social Culture	Manpower, Transmigration and Residential Affairs
	Social Prosperity, People's Housing and Health
Fiscal & Monetary	
Control of Implementation	Development Projects Implementation
	Natural Resources Management and Environment
Regional and Area	Regional I and II
	Physical and Spatial Layout
	Regional Economy and Social
	Regional Development Assistance
Admin-istration	

PROJECT/BUDGET APPROVAL AND OVERALL PLANNING ASSESSMENTS BY NATIONAL PLANNING BOARD (BAPPENAS)

Ministry	Directorate-General	Directorates
PUTL	Water Resources	Project for Opening Tidal Ricefields
	Highways	
Agriculture	Food Crops	Production
	Fisheries	
	Forestry	Forest Production Nature Conservation Regreening & Rehabilitation
	Animal Husbandry	
Manpower, Transmigration & Cooperatives	Transmig-ration	Survey Land Opening Construction & Development
Communications	Sea Com-unications	Harbors & Exploitation Navigation

PROJECT PLANNING AND CENTRAL COORDINATION OF IMPLEMENTATION BY MINISTRY (DEPARTMENT)



AREA DEVELOPMENT POLICY AND PROGRAM IMPLEMENTATION

Figure 6. Government bodies concerned with swampland development.

III. RESOURCE AND ENVIRONMENT PROBLEMS

By eliminating those decisions not likely to cause settlement abandonment, a prolonged period of low food production, or serious decline in one or more harvestable natural products, the list of Table 1 can be reduced to key categories which can then be related to potential R and E problems as summarized in the matrix of Table 2 and its appended notes. Problem identification came from field surveys and deduction from secondary sources. Clearly all the problems will not be of the same magnitude, nor will they all share the same time response. A time-based classification would include three categories :

(1) problems of immediate significance once development starts: e.g. low drinking water quality for humans and livestock; multiple allocation of same resources; short-term impacts of infrastructure development such as road construction.

(2) problems of periodic occurrence e.g. salt intrusion (seasonal, widespread 1 year in 5); catastrophic flood or drought; oil spills on the river.

(3) problems gradually increasing in intensity over time: e.g. soil toxification or fertility decline (1 to 20 years); fisheries decline (> 5 years); weed competition (> 4 years); infrastructure instability including housing (> 3 years); insidious environmental degradation (> 5 years).

Three scenarios could occur over the long-term (e.g. 20 year span) as a result of the land development options :

(1) large scale abandonment of agricultural land with succession to low value secondary forest; decline in fisheries production; communities existing at a subsistence level;

(2) subsistence and more prosperous communities present in the same area; significant loss of harvestable natural resources such as fisheries and forests; stable agricultural land use in some areas -- but full potential not realized;

(3) prosperous, healthy communities with diverse and stable agriculture that includes animal husbandry; productive fisheries and aquaculture in both fresh and saltwater areas; sufficient mangrove, swamp forest and planted economic forests to meet local needs, to allow export of some products and to serve natural nutrient regeneration processes. Of course the third outcome would be the most desireable, and could even serve as a concisely stated set of objectives for resource and environmental management. These scenarios represent a base to which other environmental changes (e.g. from the road or port) can be related.

Obviously timing of decisions is important for certain problems to be avoided. Hence the best possible analysis is important early in the planning stages when, for example, irreversible damage can be done to the soil through overdrainage, or through destruction of the organic layer by burning. A simplified diagram of the destructive and regenerating processes at work on the delta soils is shown in Figure 7. If

Table 1. Resource and environmental decisions for development in the Musi-Banyuasin coastal zone.

1. Forest exploitation
   a. *Selection of permissible uses by forest type (mangrove; nipah; nibong; freshwater swamp forest) and location.*
   b. *Allocation of forest use rights (traditional and concessions).*
   c. *Method of exploitation (clear or selective cutting; construction of ditches or trails; mechanized logging).*
   d. *Selection of techniques and areas for sustained yield forest use.*
   e. *Timing of logging.*

2. Agriculture
   a. *Choice of new farming areas.*
   b. *Allocation of land among settler groups.*
   c. *Decision to abandon or continue crop production in specific areas.*
   d. *Selection of crops and varieties.*
   e. *Cropping patterns (wet and dry season land use; field and home gardens).*
   f. *Choice of land preparation techniques.*
   g. *Application of intensification "package" (fertilizer, pesticides).*
   h. *Development of integrated pest management techniques.*
   i. *Introduction of animal husbandry.*

3. Fisheries
   a. *Allocation of fishing rights (location, season, catch limits) among resident or non-resident groups.*
   b. *Choice of vessels and gear, and types of fixed gear.*
   c. *Recruitment of new fishermen or aquaculturists.*
   d. *Choice of aquaculture sites (brackishwater or freshwater ponds; rivers; fields).*
   e. *Choice of aquaculture techniques and species.*
   f. *Introduction of new species or stock manipulations (predator removal; controlled stocking).*
   g. *Habitat improvement and identification of protection areas.*

4. Water resource development and maintenance
   a. *Choice of water control systems*
      (1) *Irrigation and drainage canals*
         (a) *Location and interconnection.*
         (b) *Size (width and depth) and density of network.*
         (c) *Use of canals (drainage, irrigation, transportation) and method (tidal, pumped flow).*
         (d) *Canal maintenance procedures.*
      (2) *Control structures*
         (a) *Location of field dams or polders.*
         (b) *Creation of closed canal system with pumps and/or tidal gates.*
      (3) *River alteration*
         (a) *Upstream diversion.*
         (b) *Dam and barrage construction.*
         (c) *Dike construction.*
         (d) *Dredging to improve channel flow.*
   b. *Water quality alteration*
      (1) *Choice and degree of enforcement of standards for agriculture, fisheries, human and industrial water use.*
      (2) *Waterway design to limit salt intrusion.*

5. Settlement
   a. *Population density and cultural mix (among transmigrants; local settlers, Bugis).*
   b. *Choice of village sites (near river bank, delta interior; cluster, linear).*
   c. *Land use allocation within site and in surrounding areas.*
   d. *Choice of village transport network (roads; waterway; bridges).*
   e. *Choice of materials, size and siting of housing.*
   f. *Drinking water system and sources.*

g. *Waste disposal system.*
h. *Disease or disease vector management (biocide application; habitat alteration; settlement location).*

6. Communication and navigation
   a. *Location and navigation.*
   b. *Dredging and spoil disposal procedures and location.*
   c. *Deepwater port location.*
   d. *Method of transport between Palembang and coastal area.*
   e. *Location of road and methods of construction.*
   f. *Promulgation and enforcement of anti-pollution regulations for seagoing freighters.*

7. Resource conservation
   a. *Designation of ecologically sensitive areas, areas of special interest, and specification of use limitations.*
      (1) *Reserves (forest protection, fishery and fish nursery areas, wildlife and ecological reserves).*
      (2) *Areas of human interest (shrine or sacred spots).*
   b. *Soil conservation program for soil fertility and structure.*
   c. *Reforestation program (economic "peoples" forest, green belt).*
   d. *Riverbank and coastline erosion control.*

a balance is not maintained land abandonment is almost inevitable. The greatest fear is that of exposure of the acid sulphate soils -- a process which could occur quickly if the land is deeply plowed or becomes very dry. The range of possible changes over time is shown in Figure 8, which also includes available observations on the peat layer of Delta Upang after 5 years of cultivation and drainage. The middle course — moderate shrinkage of the peat layer appears to have occurred. In other words, immediate threats of disaster have been avoided. The reasons why the dire predictions of the soil scientists quoted earlier have not come about in Upang can be traced to relatively simple precautions: limited burning, no land plowing or use of tractors or heavy livestock in agricultural field preparation, and limited development of tertiary and quarternary canals. These recommendations were effectively transmitted through a close working relationship between the universities and PUTL at the project implementation level.

Over the long run the question of land abandonment still remains. Soil fertility decline is a complex problem that likely to appear over time. Interviews with farmers suggest a peak in production is reached after 3 to 5 years of use. The decline in production which follows is partly due to micronutrient (Cu or Zn most likely) or macro-nutrient deficiency but may also be caused by weed competition. Poor water level control, a long fallow period and declining soil fertility, which favors invading weeds, combine to produce an environment where farmers cannot profitably grow a rice crop. The same holds true for burned-over sites which become acid. The remarkable range of plant succession possibilities is shown in Figure 9, along with recommendations on land use (in the absence of chemical weed controls or chemical soil conditioners).

