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# SUSTAINABLE DEVELOPMENT OF COMMON PROPERTY: THE CASE OF THE PHILIPPINE MANGROVES

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***ABSTRACT***

This paper highlights the relevance of policy evaluation as a technique for resolving inefficiencies of policies and programs in achieving sustainable development of natural resources, a common property. Evaluation here is based on a multi-disciplinary perspective of sustainable development including the analysis of the interrelationship of socio-economic, ecological and institutional issues relating to the utilization of natural resources, such as mangroves, for human purposes.

The Philippine case study illustrates the application of the Goal Achievement Matrix (GAM) which is used as a framework, within which to review the effectiveness of programs in managing mangrove ecosystems. The evaluation concludes with the general recommendation that Philippine mangrove policies and programs for managing mangroves may be improved by avoiding conflict between policies and programs and fostering community interest in their implementation to achieve a more efficient and more holistic approach to management of mangrove ecosystems.

The study reinforces efforts to implement the concept of sustainable development in natural resource management. Conceptual goals and criteria are developed, which may be used in any tropical country to ensure sustainable development of mangrove ecosystems, and to increase the usefulness of GAM as an evaluation tool in resource management.

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It is hoped that resource managers, researchers, and other concerned individuals will be motivated to undertake program evaluation more effectively in order to achieve sustainable development of natural resources.

*Keywords* *Policy evaluation, resource management, environmental management, coastal management, mangrove ecosystems, sustainable development, common property, Goal Achievement Matrix (GAM).*

## INTRODUCTION

In recent years, natural resource and environmental management efforts have concentrated on the formulation of policies and programs to achieve both social and ecological needs. However, dissatisfaction and complaints have been widespread about the inefficiency of such policies and programs (means) in achieving their intended goals (ends), at times even producing undesirable consequences. Most often, policy inefficiencies have been blamed on the process of making judgements which is largely influenced by individual (e.g. political) or complex organizational (e.g. funding agencies) behavior. Such processes have sometimes led to desirable policies, but most often they lead to undesirable ones. One way to reduce the number of undesirable or inefficient decisions is to develop a more formal approach to policy analysis or evaluation.

The case of the management of mangroves, especially in Asia and the Pacific Region is a typical example to the problem. In the Philippines, for example, policies and programs about mangroves have contributed in most part, to the rapid destruction of the resource (DENR 1990). Mangrove policies and programs has favored short-term economic benefits derived from the resource through the intensive timber exploitation and construction of fishponds. They have neglected the view that mangroves, a common property are composed of complex issues that needs to be considered in planning and decision making about the management of the resource.

This paper illustrates the usefulness of policy evaluation for ensuring the effectiveness of policies and programs in achieving community's goals of conserving and protecting the mangrove resources. Although policy evaluation is not yet a perfected discipline (Quade 1982), it is appropriate for dealing with complicated socio-economic, ecological and institutional problems associated with management of natural resources, like mangroves. It provides decision makers with information through research and analysis, isolating and clarifying issues, revealing inconsistencies in policies and efforts, generating new alternatives and suggesting ways of translating ideas into feasible programs to achieve communities' ends.

The integration of criteria relating to concept of sustainable development provides a challenge in the evaluation of environment and natural resource management policies and programs. As mentioned in Caring for the Earth by the World Conservation Union (IUCN 1991), the World Conservation Strategy (1980) emphasized that:

> conservation includes both protection and rational use of natural resources, and is essential if people are to achieve a life of dignity, and if the welfare of the present and future generations is to be assured... conservation calls for globally coordinated efforts to increase human well-being and halt the destruction of the Earth's capacity to support life (IUCN 1991, p. 1).

The challenge now is to integrate into an evaluation framework any special socio-economic, ecological or management criteria which measure whether or not sustainable development of mangrove ecosystems is being achieved as a result of the implementation of specific management policies and programs about mangroves and the communities which rely on their existence.

Policies and programs about the management of mangroves in the Philippines provide a challenging test case of the proposed policy/decision making technique. Mangrove policies and programs are those courses or plans of actions prescribed by society to influence decisions related to the management of mangroves. Formal policies are embodied in the programs or plans, forestry laws, rules and regulations in mangrove management.

