

COASTAL ZONE MANAGEMENT IN INDONESIA : ISSUES AND APPROACHES ^{*)}

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ABSTRACT

The coastal zones and their embodied natural resources are a frontier area that offers Indonesian nation opportunities and challenges to enhance its economic development on a sustainable basis. Being the largest Archipelago State in the world, Indonesia is endowed with abundant and diverse coastal and marine resources. As natural resources on land are becoming scarce or difficult to develop, marine and coastal resources will be a importance resource for sustaining Indonesian economic development in the twenty first centuries. Furthermore, the shift of the global economic center from Atlantic to the Pacific Rim will inevitably increase the use of Indonesia's marine and coastal areas for various development activities, especially sea communication and transportation, fisheries and aquaculture, tourism, mining and energy, maritime industry, and coastal and offshore engineering.

However, experiences in developing marine and coastal resources during the First Long-term Development Period (1969-1994) have resulted not only in economic successes but also caused environmental degradation at a level which threatens the sustainable capacity of marine and coastal ecosystems to support further Indonesia's economic development. Cases like water pollution in highly populated or industrialized areas, overfishing of some fish stocks, physical destruction of important coastal ecosystems (especially mangroves and coral reefs), and coastal resource use conflicts among coastal users indicate such a threatened condition. In addition, the majority of coastal communities are still lingering on absolute poverty.

The paper critically identifies and analyses the root of the problems, which threatens the sustainable capacity of coastal ecosystems, and suggests an alternative development paradigm towards sustainable development of Indonesia's coastal and marine resources. Such a paradigm provides a framework for reorientation of Indonesia's development policies and programs with respect to coastal and marine resources to achieve sustainable development for the utmost benefits of all Indonesian people.

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I. INTRODUCTION

In its struggle to achieve a developed nation characterized by an industrialized, justice and prosperous society, Indonesia has come a long way since its First Five Year Development Plan (1969/1970 - 1974/1975) which sets the direction and pace for national development. Through a systematic development planning process, the nation has generated some remarkable achievements. Basic human needs (i.e. food, clothing, housing, health and educational services) which used to be a privilege for only a few are now accessible to the majority of the population. In 1970 those who live under the poverty line amounted to about 58% of the population (67.9 million), while in 1996 the number has decreased to 22 million (11% of the population) (Walton, 1990, Kantor Menteri Negara Lingkungan Hidup, 1997). Furthermore, psychologically, the most important success of the national development has been the shift from being the world largest rice importer to becoming self sufficient in rice since 1986. Average per capita income has increased more than ten times, from US\$ 90 in 1970 to US\$ 1,000 in 1996. In the same period, Indonesian economy grew at an average rate of 6.8% (Kantor Menteri Negara Lingkungan Hidup, 1997). Not surprisingly, Indonesia's economic position in the world has also moved from being a poor-income country to a middle-income one.

Such a sustained success of the economic development during the First Long-term Development Plan (1969/1970 - 1994/1995) has, without

doubt, relied heavily on the nation's wealth in natural resources both renewable resources (e.g. forests, agricultural land, and fisheries) and non-renewable resources (e.g. oil and gas, copper, gold, coal, tin, bauxite, iron ores). As natural resources on land are becoming scarce or difficult to develop, marine and coastal resources will be an important source for sustaining Indonesian economic development in the Second Long-term Development Plan (1995/1996 - 2019/2020). This is supported by the fact that Indonesia is the largest Archipelago State in the world blessed with abundant and varied coastal and marine resources, whereas the level of their utilization is generally not optimal yet. In addition, the shift of the global economic center from Atlantic to the Pacific Rim will inevitably increase the use of Indonesia's marine and coastal areas for various development activities, especially sea communication and transportation, fisheries and aquaculture, tourism, mining and energy, maritime industry, and coastal and offshore engineering.

Unfortunately, experiences in developing marine and coastal resources during the First Long-term Development Plan have resulted not only in economic successes but also in environmental degradation at a level which threatens the sustainable capacity of some marine and coastal ecosystems to support further Indonesia's economic development. Cases like physical destruction of coastal habitats (e.g. coral mining and reclamation of coral reefs and mangroves for settlements, industrial estates, and coastal aquaculture); over-exploitation of living resources; pollution; and spatial

use conflicts in the coastal zone partly indicate such a threatened condition.