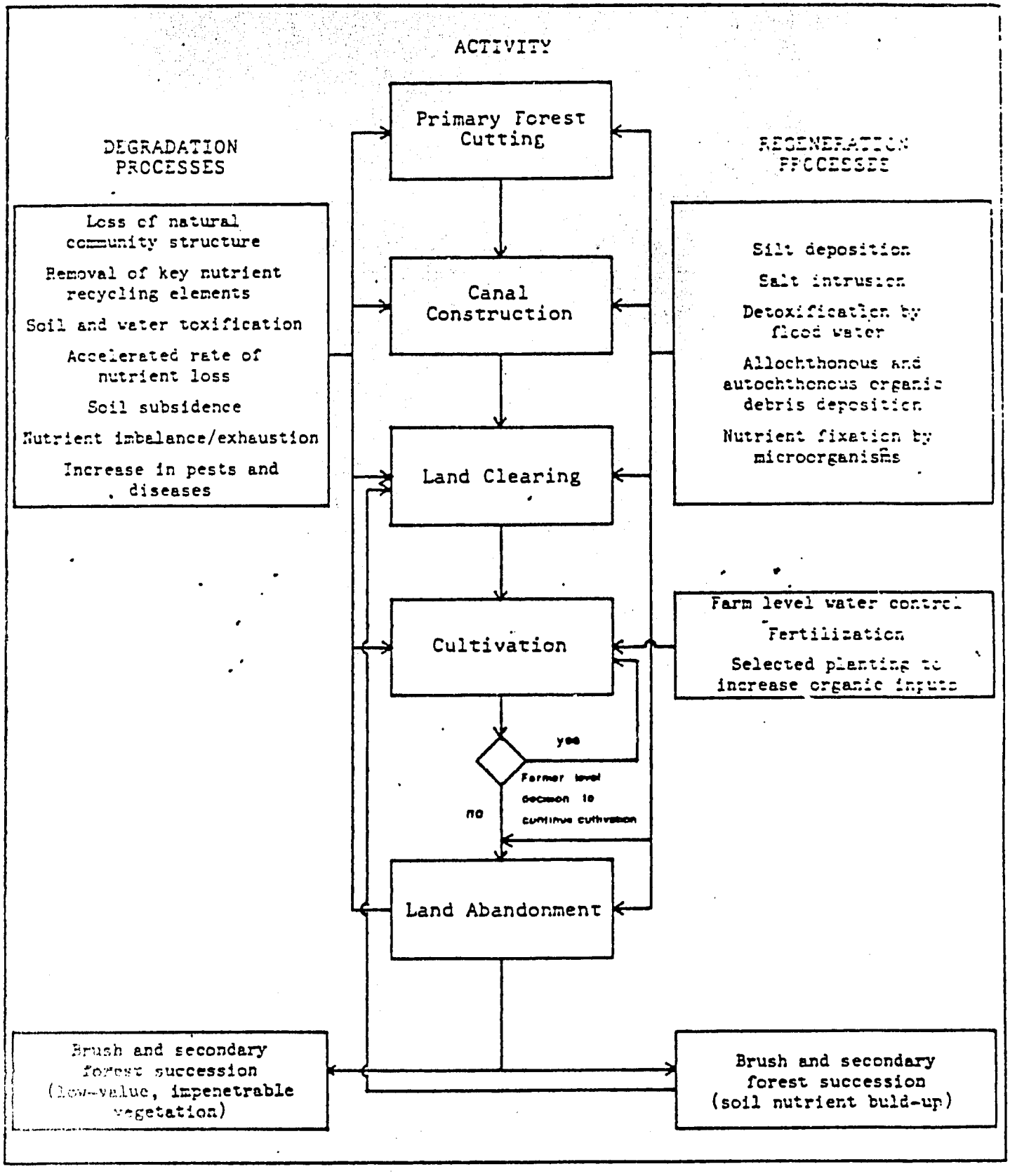


Figure 7. Land use cycle and important ecological processes.

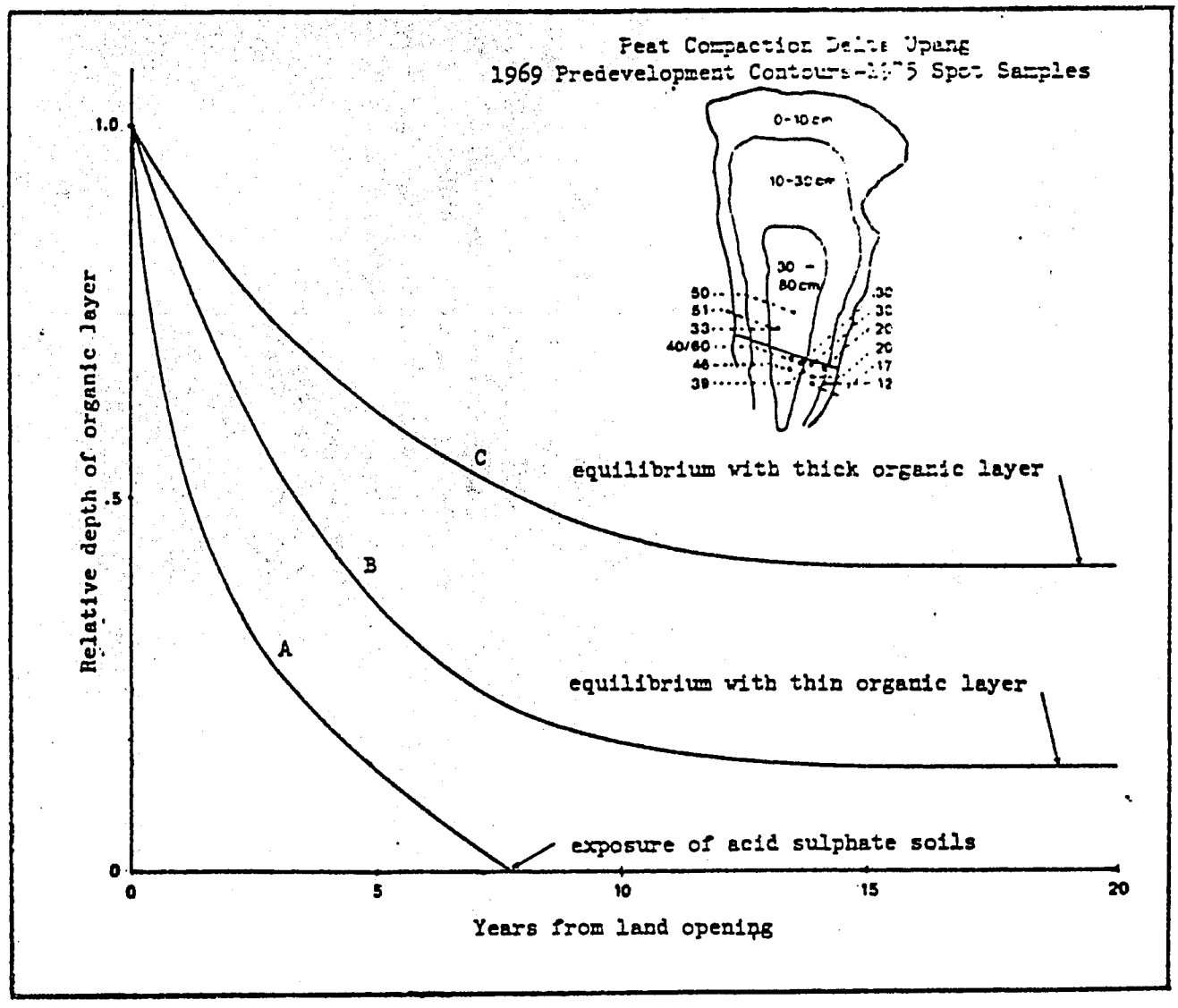


Figure 8. Hypothetical time curves for peat disappearance and actual measurements in Delta Upang.

The buildup of crop pests is an added burden for which solutions have not been forthcoming. Rats, stinkbugs and rice stem borers are very important. Farmers near forest or river bank areas must content with depradations from monkeys, deer and wild boar. The following experience is typical of the situation which results when different cropping patterns are found in the same area. Yields of farmers interviewed in Delta Upang in 1975 decreased from 25 to 60% as a result of invasions of the stinkbug Leptocorisa varicornis. The species has good dispersal capacity and can take advantage of the staggered periods of crop ripening. Thus the plant hoppers build up in numbers during the transmigrant crop ripening period and then appear to transfer to the late maturing Buginese and local resident fields. Extensive areas of abandoned river bank

LAND USE			VEGETATION SUCCESSION	RECOMMENDED PRACTISES
two rice crops/year (hypothetical case at present)	- high fertility maintained	→	ricefield relatively free of dominating weeds	maintain/diversity agriculture
one rice crop/year (freshwater)	- high fertility maintained	→	mixed rice, wild grasses, ferns, sedges	weed control; or convert to pasture or tree crops
	- fertility decline and abandonment	→ moderate	sedge association	convert to pasture or tree crops
		→ severe	Melastoma shrub association	return land to forest or tree crops
one rice crop/year (brackishwater)	- high fertility maintained	→ freshwater	mixed rice, Scirpus sedge, Acrostichum fern	weed control; or convert to tree crops
	- fertility decline and abandonment	→	Acrostichum association	leave as saltwater buffer zone
occasional rice crop (< 1 crop/year)	- land abandonment	→ brackishwater		
	- initial lag in planting	→ brackishwater / → freshwater	mahang (Macaranga) shrub association	re-establish agriculture
forest destroyed by fire	- slight damage to organic layer	→	pulai (Alstonia) secondary forest association	leave in forest; or convert to agriculture
	- considerable damage to organic layer	→	gelam (Melaleuca) secondary forest association	leave in forest

Figure 9. Vegetation succession under various land use conditions.

field form an alternative feeding zone between rice crops. Should a double cropping system be established in the transmigrant areas the problem of such a pest is likely to be very severe. Extensive use of pesticides may be essential -- with implications for ricefield, canal and estuarine fisheries.