## THE SUSTAINABLE DEVELOPMENT CONCEPT

Sustainable development has become a normative planning concept which should be considered as a fundamental objective of natural resource management policies. Since the Cocoyoc declaration on environment and development in the 1970s, it has served to catalyse debates over the relationship between economic change and the natural resources (Redclift 1987). The sustainable development concept is founded on the conviction that people themselves can alter their behaviour when they see that it will make things better, and can work together when they need to. It is aimed at change because most societies' economies and values need to alter if we are to care for the Earth and build a better quality of life for all, now and in the future (IUCN 1991).

The concept of sustainable development was created from the context of renewable resources, such as forest or fisheries. Literally, sustainable development simply means development that can be continued, either indefinitely or for a certain period of time. However, most proponents of sustainable development have taken it to mean the existence of ecological conditions necessary to support human life at a specified level of well being through future generations. There has been a strong emphasis on ecological sustainability: the biophysical laws or patterns that determine

environmental responses to human activities and a human's ability to use the environment. This initiated the realization that, in addition to or in conjunction with those ecological conditions, there are also social conditions that influence ecological sustainability or unsustainability of the people/nature interaction (Lèlè 1991). Along this line, several definitions of sustainable development (IUCN 1980 & 1991, Repetto 1986, World Commission on Environment and Development (WCED) 1987, Naess 1990, Engel 1990, Redclift 1987, Fri 1991) have evolved.

The definitions of sustainable development, although contrasting with each other, provide a clear understanding of the need to improve the quality of human life and the environment for present and future generations as the main objectives of economic and environmental development. However, as noted by Redclift (1987) and Flaver and Glaeser (1979), the main issues of whose needs are going to be met, who are the participants, and which groups or organizations will be hurt by environmental harmony, remain unresolved. The scepticism of Flaver and Glaeser is still well founded as indicated in recent United Nations Conference on Environment and Development (UNCED), the Earth Summit in Rio de Janiero in June 1992. There is still an immense aversion of governments and international organizations to really achieve sustainable development. Examples include the refusal of the United States to sign the bio-diversity convention, and the remaining control by the World Bank over environmental funds. The vested interest of the 'superpowers' still prevail imposing solutions that maintain their power and standards of living intact (The Editors, Ecologist 1992). The World Bank still retains its control over environmental loans despite noted adverse effects, such as deforestation and environmental degradation in the Philippines and other countries (United Press International 1992).

For sustainable development to become a reality it is necessary that priority is given towards the alleviation of poverty, especially in the poor countries which have been marginalized by international development (Redclift 1987). Development must be directed along the line of each culture, not along a common centralized line (Naess, 1990).

Therefore, in policy formulation or evaluation, it is necessary to understand the interrelationships between all issues, as shown in Figure 1 whatever management priorities or weightings may be given to individual issues.

It is also important at this point to remind ourselves of the principles outlined in the 1991 Strategy for Caring the Earth (IUCN 1991):

- improvement of the quality of life
- conservation of the Earth's vitality and diversity
- utilization within carrying capacity limits

- respect and care for the community of life
- changing personal attitudes and practices
- enabling communities to care for their own environment
- integration of development and conservation
- creating a global alliance

The concept of sustainable development implies drastic changes in the current modes of utilization, production and decision making as they relate to the environment and natural resources. As shown in Figure 2, the principles underlying sustainable development, suggest that sustainable development of natural resources should permanently achieve necessary goals.

These goals are general, providing guidance to anyone using natural resources. They cannot be achieved overnight by the expressions of visions on the part of world leaders, but through a change in attitudes and practices of each individual. Sustainable development requires that humanity work to live harmoniously with the natural world. Obviously, this is more easily said than done since it requires drastic changes in our life style and development process that respect the limits of nature. It requires that development must be achieved, not at the expense of others, but, for a real improvement in the quality of life of all, now and in the future.

## MANGROVE ECOSYSTEMS

The mangroves are self-maintaining and renewable ecosystem wh/ich consist of complex interrelationships of ecological and sociological factors. These factors need to be explicitly considered in policy formulation and evaluation to achieve sustainable development of mangroves.

Mangroves are considered one of the most productive ecosystems in the world. They have been variously described as 'coastal woodland', 'tidal forest', and 'mangrove forest'. They consist of intertidal salt-tolerant flora, dominated by broad-leaved trees with stilt roots or pneumatophores, adventitious roots and viviparous seedlings. They occur in relatively sheltered lagoons, estuaries, and quiet backwaters in the tropical and subtropical coast. When left undisturbed, with mild tidal action and favorable soil conditions, the mangroves extend both inland and towards the sea (Rao 1991). Extensive mangrove areas are established in the estuaries of big rivers and sheltered coastline with great diversity of ecological structure. They range from vast areas covering hundreds of hectares with high species diversity, to an isolated tree clinging to coral reefs, to mangroves which have been managed by man (Hellier 1988).