The problem is that Indonesia as a developing nation can not stop developing its coastal and marine resources, simply because Indonesia still needs economic growth to improve quality of life of those poor people and eventually to achieve a justice and prosperous society. The challenge for any coastal management of this country is then how to develop coastal and marine resources for the utmost benefit of the entire nation and, at the same time, maintaining the sustainable capacity of coastal and marine ecosystems so that coastal and marine resource development can be on an optimal and sustainable basis.

II. PROBLEMS AND ISSUES

2.1. Threats to Sustainable Capacity of Coastal Ecosystems

Despite a pivotal role of coastal and marine resources in sustaining economic development of Indonesia, there are many threats to these resources. In Indonesia, as elsewhere around the globe, coastal and marine ecosystems are under siege from loss of habitats, pollution, overuse and overexploitation of marine species, introduction of exotic species, and from the potentially catastrophic effects of global climatic changes including ozone depletion, global warming and El-Nino (Beatley, 1991).

(1) Physical Destruction of Coastal and Marine Habitats

The sustainable capacity of many coastal and marine ecosystems is being subjected to stresses and degradation from inappropriate development activities within the coastal zone itself as well as in the ocean (open seas) and in the upland areas. The main causes to the degradation of these coastal ecosystems are described below.

- a. Coral reef damage caused mainly by coral mining, the use of explosive (booming) and poisons to harvest reef fish and other biota, reclamation, and sedimentation from upland soil erosion can be found almost throughout the archipelago. Based on the percent coverage of living corals, it was reported that 39% of the Indonesian coral reefs is severely damaged, 34% moderately damaged, 22% in good conditions, and only 5% is excellent (Moosa et al., 1996).
- b. The conversion of mangroves to other land uses, such as tambak (brackishwater shrimp/fish ponds), settlement, and industrial estates, and over-harvesting of mangrove timber has resulted in the reduction of their area extent and quality. The Indonesian mangrove area has been decreased from 4.25 million hectares in 1982 to 3.2 million hectares in 1993.
- c. Sedimentation that increases turbidity of marine waters is so far the most deleterious effects on seagrass

beds in Indonesia. Heavy coral mining and collection from reef flats, such as on the Seribu Islands and the coast of Bali, have also deteriorated seagrass beds.

- d. Beach erosion due mostly to inappropriate coastal development or construction is common phenomena in Indonesia. Other practices that have resulted in beach erosion include collecting beach sand for construction materials; construction of airports, hotels, and other structures too close to beaches or in offshore waters; and sand mining.

(2) Overexploitation and unbalanced utilization of marine and coastal resources

Although the exploitation rate of fisheries resources for the overall Indonesian marine waters is currently estimated at 48% of its sustainable potential (MSY = Maximum Sustainable Yield), there are some marine areas, particularly those with dense population and high industrialization like the North Coast of Java, the Straits of Malacca, and the Strait of Bali, which have already been overfished (Naamin and Hardjamulia, 1990; Dwiponggo, 1991). This is because the distribution of fisheries activities is highly skewed, where most fishermen mainly the traditional ones (85% of the total Indonesian fishermen) are concentrated in these coastal areas. Furthermore, due to high world demand and prices, the utilization rate of Penaeid shrimps have been very high, not only in those areas but also in other marine waters including South/West and East Kalimantan, East Coast of Sumatra,

South Sulawesi, West Nusa Tenggara, and Arafura Sea. Such an unbalanced utilization is also occurring at other marine and coastal resources like seaweed and mangrove timber.