It is impossible to completely separate effects of these crop ecology problems. They require both specialized attention and integration with other resource use issues. In some cases technical solutions are known (eg. herbicide use for weed control), but are not available to area residents. Clearly the struggle to stabilize or increase agricultural production will be a long-term endeavor, with a chance for failure in some locations.

Water regulation is, of course, the critical element in the stability and productivity of the ecosystem. The area is distinctively zoned in several ways: levees, which are rarely inundated; behind-levee backswamps, which are particularly prevalent upriver; and higher central regions of the delta. Salt intrusion further zones the wetlands. These variations are significant to choice of varieties and timing of crop planting which, at present, occurs at the rising flood stage in the more elevated sites and at the falling waters late in the wet season in some backswamp areas. This adaptive procedure minimizes danger of flooding. Flood hazard is much lower than the more inland sites near Palembang where 3 to 4 m fluctuations in water level occur. Near the coast field flood water levels greater than 0.5 to 1 m are unlikely, a fact which seems counter-intuitive to those who do not understand coastal formation and river hydrology. Thus deepwater floating rice varieties are not needed in most areas.

A much more serious problem is the matter of periodic very dry years (about 1 year in 5 has rainfall of less than 2000 mm/year). During these dry periods forests burn and maximum peat soil shrinkage will occur. Salt intrusion extends further up channels. These years are the time of maximum ecological change and stress on the human population (crop failures, pest damage, lack of drinking water, increased water-borne disease). Even in the average dry season there is doubt about the adequacy of water supply for a rainfed second crop. Improved water management hinges on extending the period of water availability at both beginning and end of the dry season in order to allow double cropping -- in addition to careful regulation at various stages of the main crop.

How water availability can be controlled, given the simple open canal systems being developed, is an important matter that is unlikely to be settled quickly. The possibility of field-level bunds, pumping systems, large main canal water-gates and perimeter bunds (to create a closed system), downstream dams and barrages and upstream diversions of water could add greatly to the expense and to the extent of ecological change in the region. The present strategy, the wisest, is to work at the level of field level water control. For example, experiments are underway to construct simple means of slowing runoff through farm level bunding. Simple contouring to produce very wide terraces over the gentle slope of the delta may be an effective means for water control. It is very important to stress such land improvements since they do not

destroy natural soil structure and are adaptive to the slight but very significant terrain variation. The opposite is likely to be true for any large-scale water regulation structure. Upstream water diversion or dams are not in short-term plans for the Musi-Banyuasin basin but are being contemplated in long-range plans. Controlling the upper flood plain system (lebaks) could also have a significant impact on the coastal development.

Attention to the agricultural problems alone is insufficient to create optimal resource use patterns for this coastal zone. Explicit management principles must be developed for each potential resource type and, in some cases (e.g. Rhizophora forest, Macrobrachium prawns), for individual species present. Such strategies must take into account the possibility of multiple user groups and extreme ecological variation which geographically concentrates specific resource types. This is especially true for the fisheries which expose individuals to capture at various points in their life history as a result of migratory habits. The brackishwater forest is of particular significance. In meeting the needs of local residents it is quite possibly more valuable than the interior peatland forest. The nipah leaf is an essential product for roofing in the area and, as well, is exported in great quantities upriver. In the narrow boundary between the nipah and the freshwater swamp forest the nibung palm Oncosperma, valued for construction of piers, housing and fish-trap supports, is found in densities in excess of 1000 per hectare. This density drops to 10 to 20 trees per hectare in the freshwater swamp. Land opening which does not respect this boundary will destroy this resource.

Related to the multiple use problems are the long-term needs to intensify resource exploitation. Rapid development carries the threat of wasteful exploitation. A strategy of extensification means, in general, the opening of as much land as quickly as possible. This is the strategy of Buginese settlers as well as of the government program. The elements of underutilization include a freshwater forest yield of only about 1/5 the potential yield under good management (Dixon, 1973), since cutting is very selective. In areas where the land is opened for agriculture the yield is likely even less since valuable timber is burned. The agricultural land supports one crop per year, except in the home garden areas. Even on the more intensively managed home gardens the plots are not yet the efficient solar energy traps of the home gardens on Java (Soemarwoto, et al., 1975). Economic tree crop/forest plots have not yet been created although this is likely only a matter of time. Fodder for livestock, duck rearing systems, pond or cage aquaculture and even capture fisheries are below their potential production levels. A central hypothesis of development in the tidal swamplands could be that it will be these products rather than the ricefield yield that will determine long-term success of the venture. If fertilization of the sensitive soils does not produce a high rate of return, alternative farming approaches, particularly in the dry season, may be more profitable. At present the inputs necessary for these alternatives to develop are very limited.

The environmental management problems of human settlement, transport development and infrastructure maintenance interact with the natural resource issues described above. Fortunately some of the most debilitating water-related diseases are not found in the Indonesian coastal zone. The exception is malaria which can be expected to build up in intensity over time as the brackishwater swamp habitat is disturbed (Sandosham, 1965) and as more people come into contract with vectors near the freshwater forest edge. As in all other settlement developments the supply of good quality drinking water is a pressing need that could be met through low technology plans (e.g. rain water collection and dry season solar distillation). The irony of development in the coastal zone is the great availability, but low quality of water for domestic use. Buginese families living near the sea transport river water 20 km by boat during the dry season. The transmigrant families suffer occasional cholera outbreaks and a high incidence of enteric diseases in this season.

The final category of problems -- those of insidious environmental change -- is among the most difficult to even properly describe. Effects of channel deepening; water diversion and canal construction could all affect distribution of salinity -- with resultant impacts on the distribution of aquatic and forest resources and on coastal formation. A major hypothesis vital to understanding the productivity of the estuarine zone is that the aquatic food chain depends on the maintenance of nutrient inputs from delta sources such as the mangrove forest, or the blackwater exudate from the peat. If this is the case, the agricultural development may have a long-term detrimental impact on fishery resources. Another hypothesis concerns the use of canals and swamp areas by juvenile fish and shrimp. These have been shown to serve as nursery area for valuable shrimp species (Salam, 1976). Thus great care in pesticide use is needed, particularly during periods of salt intrusion when marine shrimp enter some canals.

These very incomplete observations on the nature of R and E problems listed in Table 2 do provide guidance in the formulation of environmental management strategies. There is a need to provide environmental guidelines from the earliest planning stages and on an on-going basis. Secondly, in considering management mechanisms, key control features that will influence several problems should be given priority for study and experimentation. Field-level water management is the most important example. Thirdly, an understanding of local needs and adaptations to the resource base, and identification of the methods of all users is needed as background for the multiple allocation problem. This must lead to trial methods to intensify and broaden uses of the ecosystem, without destroying major elements of it. Fourthly, a discrete set of ecological hypotheses must be formulated to test: (1) optimal levels of utilization and carrying capacity of specific resources; (2) the specific questions related to ecosystem degradation. Finally, there must be an environmental monitoring program and long-term impact assessment that takes into account human ecology needs of individual settler groups and the various activities that are now taking place with relatively ineffective inter-sectoral communication.

Table 2

KEY RESOURCE AND ENVIRONMENT PROBLEMS

Matrix relating important resource and environment decision categories to key problems in the Musi - Banyuasin coastal zone

DECISION CATEGORY	1 Soil toxification/fertility decline	2 Land instability/river shallowing	3 Low water quality/salt intrusion	4 Catastrophic flood/drought	5 Fisheries decline	6 Forest product shortage	7 Vegetation succession/competition	8 Agricultural pest outbreaks	9 Disease and vector build-up	10 Stable infrastructure & envir./impacts	11 Multiple allocation of same resource	12 Underutilization of resource base	13 Insidious environmental degradation
1 Forest use allocation						•		•			•	•	
2 Land clearance timing/methods/location	•	•	•	•	•	•	•	•	•			•	•
3 Crop varieties/patterns/methods	•	•	•	•		•	•	•				•	
4 Agricultural intensification	•		•		•			•					•
5 Fishing right allocation					•						•	•	
6 Choice of fishing gear					•								•
7 Canal location		•	•						•	•			
8 Canal size	•	•	•	•							•		•
9 Field-level water control			•		•		•	•	•			•	
10 River alteration	•	•	•	•	•						•		•
11 Population density	•			•	•	•	•		•				•
12 Settlement site	•	•	•	•					•	•			•
13 Drinking water supply			•										
14 Vector control					•				•	•			•
15 Dredging canals/channels		•	•		•		•						•
16 Port location	•	•			•				•				•
17 Road location/construction methods	•	•							•	•	•		•
18 Reserve designation	•	•	•	•	•	•	•	•					•
19 Soil conservation	•	•					•	•					•

Table 2 (continued). Explanatory notes for matrix of key resource and environment problems. Numbers correspond to decision categories.