Like tropical rainforest, mangroves have various functions and uses, namely: economic, ecological, recreation/scientific (Table 1). They have played a significant role in the economies of tropical countries for a long time. Mangrove trees provide direct economic uses, such as timber for construction and paper production, poles for fishing, charcoal for fuel, tanbark for textile and leather production, food, drugs and beverages, and as a fishery resource (Saenger, et. al 1983; PCARRD 1987).

Mangroves also serve as breeding, nursery and feeding grounds for commercially harvested fish, shrimps and shellfish and other marine organisms. The early stages of some fishes, shell-fish and other marine organisms are spent in the mangroves. The extensive prop roots and pneumatophore system of mangrove vegetation serve as an excellent sanctuary from predators. The detrital food chains that support fisheries production are fuelled by the food generating activities of mangroves (Helier 1988).

In some places like Florida in the US, the primary benefits or services are derived from the mangroves ecological role (Helier 1988). Research (Hellier 1988; Mercer and Hamilton 1984; Macintosh 1983) indicates that besides the productivity and valuable use of mangroves for various purposes, they also serve as a crucial coastal stabilizer. In Florida, mangroves provide some degree of protection to local people, preventing loss of life and damage to property and public utility structures further inland areas. Mangroves also assist in natural reclamation. They trap sediment, litter, debris and other decomposed foreign materials along the shoreline and mangrove edges. This process of soil accretion increases the gradient and extent of the land (Macintosh 1983).

Mangroves also possess a rich genetic diversity, necessary for the development of salt-tolerant plant species both for the immediate purpose of protecting coastal areas and for meeting long-term needs for suitable donors of genes for sea water tolerance. Recent development in bio-technology research, for example, has made it possible to isolate mangrove species genetic material conferring tolerance to sea water intrusion and transfer them into other plants growing near coastal areas (Swaminathan 1991).

In addition, mangroves likewise possess a variety of sub-habitats in which natural and aesthetic values offer a range of recreational opportunities. The bird life, for example, provides valuable opportunities for tourism, education and scientific study. While it is difficult to put monetary value on these wildlife based-activities, they are nonetheless significant uses which add to the importance of the mangroves (Saenger, et. al. 1983).

Mangroves are being destroyed intentionally by poor people, or as a secondary result of other activities. In research made on the global destruction of the resource (Saenger, et. al. 1983), the causes of mangrove destruction can be further subdivided by the scale of impacts encountered with destructive uses as seen in Table 2.

The table implies that repeated or simultaneous action in a region increases the total impact. For example, one traditional exploiter is significant, however, 10,000 exploiters focusing on one area would have an even more significant impact. Furthermore, a combination of actions imposed on a local area would have an accumulative impact on the total mangrove ecosystem (Saenger, et. al. 1983).

Some of the major causes of destruction of mangroves considered are:

- forest exploitation
- conversion to agriculture and aquaculture
- salt pond construction
- diversion of fresh water
- mining/mineral extraction
- coastal development

## ECOLOGICAL IMPLICATIONS OF MANGROVE DESTRUCTION

A literature review of the ecology of the mangrove ecosystems implies several issues that should be considered in policy formulation and analysis. First is the fragility and uniqueness of the mangrove ecosystem. Unlike the terrestial rainforest, they only occur in the coastal areas either in abundance or in bands of trees, and are vulnerable to the adverse impact of several environmental factors. They have evolved in environments subject to great change and dynamism and as a result they have developed adaptations that allow rapid colonization and maximal resource use in relatively ephemeral environments. This selection process has led to the development of a resilient and highly malleable ecosystem. Their resilience is expressed in the rapid recovery of the vegetative cover after a disturbance, given that site conditions remain unaltered (Novelli, et.al. 1991). It is this resilience that allows their management through the concept of sustain yield management.

Secondly, the species distribution, as shown in Table 3 indicates that mangrove species are not widely distributed. Most of them occur only in Asia, where a large number of the impoverished population have been dependent on them for survival. This rarity of mangrove tree species

therefore implies the necessity of protecting them in a particular area where they have established themselves.