(3) Coastal and marine pollution

A variety of wastes originated from both land-and marine-based activities eventually enter into the marine environment. Sources of land-based pollutants include: coastal and upstream agriculture which discharge pesticide, fertilizer and sediment runoff; and urban and industrial development leading to discharge of untreated wastes and effluents. Sources of marine-based pollutants include: oil and gas related activities resulting in discharges of drilling wastes, chronic spills and potential major oil spills (tanker accidents, blowouts); and marine traffic accidents resulting in release of waste and toxic materials. The accumulation of wastes in coastal and marine waters, especially in areas with high population density and industrial activities like the North Coast of Java and the Malacca Straits, has caused heavy pollution in these areas which, in turn, could threaten the sustainability of marine living resources and the human health. Cases like massive fish kills in Jakarta Bay (1986, 1993, and 1994) and in Bontang Bay of East Kalimantan in 1989, and Minamata like diseases found in the North Jakarta (Tempo, 1986; Dahuri, 1991) indicate such a polluted condition.

The ever increasing coastal and marine water pollution is also believed to be one of the most important factors that have brought about harvest failures of

brackishwater shrimp production in the last five years in virtually all populated or high industrial development areas including along the North Coast of Java, South Sulawesi, and Aceh.

(4) *Irresponsible extraction of coastal and marine resources*

Illegal utilization of coastal and marine resources include: the use of extraction techniques which are forbidden by Indonesian laws and regulation (e.g. coral mining, the use of explosive and poisons to catch fish); and illegal fishing by foreign fishermen.

(5) *Global warming and sea level rise impacts*

If the global warming prediction/scenarios were to take place, Indonesia may be one of many island countries in the world that will detrimentally be affected by global warming and sea level rise phenomena. This is simply because coastal areas in Indonesia are mostly flat. In addition, most of Indonesian marine organisms like in other tropical oceans have a narrow range of tolerance to temperature changes (stenothermal). Thus, the increase in the temperature of the sea as a result of global warming will eventually affect the life and growth of the majority of coastal and marine biota.

2.2. *Roots of the Problems*

The roots of the problems that cause the degradation of coastal and marine ecosystems include the following socio-economic and cultural factors.

(1) *Rapid population growth*

The Indonesian coastal zone supports a large variety of critical coastal ecosystems, which are essential for the maintenance of diverse marine resource bases. The marine and coastal areas bring together a wide spectrum of natural resources that are dependent on the well being of highly diverse, productive, and complex coastal and marine ecosystems including mangroves, seagrass beds, and coral reefs. In addition, the coastal zone also provides a strategic location for industry, commerce, tourism, and settlement. As a consequent, most of Indonesian population (65%) presently lives within the coastal zone.

(2) *Poverty*

Environmental degradation, which threatens marine biodiversity, is a result of both industrialization and poverty. This is especially true in developing countries like Indonesia where poverty is still lingering on the majority of coastal communities. Poor people within the coastal areas have generally no alternative livelihood, so that they are forced to exploit resources and environmental services from ecologically marginal marine and coastal ecosystems. Coral mining around Bontang Bay of East Kalimantan, the use of destructive fishing techniques in Seribu Islands and other coral islands in the country, and mangrove cutting for firewood and construction materials throughout the archipelago, are a few examples of coastal ecosystem degradation caused by poverty.

(3) Lack of awareness concerning the strategic importance of marine and coastal living resources for sustainable economic development

The majority of planners, decision makers, and resource users in Indonesia perceive renewable coastal and marine resources, such as fish and mangroves (as a resource base for sustainable development) are less valuable than non-living resources like oil and gas and other minerals, and environmental services of marine ecosystems like aesthetic values for tourism and transportation. Mangrove, seagrass beds, and coral reefs are examples of coastal ecosystems where their environmental goods and services, and ecological functions are undervalued. As a result conversion of these ecosystems into man-made land uses has taken place throughout the country.

(4) Short-term benefit orientation

Despite the increasing public awareness in environmental affairs in the last two decades, the majority of planners and decision-makers in both government and private sectors in Indonesia are still overwhelmed by short-term benefit and economic growth orientation. The current rapid development activities that occur in both coastal and upland areas have exerted considerable strain on the sustainable capacity of many coastal ecosystems. Economic growth mania has tempted government officials and private sectors to rationalize significant losses in ecological values and functions of coastal ecosystems in the name of economic development and improved living standard.