Problem 1. Soil toxification/fertility decline

The already acid peat is underlain by a potential acid sulphate clay which quickly oxidizes to sulphuric acid if exposed and dried. Even when wet the clay fixes nutrients, particularly phosphorus. The peat layer is difficult to fertilize but is likely deficient in both macronutrients and micronutrients. In the early stages of reclamation soil is toxic from the semidecomposed materials and swamp gases. Later, aluminium and iron toxicity effects increase. There is considerable local variation in severity of soil problems according to degree of mixing with levee alluvial soils, distance from sea and depth of organic material.

2. *Prolonged period between forest clearance and agricultural planting leads to secondary gelam (Melaleuca) forest which creates more acid soil conditions. Where potential acid sulphate clay is exposed by opening areas with a very thin overlying organic layer, by mechanical disturbance of thicker deposits, or by destruction of the peat through burning, soil acidification occurs. Excessive removal of nutrients by frequent flushing of the organic or mineralized plant and soil residues will cause a decline in soil fertility.*

3. *Choice of species requiring heavy nutrient input (e.g. cassava), the removal of crop wastes after harvest, or double cropping will threaten soil fertility. Ricefield land preparation techniques (e.g. plowing) commonly practised on lowlands of Java would disturb potential acid sulphate soil layer.*

4. *Use of some fertilizer types (e.g. ammonium sulphate) will cause decline in soil pH.*

8. *A high density of deep drainage canals without water control structures will overdrain areas, creating oxidation of potential acid sulphate soils. Canal spoil (acid sulphate) is toxic. Opening area without sufficient drainage leaves the raw peat soil in an excessively acid condition.*

10. *Upstream diversion of water will lower dry season water table, increasing possibility of acid sulphate soil formation.*

11. *Crowding will increase tendency to settle in forest areas considered very marginal or hazardous for agriculture (e.g. nipah zone).*

12. *Land preparation for market areas or for roads will expose acid sulphate soil layer to oxidation resulting in soil toxification.*

16. *Excavation and disturbance of soil surface will open potential acid sulphate soils to oxidation. The acid drainage may affect any nearby farmlands or fishponds as well.*

17. *Road construction entails excavation to basal layer of sandy deposits and removal of huge quantities of potential acid sulphate soil. Wherever the soil is deposited (unless in the sea) the ground will be toxic.*

18. *Three different soil types, and the presence of marginally saline soils near the sea, requires careful identification of zones for specified uses. Some areas may support year-round agriculture, others should be left under natural vegetation or cropped only once a year.*

19. *Procedures to avoid disturbance of potential acid sulphate soils, excessive drying of either clays or peat deposits, and loss of soil nutrients are essential for sustained agricultural production.*

Problem 2. Land instability/river shallowing

The recently deposited soils are water-filled and therefore do not have good weight-bearing capacity. They slump when piled and cannot support heavy infrastructure. Peat layer will irreversibly shrink if dried. The constant deposition process raises the river bed and creates areas of erosion and deposition along the coastal and river shorelines.

2. *Excessive drainage causes rapid or gradual land subsidence (estimated minimum of 50 cm on muck soils). Land is then subject to deeper flooding and becomes more difficult to drain.*

3. *Destruction of the natural vegetation cover permits drying of surface peat layer during the dry season unless there are simultaneous measures to control water table.*

7. *Canals opening onto natural sediment deposition or erosion sites are subject to shallowing or erosion at their mouth. The way in which canals are connected can lead to dead spots where detritus and sediments accumulate, causing shallowing of the canal.*

8. *Many deep canals will accelerate land subsidence.*

10. *Flow diversion or partial blockage of the river mouth will create new areas of shallows and erosion.*

12. *Canals near settlements fall into disrepair from bank slumping, and accumulation of debris. Stilt settlements on river exacerbate erosion and sediment deposition problems, leading to a need for frequent change in settlement site. The major fishing village is in a constant state of retreat as a result of bank erosion (up to 10 m/year).*

13. *Extensive groundwater pumping, should underground freshwater be located, will accelerate land subsidence.*

15. *Development of new canals increases the rate of land subsidence. It can lead to river shallowing in other areas. Channel dredging causes bank erosion and redeposition of material. Wake from passing ships has same effect.*

16. *Most potential port sites are locate on unstable shorelines. The development of jetties and extensive shore facilities will alter existing patterns and rates of coastal change and local land subsidence.*

17. *Road construction will require drainage and deposit of road materials on unstable sediments, creating land subsidence.*

18. *Failure to reserve land on shores where erosion or sedimentation occurs will allow uses which exacerbate the problem.*

19. *Without procedures to prevent top soil drying land subsidence cannot be held to minimum levels.*

Problem 3. Low water quality/salt intrusion

Extreme gradients in water characteristics exist. Swamp waters are nutrient deficient and frequently anoxic. The coastal seawater is toxic to plants and can destroy soil structure. At high concentrations it cannot be used in irrigation. However at low concentrations brackishwater may be beneficial in restoring soil nutrients and buffering of acid soils. Water quality gradients imposes a strong ordering on natural communities of plants and animals. Many communities are packed into a small area and can easily be destroyed if existing gradients are changed. Water quality is particularly low in canals since these are receiving a high organic input and have an inflow of swamp water. Pollution from oil tankers is a periodic problem in rivers.

2. *Brackishwater forest lands cleared for agriculture create a salt intrusion hazard for the surrounding areas if connected by canals. Land clearing reduces water quality by increasing organic debris in drainage canals and by increasing water temperature from 27°C to 38°C or more.*

3. *Dry season crop increases likehood of salt intrusion damage in areas which otherwise may support a single crop with minimal risk. Choice of crop varieties will influence impact of salt intrusion.*

4. *Fertilizer-induced eutrophication will increase algae content of water and reduce its palatability for human or animal consumption. Pesticide residues could exceed standards for human use or taint fish habitats.*

7. *Canals opening into high salinity estuaries will open land areas to salt intrusion.*

8. *Small, shallow canals (e.g. Buginese) cause less salt intrusion than deeper, larger canals. Very deep canals (below low tide levels) would become anoxic.*

9. *Salt water soil buffering and fertility restoration possibilities are reduced.*

10. *Salt intrusion will increase in both intensity and extend if flow from upstream is reduced. The shift in boundary between fresh and salt water will change location of flocculation zone where sediment deposition occurs.*

12. *Settlement areas in delta interior contribute high organic load to canals.*

13. *Use of canal water or shallow groundwater as a source of drinking water sets highest water quality standard, thereby defining water quality problem in its most severe form.*

15. *Presence of a major shipping route for petroleum products leads to periodic oil spills on the river and other waste discharges. Channels deepened to accommodate large ships increase salt-water penetration upriver.*

18. *Salt intrusion becomes apparent as a problem when natural mangrove boundaries are ignored in land use designations.*

Problem 4. Catastrophic flood/drought

Deltas emerge in relation to sea level and river flood stage. Any alteration of land level or drainage patterns can increase hazard of naturally-occuring floods. During the dry season, periods up to 90 days without rain have been observed. Excessively dry years occur about one year in five. Forest fires and irreversible soil drying occur. Failure of a second crop due to drought and related salt intrusion must be expected in these very dry years.

2. *Location of land opening in areas most prone to flooding increases risk of damage. Highest points are subject to greatest chance of dry season crop failure.*

3. *Use of rice varieties killed by moderate submergence (50 to 75 cm) increases flood risk. Alteration of planting schedule increases possibility of drought.*

8. *Overdrainage by large, frequently spaced canals will enhance effects of drought.*

10. *Upstream water diversion or storage will exacerbate dry season water shortage for crop culture in coastal zone.*

11. *Population build-up will increase use of deeply flooded areas such as lebak zones (backswamp behind levee) or more inland swamp sites for food cultivation. These are higher risk sites.*

12. *Locating housing in areas subject to most intensive flooding (either in depth or in length of inundation) creates a hazard.*

18. *Failure to detect particularly high or low spots and to restrict their use increases hazard associated with drought and flood.*

Problem 5. Fisheries decline

The estuary and brackish water swamps are the spawning or nursery ground for both freshwater and brackish water migratory shrimp and for fish of commercial value. The canals dug for irrigation become part of this nursery area. Production from the rice-fields and canals alone could meet most of the fish protein requirement in settlers diet. Overfishing, habitat destruction and toxification of waters will, individually or in total effect, reduce the potential of a resource base already being exploited by more than 5000 fishermen.