Thirdly, mangroves are one of the most productive ecosystems in the world and so need to be protected and conserved. They possess a rich genetic diversity, including tolerance to sea water intrusion. Thus, the conservation of mangrove species and other coastal plant material is important both for the immediate purpose of protecting coastal areas from the adverse impact of storms and cyclones, and for meeting the long term need for suitable donors for sea water tolerance (Swaminathan 1991).

Fourthly, the productivity of the mangrove forest is largely controlled by physical factors and biological processes. The former includes rivers, tides and terrestial run-off. The biological processes comprise leaf fall, decomposition, mineral uptake and cycling, and faunal activities. For example, in a mangrove forest, leaf fall makes up a large percentage of the detrital material which serves as energy budgets of fisheries within the mangroves and offshore.

The fifth issue is the relevance of the mangrove forest as the last frontier in our defense against the adverse consequences of sea level. The predicted change in temperature of 2°C per decade and a sea level rise of 40 centimeters by 2090, at the Second World Conference held in Geneva in 1990 (Swaminathan 1991), seems alarming and it will be a tragedy if we lose this defence. Thus, it is necessary that a considerable extent of mangrove forest will be maintained along coastal areas to serve as a barrier to the impacts of climatic and environmental changes.

Lastly, mangroves must be protected as a nursery and feeding ground for fish species to maintain the sustainability of fish catches offshore and within the mangroves. The mangrove species composition and structure has to be maintained in order to sustain the continuous production of detritus particles necessary for the survival of the aquatic organisms that use the mangrove areas for their early development.

## SOCIOLOGICAL IMPLICATIONS OF MANGROVE DESTRUCTION

Mangroves are inhabited by about 25 million impoverished people in Southeast Asia, relying on the mangrove forest, fisheries, aquaculture and allied industries (Leekpai 1991). Thus, the sociological implications of the mangrove ecosystem that need to be considered in the formulation and implementation of mangrove policies and programs are: Firstly, because of poverty, mangrove resources have been continually depleted making life more miserable for those dependent on the

resource. Mangrove development policies need to understand poverty problems because it has grown as one of the main causes of mangrove destruction.

Secondly, there is an inequitable utilization of mangrove resources that needs to be considered in order to promote sustainable utilization of the resource. Policies about the management of mangroves should recognize traditional communities or users of a particular mangrove area. They should encourage local utilization of mangrove resources by reducing or eliminating commercial exploitation.

Lastly, formulation of policies and programs about the management of mangroves should recognize existing socio-cultural factors within a particular mangrove area. The people who are directly dependent on the resource should be involved in deciding what is best for them.

## MANAGEMENT IMPLICATIONS OF MANGROVE DESTRUCTION

Mangroves are being managed with conflicting views or interests. Apparently, they have been viewed as an economic resource that needs to be utilized, with limited consideration of their ecological importance. As such is the case, value reorientation is required both from the government and the people to consider the interrelationships of economic and ecological uses of mangrove forests.

## GOALS FOR MANGROVE SUSTAINABLE DEVELOPMENT

A combined set of management goals for sustainable development of mangrove ecosystems which integrates general sustainable development goals from the 1991 Strategy (IUCN 1991) and the ecological and sociological implications of managing mangrove ecosystems is shown in Figure 3.

## CRITERIA FOR EVALUATING MANGROVE POLICIES AND PROGRAMS

The criteria for sustainable mangrove development in evaluating mangrove programs are presented in Table 4. They are considered to be general criteria providing sociological, ecological and management implications of program impacts. However, they may also be effective in anticipating weaknesses and strengths of programs in achieving sustainable mangrove development and may be applied in the framework provided by the Goal Achievement Matrix methodology.

## GOAL ACHIEVEMENT MATRIX

The Goal Achievement Matrix developed by Hill (1968), in an urban planning context, is an analytical technique that attempts to determine the extent to which alternative plans or policies achieved predetermined development goals or criteria (Hill 1968). GAM provides the relative ranking of each alternative policy considered, and the extent to which development criteria are fulfilled (Patton 1986). To achieve this, each policy alternative is designated with accounts to measure the degree to which it achieves a particular development criterion, and its overall performance in relation to the development criteria.

To illustrate, Table 5 shows an example of a Goal Achievement Matrix.