(5) Lack of recognition of adat rights and indigenous knowledge, community-based participation, and empowerment to local government

So far most marine and coastal related programs and projects were based on top-down approach. Very little were programs or projects on marine and coastal resource development initiated and managed by local coastal communities themselves. This approach is believed to be one of the main factors that result in unsustainable development of marine resources in the country.

(6) Lack of integrated management approaches in marine and coastal resource development

Most marine and coastal resource development programs or projects carried out were based upon sectoral approach. This is caused by a lack of man-power within both central and regional government institutions that have an ability to develop and implement integrated marine and coastal resource development plan that ensures the sustainable development of these resources. In addition there are no working models that can demonstrate that the integrated coastal and marine resource management approach is indeed more beneficial (better) than the sectoral approach.

(7) Lack of capable human resources in integrated coastal management

In general there is a lack of man-power with skills required to carry out marine and coastal resource inventory

and environmental assessment; to formulate integrated marine resource planning and management; to implement, to monitor, and to evaluate such an integrated plan; and to enforce regulations. There is also a lack of technical and managerial skills in integrated coastal and marine resource planning and management on the part of local community organizations and in the private sector. Furthermore, there is a skewed distribution of skilled manpower, with a major concentration being in Java. Shortages of skilled personnel, particularly in the outer islands, make it hard to decentralize planning and management functions of coastal and marine resource development to levels where development initiatives are implemented, and to develop resources in response to regional or local needs.

This lack of capable manpower is due mainly to: (1) the absence of education and training programs which focus specifically on integrated coastal and marine resource management; (2) the lack of integrated, interdisciplinary approaches in marine sciences and fisheries education and training programs; (3) inadequate preparation in the basic sciences such as mathematics, physics, chemistry, and biology; (4) lack of coordination among agencies in delivering effective extension programs about integrated coastal and marine resource management.

Fortunately, since 1994 Bogor Agricultural University (IPB) in cooperation with Directorate General of Regional Development (BANGDA), National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) and

National Development Planning Agency (BAPPENAS) through an ADB loan project, MREP (Marine Resources Evaluation and Planning), has trained some 250 persons from various government agencies, mostly from province and district levels, in Integrated Coastal Zone Planning and Management (ICZPM) for the duration of 1.5 to 4.5 months. In 1995 University of Hasanuddin (UNHAS) also conducted the same training for about 20 persons. In addition, started in August 1997, IPB has offered M.Sc. program in Integrated Coastal Management that is the first program of its kind in Indonesia.

(8) Lack of information as a basis for rational and optimal marine and coastal resource management

Information is a fundamental prerequisite for rational and effective planning and management of sustainable marine and coastal resource development. Although the basic components of marine and coastal database are currently available, there are many deficiencies which need to be improved. In many cases, existing data are contained in manual systems, particularly at the provincial and district levels, which makes retrieval, analysis, and dissemination difficult. Analysis is also made by the lack of data that are structured in such a certain database system that suits the need of marine and coastal resource management for sustainable development. There is insufficient baseline information on key biophysical and socio-economic-cultural aspects that are needed for planning and management of sustainable marine resource develop-

ment. Accessibility for the public to obtain data and information regarding marine and coastal resources, especially those categorized as secret/ security data, is still very low. Finally, although there is sufficient data and information, very rarely that middle managers and top managers in most government agencies use the available information as a basis to make planning and decisions for marine resource development. The majority of planners and decision makers still use "management by feeling approaches" instead of rational and management approaches in marine resource development.

(9) Lack of coordination and law enforcement

Actually there have been many laws and regulations in Indonesia related to the management of coastal and marine resources utilization on a sustainable basis. Unfortunately, these laws and regulations are mostly not implemented. This is due mainly to poor law enforcement, sectoral egoism, lack of coordination and orientation toward economic growth.