2. *Removal of mangrove forest will reduce spawning habitat, destroy nursery ground area and possibly reduce long-term supply of leaves to detritus food chain. Drying of freshwater swamps and destruction of small drainage creeks will diminish area of freshwater habitat.*

4. *Presence of fertilizers or pesticide residues may lead to decline in productivity of various components in aquatic food chains and to direct mortality of fish.*

5. *Uncontrolled fishing, including the granting of rights to too many individuals, will eventually result in reduction of stocks, or in size of organisms caught, to a point where most are caught at a sexually immature stage.*

6. *Large numbers of non-selective or highly efficient gear units and powered equipment will change fish community composition.*

9. *In agricultural areas marginally influenced by salinity, water control devices may reduce salt content to a point where brackishwater-seeking fish and shrimp larvae will not enter canals.*

10. *Drying up of spawning creeks, alteration of natural flood cycles (which stimulates migration into swamps and coastal areas and, possibly, reduction in nutrient inflow from uplands) are potential consequences of upstream water diversion/storage. The presence of downstream barrages could influence migration to and from the sea.*

11. *Movement into marginal lands as population builds up threatens destruction of both fresh and brackish water fisheries habitat. Heavy fishing pressures reduce both catch per unit effort and, eventually, total catch.*

14. *Widespread spraying of open water surfaces (e.g. swamp, field area or settlement sites) for mosquito control may have toxic effects on larvae, juvenile or adult aquatic organisms including commercially important fish and shrimp.*

15. *If ship traffic is associated with frequent petrochemical pollution incidents, or if a high, chronic level of pollution results from smaller discharges, aquatic stocks are likely to be reduced.*

16. *Port facilities located in the estuary are a competitive use of fish growth and spawning area, especially if extensive landfill is required in wetlands.*

18. *If mangrove and tidal creeks are altered, or if bulk-heading and other destructive practices are conducted in rich feeding areas, fisheries can be expected to decline.*

Problem 6. Forest product shortage

The swamp forest is by far the largest remaining forest stand in the province. Local settlers and Buginese depend on its products for cash income, for housing and infrastructure. Regeneration or preservation of the original forest type is difficult without careful site analysis and management. Most secondary forest areas are of low value wood. Deep drainage will kill surrounding forested lands. The rate of forest disappearance from direct cutting and from dry season fires is high enough to suggest that at least the primary freshwater swamp forest will disappear without an enforced

policy of forest land reserves.

1. *Without clearly defined timber reserves swamp forest logging management for sustained yield is impossible. Brackishwater forest allocation for fish ponds or agriculture reduces potential for sustained yield harvest of traditional forest products (nipah palm leaves, nibong poles, Rhizophora for charcoal), or for mangrove wood chips in a pulp mill proposed to be dependent on this source.*

2. *Complete forest removal will lead to timber shortage for future infrastructure and housing needs.*

3. *Concentration of development efforts on one or a few crops (e.g. rice) reduces possibility of developing self-sufficiency in tree products by the planting of economic forests.*

11. *Movement into marginal agricultural lands destroys sustained yield forest management. Destruction from illegal cutting in all forest areas is likely as population expands and local forest product needs increase.*

18. *Failure to designate and manage timber reserve areas reduces seed stock and land available for future wood cutting.*

Problem 7. Vegetation succession/competition

The catena of forest types established between the center of the peat swamps and the sea is readily disturbed, leading to a low commercial value forest of either gelam (Melaleuca leucadendron) or pulai (Alstonia). On lands planted in rice, weed competition becomes increasingly severe as perennial grasses and sedges begin to become established. This can lead to land abandonment 4 to 5 years after cultivation begins. Where soil nutrients have been badly exhausted a succession to the shrub Melastoma occurs. Weeds likely play an important role in soil regeneration during and after crop cultivation, but this value is not systematically exploited.

2. *Incomplete control over weeds in rice fields leads to gradual dominance by rhizomous forms (e.g. Scirpus) which are difficult to eradicate, a major reason for land abandonment in Buginese areas. Delay between forest opening and agricultural land use allows very dense, and hard to clear, growth of ferns (e.g. Acrostichum) and brush.*

3. *Aquatic weed competition develops in rice fields if weeding is not carried out. Seasonal fallow means 2 months work to remove natural vegetation before planting next rice crop. This fallow period vegetation, however, may be important in nutrient fixation.*

9. *Field level water control is an ecologically-sound method of weed control which is not used effectively at present.*

11. *Most lands not intensively farmed will be degraded to lower value secondary forest and brush rather than primary forest as population density increases. The possibility of continuing shifting cultivation along river banks (which depends on plant succession for restoring soil fertility) will be reduced.*

15. *Mangrove trees (Sonneratia) become established along major canals. These obstruct traffic but also likely provide a source of wood and organic material for aquatic food chains.*

18. *Accurate designation of primary forest reserves is needed to save valuable stands from succession to low value bushes through uncontrolled burning and cutting.*

19. *Species composition and control over seasonal changes of vegetation are essential elements to be considered in maintaining soil fertility.*

Problem 8. Agricultural Pest Outbreaks

Newly created fields, surrounded by forest and some abandoned agricultural land, are vulnerable to invading pests and are unlikely to offer a balance of appropriate predator or parasite defences. The presence of three settler groups, each with a distinctive planting and harvesting period for their rice crop, predisposes the area to attack by the stinkbug Leptocorisa varicornis. Mammalian pests, especially rats but also deer, monkeys and wild boar, cause serious damage. Several arthropods (rice stem borers, mole crickets, grasshoppers) are important pests. In some years at least 70% of the main crop can be destroyed by pests. Dry season rice crops trials have failed as a result of attacks by the residual pest populations.

1. *Isolated forest clumps will become a refuguum for mammalian pests.*
2. *Abandoned farmlands serve as a pest reservoir for nearby actively farmed areas since rice and other grasses grow wild.*
3. *Improved rice varieties (IR-5, PELITA I/1) have low resistance to area pests and diseases. Double cropping or differences in phasing of rice crops in adjacent areas encourages build up of Leptocorisa population densities since there is no break in the pest's food supply.*
4. *Frequent application of pesticides will destroy predatory forms, leaving area open to uncontrolled invasion by pests from surrounding lands.*
9. *Without soil drying continuous population build-up of resident soil pests and disease organisms, as well as crop pest insects with an aquatic stage life history, can take place.*
18. *Presence of reserve areas near agricultural lands will create a refuguum for mammalian pests (rats, monkeys, deer and wild pig).*
19. *Failure to prevent soil nutrient deficiencies will weaken plant resistance against pest or disease attacks.*

Problem 9. Disease and vector build-up

There is a succession of lowland malaria vector mosquitos between the brackish-water forest and the other vegetation units. The brackishwater vector (Anopheles sundaicus) requires a disturbed forest setting where there are stagnant pools; other species have specific ecological requirements as well. Inattention to these characteristics in development will lead to increased mosquito populations. The prevailing habit of defecting into canals which are also used for bathing and, in some cases, for drinking leads to dry season outbreaks of disease, particularly enteric illnesses including cholera.

6. *Land disturbances which create stagnant water pools, and land opening in mangrove forest areas, will lead to increased incidence of malaria near these areas. Farmers near the freshwater forest edge are also likely to be in greater danger from this disease.*
7. *Canals located in difficult to flush areas (e.g. delta center) will increase public health hazard for nearby settlements. Canals leading into brackishwater forest areas can promote build-up of the dangerous malaria vector Anopheles sundaicus if stagnant pools are created.*
9. *The presence of standing water areas increases possibility for disease build-up by waste contamination near settlements and by insect vector breeding in field areas.*

11. *Higher density of population will influence incidence of vector-borne diseases and water-borne skin or enteric diseases.*

12. *Concentrating populations will create zones of low sanitation thereby increasing the likelihood for disease outbreaks.*

14. *Failure to develop an integrated control program can lead to long-term build-up of disease vectors despite periodic control efforsts.*

16. *Opening a port on the mangrove forest edge is likely to cause formation of standing brackishwater pools which are breeding grounds for Anopheles sundaicus.*

17. *Mosquitos will breed in any stagnant areas created by blocked drainage or other road construction activities.*

Problem 10. Stable infrastructure and environmental impacts of their development

Development on immature soils of low weight bearing capacity, and the absence of solid foundation materials (e.g. rock or gravel) limits the lifespan of infrastructure elements including housing, roads and bridges. Canals are subject to rapid filling from bank slump and sediment inflow. Water control structures shift and become non-functional. Clearing large areas for infrastructure such as roads will expose acid sulphate soils.

7. *Canals located in recent, relatively unripened delta deposits are subject to bank slumping and subsequent shallowing; they are unstable for navigation and water delivery. Connection to areas of land clearing or log processing brings in a continuous supply of snags.*

12. *Settlements require bridges, paths or roads and waterways. All require considerable maintenance, or frequent replacement. Options for stabilizing these kinds of infrastructure are limited (e.g. lack of stone or gravel). Footing for houses shifts as land subsidence occurs.*

14. *Location and layout of villages, provision for waste diaposal and safe water supply are elements of a vector control program which may be more important than chemical control measures and therefore should influence housing and infrastructure development.*

15. *Dredging, or opening new channels will change flow characteristics and therefore the existing balances in bank sedimentation and erosion. Existing bank settlements, canal mouths and other infrastructure (fish traps, navigation systems) are thereby endangered.*

17. *Road construction will interfere with present and planned settlement locations and agricultural canals (Buginese and Public Works).*

Problem 11. Multiple allocation of the same resource

Multiple uses of this coastal zone are desirable and inevitable. But users come into conflict and wasteful use of resources occurs because there is not fully coordinated planning for explitation. The marga and central government separately let concessions for the same land, and cannot fully supervise use once it has begun. Boundaries are unclear and plans are not always shared among all decision-making groups. There is a dependency on resource users outside the coastal zone to preserve resources within the swamplands (upland water users, sea or upriver fishermen catching migratory stocks).