Because the enforcement of most laws and regulations related to the management of sustainable coastal and marine resource use in the form of sanctions (punishment) and rewards is weak or frequently inconsistent, there is no incentives for an individual or communities to apply them. Lack of coordination and cooperation (egoism) among sector agencies or between central and regional governments has led to duplication of efforts in such areas as data gathering, project implementation,

and the enforcement of regulations. In addition, this lack of institutional coordination and cooperation has created resource use (development), conflicts. For example, a conflict between mangrove area conservation vs. golf course and real estate development at PIK (Pantai Indah Kapuk) nearby the Jakarta International Airport; conflicts between traditional fishermen vs. trawlers prior 1980; conservation vs. tourism in Seribu Island Marine Park, and the most recently, controversial issue on the reclamation of Manado Beach which may destroy the adjacent coral reefs.

III. A PARADIGM SHIFT IN ECONOMIC DEVELOPMENT

To achieve sustainable utilization of coastal and marine biodiversity resources, Indonesia has to undertake a reorientation of development paradigm from a maximum-economic growth orientation towards sustainable development. The shift of economic paradigm should take place not only on the conceptual (philosophical) level but also on practical levels of development activities.

At the conceptual level, the vision of the conventional (existing) economic development paradigm, and particularly of macroeconomics, is the circular flow diagram. The macroeconomic is seen as an isolated system (i.e. no exchanges of matter and energy with its natural environment) in which exchange value circulates between firms and households in a closed loop. What is "flowing in a

circle" is variously referred to as production or consumption, but these have physical dimensions. The circular flow does not refer to material recycling, which in any case could not be a completely closed loop, and of course would require energy that can not be recycled at all. What is truly flowing in a circle can only be abstract exchange values which are abstracted from the physical dimensions of the goods and factors that are exchanged (Daly, 1991). Because an isolated system of abstract exchange value flowing in a circle has dependence on natural environment, there can be no problem of resources depletion, nor environmental pollution, nor any dependence of the macro-economic on natural services, or indeed on anything at all outside itself (Daly, 1985).

The necessary shift in economic paradigm is to accept the macro-economic as an open subsystem of the finite natural ecosystems, and not as an isolated circular flow of abstract exchange value, unconstrained by mass balance, entropy and finitude. In other words, the macroeconomic is an open subsystem of the natural ecosystem and is totally dependent upon it, both as a source for inputs of low-entropy matter and energy (natural resources) and as a sink for outputs of high-entropy matter and energy (wastes).

The major implications of the new economic development paradigm (sustainable development) on economic development practices in the coastal zone are as follows.

(1) Sustainability as the goal of economic development

Most existing development activities have been designed to attain short-term economic growth without appropriate consideration to ecological sustainability. Massive and rapid development of brackishwater shrimp aquaculture along the North Coast of Java since 1980's, and has come to the brink of bankruptcy since 1992, erosion of Kuta beach due to the expansion of Ngurah Rai International Airport, and the inundation of the road from Jakarta Capital City to the Cengkareng International Airport because of the conversion of wetland areas as an hydrological recharge zone into real estate are, to name but few, examples of development activities which focus too much on short-term economic gains without proper balancing with ecological sustainability.

It is expected that the recent trend of reclamation projects in several coastal areas, including Lampung, Jakarta, Surabaya, Ujung Pandang, and Manado could go on a sustainable basis without jeopardizing the sustainable capacity of coastal ecosystems.

(2) The use of economic incentives

The implementation of fees should be initiated on the destructive use of coastal and marine resources to promote more efficient use, and ease up on income taxes, especially on low incomes in the interest of equity. Fees, taxes and subsidies should be used to change the prices of activities that

interfere with the sustainable capacity of coastal ecosystems versus those that are compatible with it. Prestigious rewards should also be given to those who increase awareness of, or contribute to, the sustainability of coastal ecosystems.

(3) Institutional improvements

Current institutions with the flexibility necessary to deal with ecologically sustainable development in the coastal zone are lacking, if they do exist at all. Indeed many financial institutions are established on the assumption of continuous exponential growth, and these should undergo major restructuring in a sustainable coastal development. Many existing institutions have fragmented mandates and policies, and often have not optimally used market and non-market measures to resolve environmental problems in the coastal zone. They also have carried out inadequate benefit-cost analyses by not incorporating environmental costs; used short-term planning horizon; inappropriately assigned property rights (public and private) to coastal resources; and made inappropriate use of incentives.

Many of those problems are a consequence of the inflexible bureaucratic structure of many existing institutions. Experiences, such as Japanese industry, has demonstrated that less bureaucratic, more flexible, more peer-to-peer institutional structure can be much more efficient and effective (Costanza et al., 1991). It is therefore timely to de-bureaucratize institutions involved in coastal zone management so that they can effectively respond to the

coming challenges of achieving sustainable development.

IV. GUIDING PRINCIPLES FOR SUSTAINABLE DEVELOPMENT OF COASTAL RESOURCES

It is obvious by now that to achieve sustainable development of coastal and marine resources, there should be an assurance that the number of human population and its associated development activities should not exceed the carrying capacity of coastal ecosystems. This is of highly relevant because the carrying capacity of these ecosystems is generally difficult to be expanded by existing (available) technologies. This is particularly true in terms of the limited ability of these ecosystems to provide natural resources (fish and other marine living resources) and to absorb wastes.

Thus, sustainable development of coastal and marine resources can only be attained by bringing the population number (including its associated development activities) and the carrying capacity of coastal and marine ecosystems into balance. In other words, economic development of a certain coastal and marine area can be sustainable only if the total human demand for natural resources and environmental services does not surpass the carrying capacity (functional ability) of such an area to provide them.

Any natural ecosystem, such as a coastal zone, provides four major

functions to the existence of human beings and its economic development: (1) life-support services, (2) amenity services, (3) material inputs (the supplier of natural resources), and (4) waste receptor services (Ortolano, 1984). Life-support services include such things that are necessary for human existence as the provision of clean water and fresh air, hydrological cycle, tidal patterns, nutrient cycle, spawning and nursery grounds for marine biota, and space for living and development activities. Amenity services from the natural ecosystem can be found in the form of surroundings that people find pleasant, attractive and renewing, such as beautiful beaches and coral reefs. The coastal ecosystem can also supply natural resources that are required by human beings for their consumption and production processes, such as fish, mangrove timber, oil and gas, and other minerals. Waste receptor services offered by coastal ecosystems reflect their ability to transform wastes into harmless substances and dilute them.

Accordingly, from ecological perspectives, sustainable coastal resources development requires that five main guidelines should be implemented when conducting the development of a coastal zone: (1) spatial harmony, (2) optimal utilization of natural resources, (3) applications of environmentally-sound marine biotechnology, (4) pollution control, and (5) minimization of adverse environmental impacts.

4.1. Spatial Harmony

Spatial harmony means that coastal space (land and sea) should not be allocated entirely for intensive development activities, but should partly be set aside for conservation and preservation zones. In other words, a coastal zone should be divided into three zones: (1) preservation, (2) conservation, and (3) intensive development (Figure 1).

The preservation zone includes areas that have great natural values, usually due to some unusual or unique ecological attributes. Spawning and nursery grounds of marine fishes, a bird rockery (nesting area) of unusual and beautiful tropical birds, and a grove of exceptional virgin mangroves, for example, may be allocated for the preservation zone. Preservation zones are often extremely fragile and easily destroyed. The only types of alternative uses, which might be compatible in this zone, include scientific research, education, and limited recreation (ecotourism). Recreation activities which involve heavy foot or vehicular traffic may be too destructive to be permitted (Odum, 1976). At least 20% of the total area of a coastal zone should be set aside for the preservation zone. Mangrove green belt as defined by Act No. 24/1992 concerning Spatial Planning is one form of the preservation zone.