1. *Local area concessions for land use overlap with central government concessions. Removal of forest allocation control from the local level (marga) can lead to uncontrolled development since there is no longer accountability to local officials, while central government monitoring and regulation are inadequate.*

5. *Estuarine fisheries capture migratory species which may be taken in offshore or upriver areas at other life stages. (Excessive removal of juveniles in estuarine or coastal fixed traps (bagan, tuguk) will reduce number of adults available for other fisheries. Hence the overall return will be reduced.*

8. *Uncontrolled use of canals for purposes (e.g. large vessel navigation, log boom storage) for which their size is insufficient causes bank slumping.*

10. *Plans for extensive agricultural development in upland areas and lebaks as well as more inland lowland swamps near or in the Musi watershed will create a demand for water that is competitive with coastal zone needs for freshwater inflow.*

17. *Road will remove a broad swath of land from agriculture.*

Problem 12. Underutilization of resource base

Rapid cutting of large areas of forest leads to a high level of wood wastage. Opening vast expanses of land for only one crop per year (2/3 of year land is idle) reduces options for sustained yield forest production compared to permanent opening of smaller areas with more intensive agriculture. Potential for multiple or mixed crops and economic forest growth has not been fully exploited. Aquaculture and animal husbandry is non-existent or casual. The development of forage crops has not occurred. In general, optimum exploitation strategies have yet to be defined for each potential resource type.

1. *Forest allocation for agriculture by marga makes no firm provision for utilization of timber; valuable logs are burned. Central government concessionaires are not required to utilize all logs. Sustained yield management areas, and terms of concession likely to provide fullest long-term use have not been devised.*

2. *Rapid clearance over large areas leads to local surpluses of logs which rot or are burned.*

3. *One crop represents a growing period of only 4 to 8 months per year. Where only one or a few species are growing there are wasted opportunities for plant production that could include horticultural crops, home gardens and trees. Forage grass-lands to support animal husbandry are possible.*

5. *Availability of suitable land and semi-enclosed waters plus juveniles of valuable fish and shrimp species could permit development of aquaculture, thereby increasing overall production from fisheries. Taking fish and shrimp as juveniles in the inshore waters, a standard practice at present, may reduce overall yield and value of the fisheries.*

9. *Without good field level water control, opportunity for a dry season crop is reduced and wet season crop yield is likely below potential level. Inputs such as fertilizer will not be effectively utilized.*

Problem 13. Insidious environmental degradation

The cumulative impacts of environmental change and resource uses may alter ecosystem relationships in ways that are difficult to detect or predict in early stages of development. Absence of models of ecological processes and input/out relationships between the components of the estuary-delta system complicate the problem of predicting changes.

2. *Gradual incursion into marginal lands will lead to increased rates of land abandonment and destruction of areas best left in primary condition.*

4. *Chronic application of agrochemicals may alter estuarine or agroecosystem balances including water chemistry, soil micro-organisms, algae composition, fish, bird and animal populations thus adding additional components of stress on an already heavily stressed environment.*

6. *A gradual abandonment of traditional fishing areas as catches drop below acceptable levels will lead to lessened concern for maintaining the area in the present relatively pristine condition necessary for productive fisheries.*

8. *Opening the delta swamp ecosystem to frequent and complete flushing may, over time, reduce dissolved and particulate organic inflow from the peatlands to the estuary, thereby reducing fertility of the waters.*

10. *Gradual changes and technical control of the rivers will alter natural habitats for aquatic organisms and birds. Interactive effects are likely to be common, possibly leading to either temporary beneficial or detrimental effects which may reverse or diminish as the system stabilizes. For example, aquatic community composition will change, and productivity may be altered as nutrient sources and substrate characteristics change.*

11. *Small scale environmental alterations by individual settlers increase in overall impact as population numbers increase to a point where "carrying capacity" or "assimilation capacity" of the natural system is exceeded. Then various ecological linkages break down and system effects are likely (e.g. capacity to absorb wastes is exceeded, water becomes toxic through direct contamination and production of deleterious algae).*

12. *Random opening of settlement sites will destroy forest reserves and perhaps increase area of abandoned land. Cluster settlement sites cause locally destructive effects which will increase in intensity over time as population increases and impacts of many small changes accumulate.*

14. *Long-term chemical or water drainage vector control procedures may have cumulative toxic effects on man, fisheries and wildlife, and cause habitat destruction in the marsh areas even in the absence of short-term toxic effects.*

15. *Long-term accumulation of wastes, spoil disposal and bank erosion may change mudflat and tidal creek habitats and species composition.*

16. *Frequent disturbance of aquatic habitat (e.g. periodic dredging), the likehood of pollution and the gradual incursion into mangrove forest areas will reduce pristine nature of estuarine habitat.*

17. *Easy access to coastal area will increase pressure on wildlife, birds and, perhaps, fisheries. It is conceivable that recreational housing development, requiring landfill and mangrove marsh destruction, will occur.*

18. *Without reserves gradual incursion into mangrove and freshwater swamp forest will transform most of the non-agriculture area into a brush environment through continued cutting with little management.*

19. *Without a definitive soil conservation program long-term soil degradation will gradually reduce productive capacity of area for forage and food crops. Destruction of physical soil structure may have an impact on other components of the coastal system including nutrient flow into the estuary.*

IV. CREATING MANAGEMENT STRATEGIES

In the first stage of development — during which the timing and area of forest removal is determined, and the canal and settlement layout defined -- relatively simple recommendations are needed to hold open options, as well as to protect forest and mangrove-dependent estuarine resources, and to avoid location on sites already occupied or of low potential for agriculture. These recommendations need not be complicated, as shown in Figure 10. What is important is to avoid arbitrary boundaries (e.g. elevation or distance from sea). There are natural guidelines to hazards such as salt intrusion and microrelief, with its soil variations. The primary development agency (PUTL) has been responsive to inputs on land use recommendations and is investing heavily in both ground surveys and aerial photography. The terms of reference for development, however, are still very basic: establish infrastructure, settle transmigrants and provide management inputs sufficient to grow one crop of rice per year. Furthermore, the primary development agencies are to withdraw from each opened area after a relatively short period (about 5 years), leaving management responsibilities to the local government decision apparatus (Figure 11).

This transfer brings the threat -- almost the certainty -- of a loss in coordination of the coastal zone development. Strategy formulation for area development can be phrased in rather prosaic terms that include 10 management elements: land/regional management; forest management; water management; crop management; pest control; animal husbandry; fishery management; public health; transport; and settlement development. These elements correspond to existing governmental units which, in general, have reputations neither for efficiency and effectiveness in operation nor for good interagency communication.

With regard to use of ecological production, the most important agency is the Department of Agriculture. This ministry could have significant inputs to planning through offices dealing with: food production; crop protection; animal husbandry; fisheries; water management; forest production; nature conservation; research and development. It is the only agency with the potential to manage the entire spectrum of living natural resources; as such it should be prepared to take on a special long-term management role. The most effective way this could come about would be through the establishment of special swampland resource management centers. These should be oriented toward reforestation and fisheries as well as to a variety of agricultural activities. To establish such units would be a distinctive departure from single purpose research stations, and provincial extension offices which lack technical advice specific enough to be used in unusual environmental conditions such as exist in the swamplands. These provincial activities are backed by national programs (most prominently the BIMAS intensification effort involving seeds, fertilizers, pesticides and some crop management inputs). Because these programs use standard inputs based on conditions in Java they are unlikely to be effective. Even if standard packages of inputs were to be designed for swamplands they could not be effective throughout the entire zone. Swamps in Jambi or Kalimantan are different from those of the South Sumatra coastal zone. Optimality in resource use can only come about through creation of adaptative strategies for each identifiable resource unit.