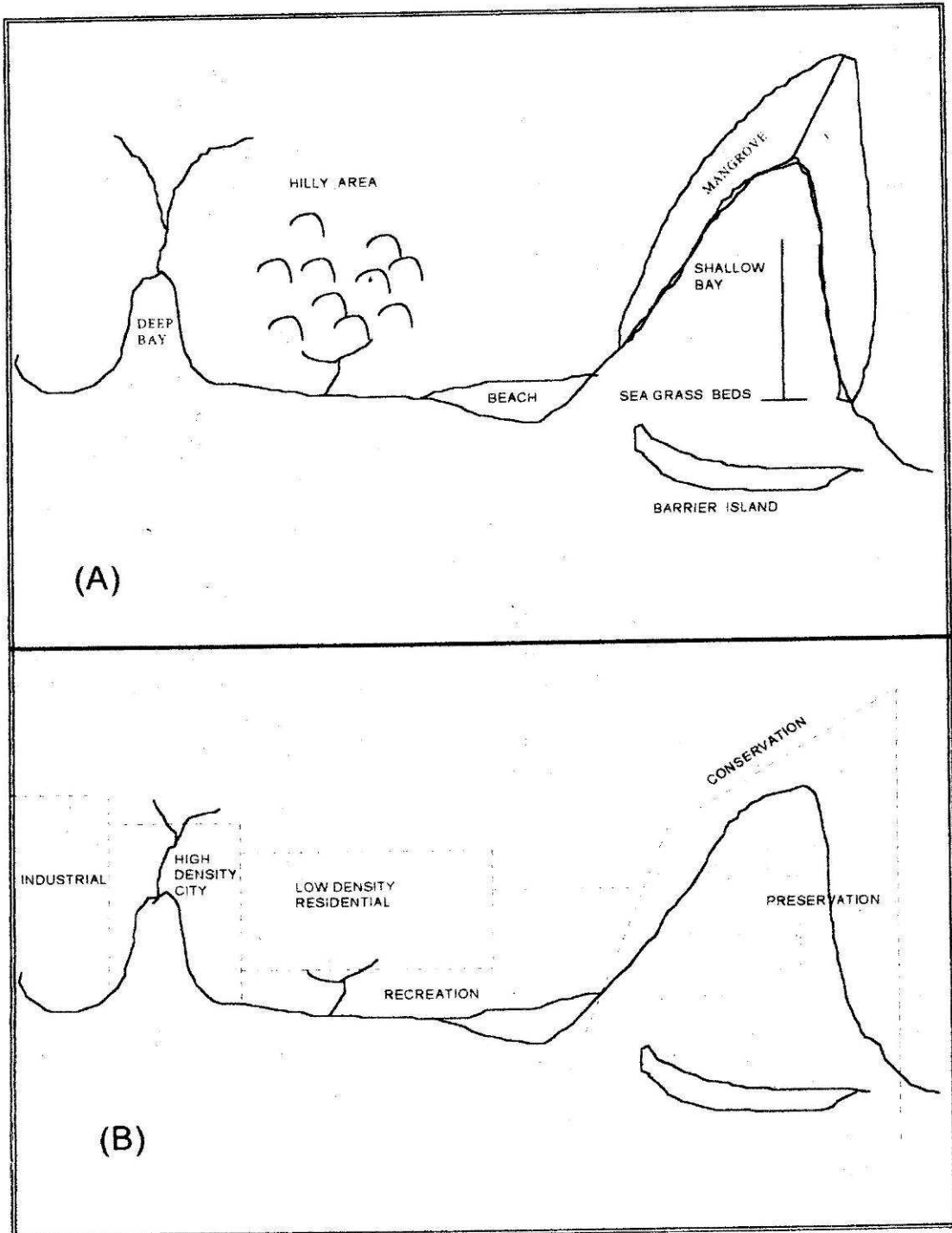


Figure 1. Natural conditions of a coastal zone (A) and its environmental zonations (B) (adapted from Odum, 1976)

The conservation zone, which means a wise utilization of coastal resources, is intended for development activities that are based on the theory of maintaining and utilizing renewable coastal resources. Examples include managed mangrove forestry, hunting, and artisanal fisheries. Other development activities, such as recreation, low-density housing and limited infrastructure constructions may be feasible at specified locations within the conservation zone. About 30% of the total area of a coastal zone should be allocated for the conservation zone.

The intensive development zone may be used for all types of "environmentally destructive development activities", such as refineries, factories, harbors, high-density housing, intensive aquaculture and agriculture. Certainly, not all of these development activities are compatible and sub-divisions within this zone must be made. In certain cases, such as heavy industry, very little can be done to soften the impacts on the coastal environment other than preventing the most destructive influences such as pollution from affecting adjacent areas. In other cases, housing for instance, efforts can be made to retain as much as possible of the natural coastal ecosystems.