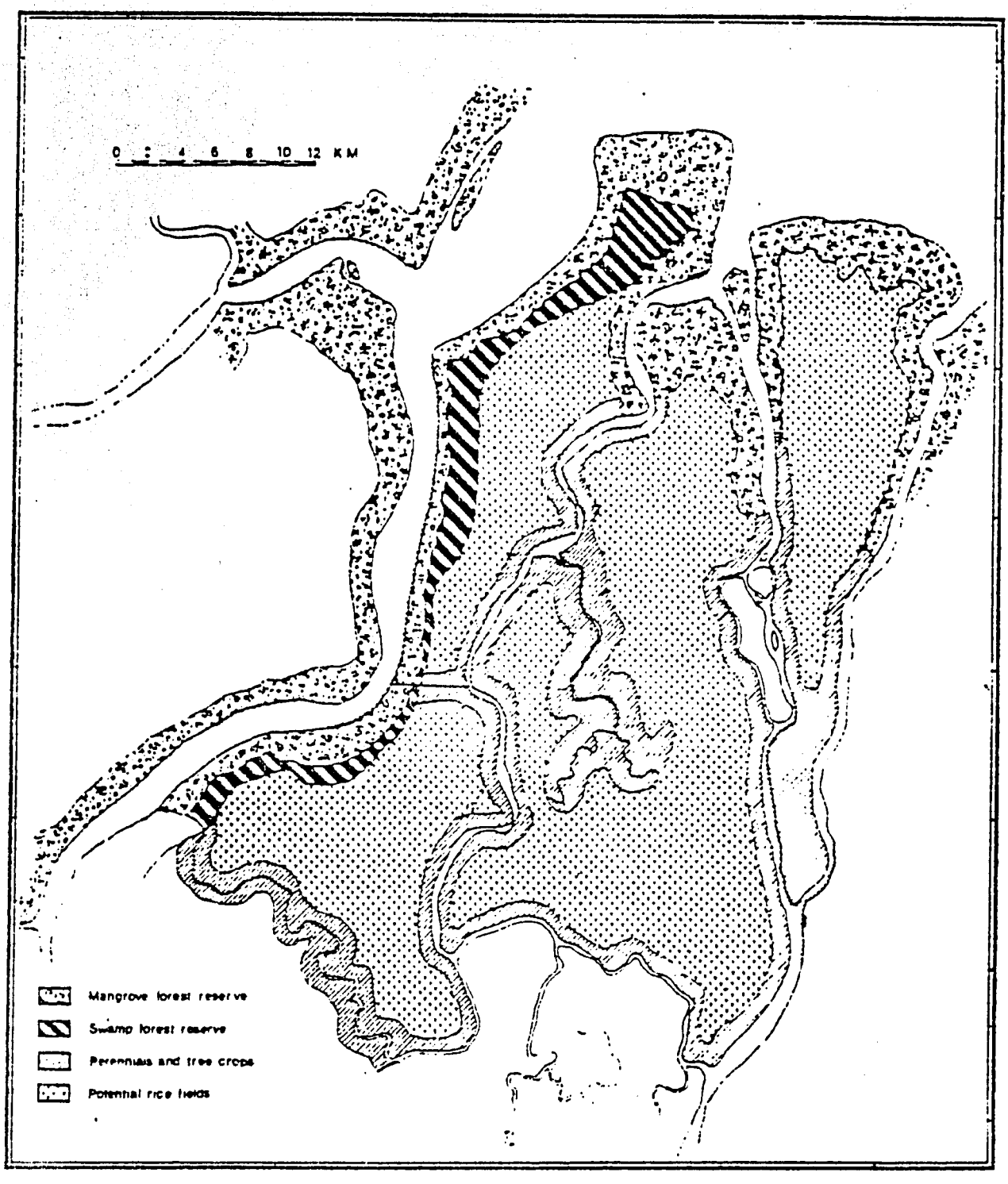


Figure 10. Recomended land use based on natural ecological zones.

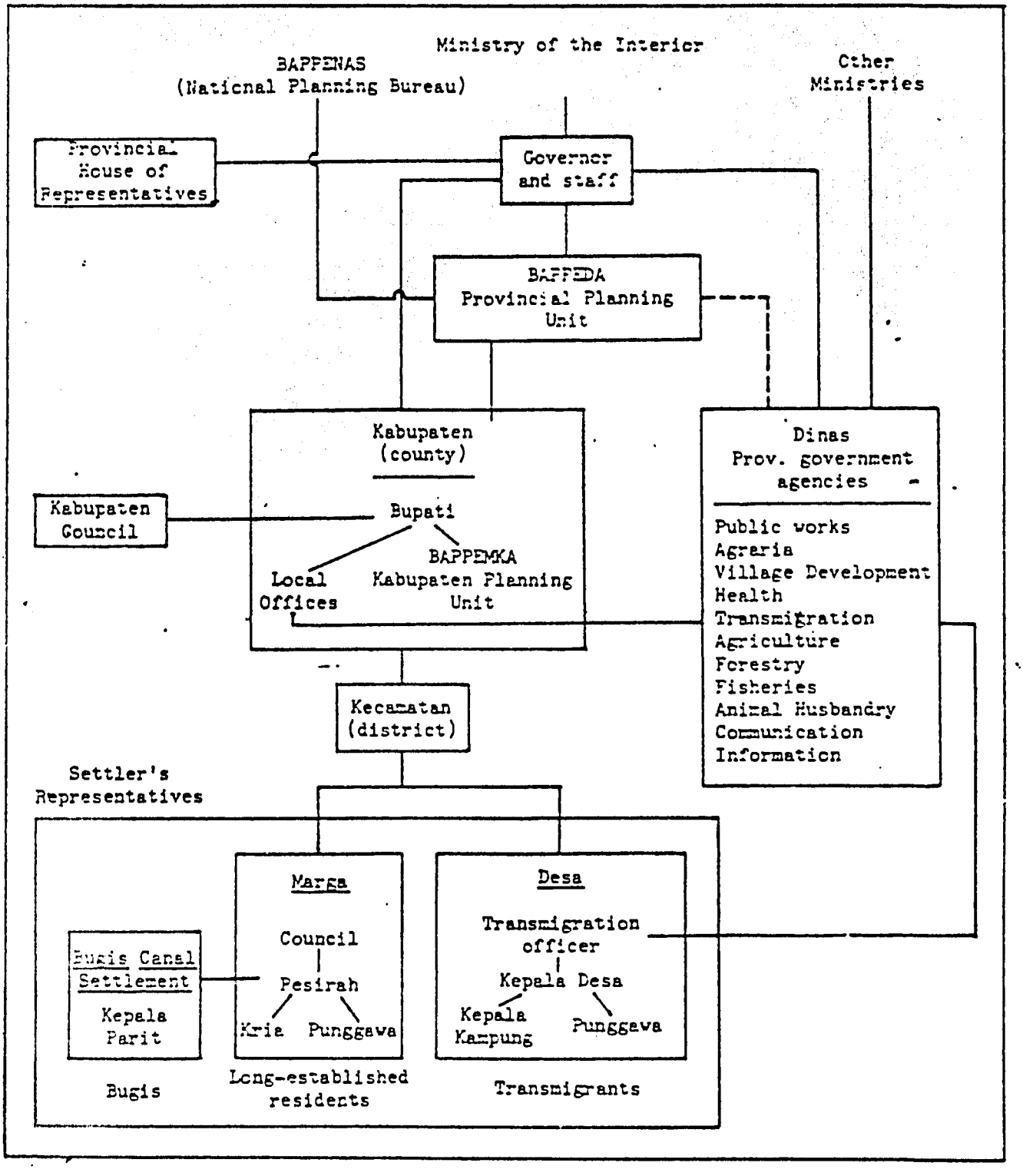


Figure 11. Regional government planning and administrative offices and local settler representatives.

By the time the primary settlement and land development agencies are ready to turn over control of an area like Upang to local management, regulations governing resource utilization, standards and methods of effective enforcement need to be established. It may be argued that even 10 to 15 years would be relatively short time to create workable procedures to bring about full use of resources, with healthy settlement conditions. This argues for a longer commitment of the primary development agencies, or an earlier start by the agencies that will assume eventual responsibility for area resource use.

Obviously land use rights are an essential element for regulation. This directly raises the question of interaction among the three settler groups -- for each is treated differently, and reacts differently toward regulations. Other examples where standards or regulations are needed are listed in Table 3. The extreme environmental gradients and seasonal fluctuations in conditions, coupled with the pioneering stage of activities, make identification of standards an extremely difficult task. Enforcement is likely to be even more difficult. Thus it is questionable how beneficial national environmental law or regulations will be to the region. The inability to regulate forest cutting, despite concession contracts which call for sustained yield management, is a case in point. As another example, in 1975 the margas were forbidden to alienate more lands in an attempt by the provincial government to slow the rate of forest loss. What this in fact means is that the degree of control in land opening formerly exercised is now totally gone. The marga becomes a disinterested party and the provincial level offices cannot police vast areas of swamp forest.

The principles governing canal water use cannot evolve directly from regulations enforced elsewhere since the system bears little resemblance to the gravity flow networks of Java and Bali. Furthermore the major canals are very important in transportation and are used for waste disposal. They are also inherently unstable and likely to require a high degree of maintenance. The regulation of these vital waterways should be under a water regulation authority located in the swampland region. Ideally it would be concerned with water quality as well as field-level water control, regulation of vessel traffic, canal bank and channel maintenance. This authority would require linkages to several government departments and would need on-going technical inputs to define low cost procedures sufficiently effective for highly variable local conditions.

The problems of externalities associated with activities in the area (e.g. road construction) or upstream (e.g. refinery or urea plant effluents), plus the critical requirement of good analysis for choice of new areas, and for increasing use of existing areas, could be met through strong regional planning units. The structure for these exists at several levels of local government as well as in the central government structure.

Over the past half decade three major regional planning studies have taken place in the Province of South Sumatra. In general, however, their treatment of the swampland issues have been superficial in the sense that they fail to perceive sufficient ecological detail to judge the development in an overall systems context. For example, in the Southern Sumatra Regional Planning Study (1976) the Upang project is ranked 153/203 in priority based on net return from rice field cultivation in comparison to other agri-

Table 3. Environmental standards needed in the Musi-Banyuasin coastal zone

1. Forestry
   - *Location of cutting*
   - *Utilization of trees*
   - *Procedure for removing logs*
   - *Replanting*
2. Water quality
   - *Drinking water for human and domestic livestock and waterfowl*
   - *Irrigation*
   - *Freshwater fishponds*
   - *Brackishwater fishponds*
   - *Forest swampwater*
3. Waste disposal in waterways
   - *Domestic wastes*
   - *Agricultural wastes*
   - *Sawmill wastes*
   - *Vessel discharges in river and canals*
   - *River dredging spoil*
   - *Canal dredging spoil*
4. Water level in agricultural areas
5. Land use in various habitats (brackishwater forest; primary freshwater forest; previously abandoned farmland or secondary forest; thick and thin layer peat agricultural soils; potential or existing acid sulphate soils; river levee).
   - *Soil exposure and drying*
   - *Land subsidence*
   - *Burning of forest and/or soil*
   - *Mechanical disturbance of surface*
   - *Dry season use*
   - *Reserve conservation*
6. Fisheries
   - *Size and number of individuals captured*
   - *Habitat maintenance*
   - *Pesticide use*
7. Canal
   - *Size, direction and abundance*
   - *Spoil disposal and bank stabilization*
   - *Regulation of water flow*
   - *Use for storage (eg. logs), shipping*
8. Construction and land opening on coast or river banks
   - *Location of infrastructure*
   - *Maintenance procedure*
9. River and canal dredging
   - *Location*
   - *Spoil disposal*
   - *Maintenance*
10. Road construction
11. Vector control
    - *Swampland stagnant water*
    - *Location of settlements in relation to forest*
    - *Chemical control*
12. Housing
    - *Adaptiveness to wetland environment*
    - *Stability*
    - *Utilization of local materials*

cultural water resource projects in the several provinces studied. The ranking is helpful but is based on assumptions biased in favor of traditional agricultural approaches. No account is taken of other resource use activities, nor of the importance of development timing. These criticisms are included to emphasize the need for greater sensitivity to local conditions in regional analysis in order for this science to make a very necessary contribution. Obviously the decisions concerning the construction of a road or other transportation infrastructure maintenance can only be properly dealt with by regional planning.

The BAPPEDA (Provincial Planning Office) is the logical entity. At present these unit are still weak throughout Indonesia -- weak both in manpower and in actual control over activities of individual implementing agencies. Yet the structure is present and could be utilized, as one example, for environmental impact assessment. Clearly there is a need for trained natural resource management staff at the BAPPEDA and BAPPEMKA (Kabupaten Planning Office) level of regional planning. These staff must be prepared to act as intervenors as well as coordinators. Strengthening regional planning activities, however, can only be a long-term endeavor, given their present state. Ad hoc inputs at various levels of government by all groups concerned with the swamplands is likely to be the mechanism for influencing regional decisions for years to come.

The complexity of development issues, coupled with the present inadequacies in meeting the issues and the need for future environmental monitoring, naturally leads to the question of the role for a specialized resource and environmental management unit. Certainly without impetus from such a unit the chances of all the important ecological issues being researched are slim. The BAPPENAS Bureau of Natural Resource Management and Environment, the National Committee on Environment and the National Committee on Resource Inventarization are the three non-departmental units directly concerned with environment. At present they function by funding research through universities or government research units and by providing a mechanism for developing coordinated interdepartmental efforts for problems of national significance such as mapping or regreening of eroded uplands. In addition, the BAPPENAS Bureau reviews environmental impact assessments and budgets for major projects. As advocates for environmental protection these agencies have limited running room since they are all recent creations, lacking in staff, and vulnerable if they intervene in too many major development activities. They can keep issues visible within government and could play an important oversight role through funding of basic studies and of independent analyses on the rapidly accumulating information base. If the theme of coastal zone management receives the attention it deserves in a maritime nation like Indonesia, a committee or office specifically devoted to the coastal zone could logically be supported through one of these environmental bodies. Obviously wetland and estuarine management would be an important objective. A direct role in field level management in the style of an Environmental Protection Agency is not likely without a considerable expansion in concept of the present environmental apparatus.

Discussions of bureaucratic structure for environmental management tend to overlook the vital fact that, whatever regulations, incentives and programs for development exist, their effectiveness is sharply limited by their perception at the level of the local decision-makers. The present situation, in which the local residents and Buginese are largely cut off from technical inputs, is not likely to be conducive to cooperation needed for synchronization of crop planting, restraints on new land development and other features of environmental management. The marga unit is a logical resource management agency in many ways. Greater attention should be given to building up its capacity to regulate forestry, fisheries and agricultural development. At present the development process is leading towards gradual dismemberment of the marga leadership's integrative capacity and to its replacement with single-purpose management. The solution is not to draw barriers between the existing settlers and transmigrants -- the existing people desperately require access to technical inputs. In addition they have evolved resource use patterns which for some areas may be a better basis for adaptation to the environment than the new systems. The Buginese canals are an example. The most important point to be advanced is that management must be focused on individual decision levels. This means careful attention to ecological detail -- farm level water control structures, understanding why fishermen concentrate their efforts in zones only a few kilometers wide using simple equipment when powered boats are available, and why distinctive boundaries exist in forest utilization. Far more than in many developed countries the coastal residents are at the mercy of government once an area becomes opened. There are practically no channels for litigation or public debate on resource allocation and grievances. On the other hand, there is a great -- and hard to regulate -- capacity for resource destruction by local user groups if traditional constraints are modified. Hence there is a need for exceptional sensitivity on the part of government to what may be termed issues of human ecology.

V. CONCLUSIONS

Integrated resource management for the coastal swampland unit should involve several concepts. The first is creation of a mechanism for analysis of choices and actual implementation among possible combinations of resource development activities: fisheries, forestry and multiple agricultural activities. This requires more careful inventory of the entire spectrum of natural resources and the existing uses, identification of effective management strategies for individual resources, and a monitoring program designed to answer specific ecological hypotheses. Because development agency goals are narrow and since the transition to line management agencies is likely to result in a less coordinated effort, there is a need for a broader-based management body specifically concerned with the long-term development of full productive potential of swamplands.

The second concept is more closely aligned to the developed country process of environmental impact assessment — in which the impacts of specific development activities are considered in relation to the entire system. The mechanism exists for such evaluation through BAPPENAS and departmental agencies. The value of such evaluations depend on how they are conducted and how seriously they are considered once completed. The tendency in Indonesia has been to commission such studies directly via the group (national or international) directly contracting to prepare feasibility studies or actual development activities. This leads to narrow terms of reference and, at worst, outright expression of vested interest. In the study area there has been a tendency to treat road, port and agricultural development as separate entities in environmental assessment. In any case, the tendency to consider environmental impact assessment as a one-time endeavor, and the very limited capacity of BAPPENAS staff to properly evaluate assessments for even a small fraction of projects are reasons to be cautious on the effectiveness of environmental assessment, unless it can be built into the planning effort as an on-going process.

The third concept in integration is the need for coastal area development strategies that take into account each settler group's special requirements for resources and for community development. Important is the recognition of local community leaders as resource managers and the understanding of how outside development influences can destabilize local attempts at creating workable resource use systems. Environmentally adaptive policies of settlement, including the means for solving basic problems of disease control, drinking water, waste disposal and stable housing needs, require further though to develop appropriate technology solutions. The answer to good drinking water, for example, likely is a combination of collecting rain water and dry season solar distillation rather than an expensive and unstable piped system.

These observations should be placed in the context of pioneer development and the earnest efforts of the government of Indonesia to make the swampland opening a success. These efforts include involvement of foreign scientists and adequate funding for domestic researchers concerned with some of the issues already mentioned. The critical problem is

the time-dependent nature of many issues. There is a 10 to 20 year commitment needed by development agencies to create adaptive cropping systems, reforestation and fishery management procedures. This commitment, and the training of good extension staff who can work with all groups in an area, have still to come. The integrative mechanisms suggested as components for resource and environmental strategies are essential as the next stage of government commitment.

At this point in time there is no basis to express either profound optimism or pessimism about the eventual outcome. In the short run the development is producing rice crops -- albeit not at the production levels and frequency of harvest wanted. The transmigrants are better off financially than on Java. In comparison to some resettlement efforts in other areas the project is smoothly functional, partly a result of the simple drainage technology and the reliance on the river rather than roads for communication. There is a breathing period now to test better strategies in the developed sites, and, to apply lessons learned in the additional areas now being opened. If these initiatives are a failure, the second decade of swampland use may be marked by expensive rehabilitation, or worse.

The Musi-Banyuasin case study is only one of six locations which might have been considered in this examination of coastal swampland development. Some areas have more serious soil problems, exceptionally important fisheries, additional environmental considerations (eg. oil wells nearby) and less intensive use for transportation. But the major problems of Table 2 are faced in all parts of this very large resource base. Many are common to other transmigration sites which are attempting to produce ricelands in inland floodplains. For example in Luwu, South Sulawesi the peat soils are not present but transmigrants have identical pest problems, threats of flood and a need to develop patterns of use that permit sustained yield harvest of a variety of resources. Throughout Southeast Asia there are more than 14 million ha of coastal peat swampland (Andriesse, 1974) and throughout Tropical Asia, there are about 35 million ha of river-built coastal areas (ECAFE, 1969) sharing at least some of the environmental characteristics described in this chapter. Because Indonesia has the largest area remaining in natural condition a UNESCO Man and Biosphere reserve has been proposed for location somewhere along the East Coast of Sumatra. Such a site, for comparative study with the areas now under development, would be a worthwhile place for more than casual attention by the world's wetland scientists to develop fundamental understandings of these very complex ecological systems.

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