Furthermore, a spatial suitability concept can be applied to make subdivision within the intensive development zone. The spatial suitability guidelines basically require that each development activity should be located in an area of the coastal zone which is biophysical (ecologically) suitable for such a development activity. In other words,

the spatial suitability includes integrated information regarding the conditions of the coastal environment including the types, extent (quantity) and distribution of its embodied natural resources which can be used to determine areas of the coastal zone that are suitable for a specific development activity. Any development activity that is located in a biophysical unsuitable area will likely be unsustainable. For example, the development of tambak (brackishwater shrimp/fish ponds) in areas with highly sandy-textured soils or highly acid soils ($\text{pH} < 5$) most likely will be a failure.

In addition, the spatial suitability also implies the need to arrange all development activities within a certain area in such a way that their cross-sectoral impacts are minimized, and their total impacts (in the form of wastes, loss of biodiversity, landscape alterations, etc.) do not exceed the capability of the coastal environment to cope with.

4.2. Optimal Utilization of Natural Resources

When considering the coastal zone as a supplier of natural resources, the sustainability (optimality) criterion for their utilization is that no larger amount of renewable resources (e.g. fish stocks, seaweed, and mangrove stands) be extracted than can be either produced or renewed over the same period of time (Clark, 1985). Meanwhile, the exploitation of non-renewable resources (e.g. oil and gas, tin, bauxite, and other minerals) should be undertaken with great care so that the associated impacts do not

endanger the coastal environment. Another criterion for the extraction of non-renewable resources is, as pointed out by Goodland and Ledec (1987), that such an extraction rate should be kept slow enough so as to allow an orderly societal transition to renewable resources as substitute.

For example, because the utilization level of marine fish stocks is uneven among Indonesia's coastal/marine waters, it is urgent to optimize (rationalize) or balance the utilization level according to sustainable capacity (MSY, Maximum Sustainable Yield) of fish stocks in each coastal/marine water of Indonesia. Muchsin et al (1993) has made estimation on the optimal number of fishermen who can be economically and ecologically supported by marine fisheries resources on a sustainable basis for each Indonesia's coastal/marine water.

4.3. The Application of Environmentally Sound Biotechnology

Optimal utilization of coastal and marine biotechnology also means increasing the efficiency of production and processing of living materials that can be derived from coastal and marine ecosystems so as to increase added values and competitiveness of the products on a sustainable basis.

With the advent and advancement of marine biotechnology, coastal and marine biodiversity provides promising opportunities for sustainable economic development in developing countries including Indonesia. Marine biotechno-

logy is defined as the use of living marine organisms or parts of these organisms, such as cells or enzymes, to make or modify products, to improve valuable traits in plants or animals, or to develop organisms for specific applications, including environmental remediation. Marine biotechnology also encompasses research and development of natural products (bioactive substances) from marine organisms (Lundin and Zilinskas, 1995).

4.4. Pollution Control

When treating a coastal zone as a receptacle of wastes, it must be ensured that all wastes from development activities both within the coastal zone and beyond its boundaries should not exceed its assimilative capacity. In this case, assimilative capacity means the ability of the coastal zone to absorb a certain amount of wastes before there is an unacceptable environmental or health hazards (Krom, 1986). However, for hazardous toxic wastes (B3) they should not be discharged into the coastal environment.

4.5. Minimization of Adverse Environmental Impacts

All development activities (projects) have some impacts on natural ecosystems (coastal zone), whether it is cutting mangrove forests, coral mining, changing river flows, extraction of ground water, intensive aquaculture, mass coastal tourism, and landscape modifications. Sustainable development

of the coastal zone requires that all these environmental impacts should be minimized and not exceeding the tolerable limit of the coastal zone to cope with.

Finally, it should be noted that development of coastal zone should be carried out through an integrated approach right from the planning to implementation stages. At present, planning and development in the coastal zone is often conducted in a sectoral basis, fragmented fashion frequently at great cost to the natural coastal environment. Rational planning and evaluation is therefore needed, through which environmental control can be formulated and implemented.

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