## APPLICATION OF GAM IN MANGROVE PROGRAM EVALUATION

Mangrove policies and programs of the Philippines will be evaluated in terms of their prospective success in achieving the integrated goals of sustainable mangrove development identified in Figure 3.

Qualitative impact indicators are used as measures to determine the programs' prospected impacts or expected output in achieving or satisfying the goals of mangrove sustainable development. Qualitatively, they may represent the expected impacts, or intentions, commitment and effort of a particular program in achieving or satisfying a particular development goal. The more they satisfy the goals or criteria of sustainable development, the more they are considered sustainable or efficient.

A particular program could be said to highly satisfy a particular goal or criterion if its impact would ensure an adequate benefit for the program beneficiary or a particular situation that could be sustained for a long period of time. It may be considered to be moderately satisfying a particular goal or criterion, if the program provides an adequate benefit but cannot be sustained for a long period of time. It is fairly satisfying a particular goal or criterion, if the program impact or benefits are enough and are only for the meantime. A program may be considered negative if its implementation does not cause any benefit to the beneficiaries and would only aggravate a particular situation.

Weightings are also assumed to the criteria in order to reflect their relative importance in terms of achievement of sustainable development of mangroves. Ideally, weightings are determined through a survey of the people concerned and the decision makers' perception of each of the goals

identified. In this paper, however, the weightings are assumed on each of the goals, based on the prevailing mangrove management situation in the Philippines, and the implementation of the concept of sustainable development.

## DISCUSSION

The mangrove policies/programs being administered by the Philippines in the management of the country's mangrove resources considered in the evaluation are the Integrated Social Forestry Program (ISFP), Fisheries Sector Program with the issuance of stewardship agreement to local communities (FSP), National Forestation Program with the application of Forest Lease Management Agreement (NFP/FLMA) and Community Forestation Program (CFP).

Results of GAM Evaluation, summarized in Table 6, disclosed that FSP and ISFP appeared to be the most sustainable or effective programs for sustainable mangrove development. Evaluation of NFP/FLMA and CFP, on the other hand, disclosed their unsustainability or inefficiency in achieving the goals of sustainable mangrove development.

The mangrove programs of the Philippine government generally indicate a disintegrated approach in the management of the country's mangrove areas. As summarized below, they have the common goal of solving the problems of poverty and mangrove degradation in the coastal areas, but with different approaches. Different types of changes to each program are necessary to ensure that it plays an appropriate role and is coordinated adequately at various levels of government:

ISFP - is a community-based self-help development program that promotes the welfare of the people and the development of the mangrove areas through the people's initiative. In the evaluation, ISFP is considered sustainable for management of mangroves. However, the program being a self-help project requires commitment, not only from the individual participants, but also from the government agencies responsible for mangrove management;

FSP - is a capital-intensive and community-based development program to promote sustainable development of mangroves in order to sustain basic human needs. A short-term program like this needs to be considered under the principles of the ISFP. Like ISFP, it requires strong commitment from its participants and the government, in order to achieve its goals sustainable mangrove development;

NFP and FLMA - is a capital and resource-intensive program that also promotes the welfare of the people and the development of mangroves through the profits derived from the resource. Such

programs need to prioritize the coastal communities in the issuance of the forest lease management agreement (FLMA). As much as possible, the corporate scheme of management should be eliminated. Programs in the management of mangroves should not be considered as an economic ventures, but as programs promoting the welfare of coastal communities and the conservation and protection of mangroves' vitality and integrity. The program likewise needs the reorientation of its institutional objectives, such as the development of more responsible and long-term partners in sustainable mangrove development;

CFP - is a resource-intensive and community-based development program that promotes the welfare of the people and the development of mangroves from profits derived from the resource. Such a program needs to recognize the peculiarities and limitations of mangroves, in order to promote its sustainability. It may not be feasible to treat the mangrove resource as the ultimate source of funding to enable reforestation of the other degraded areas. In essence, like the FSP and ISFP, it requires government support or capital to initially provide a better environment for the coastal inhabitants, and consequently sustainable development of mangroves.

The diversity of programs being implemented may not necessarily provide an effective approach in the sustainable development of mangroves. Maintaining many programs may be more expensive than having one program which encompasses all the goals of sustainable mangrove development.

Considering the discussions above and the result of GAM evaluation, it is therefore recommended that all mangrove policies and programs need to be combined to create a single program, or group of integrated programs which would achieve the goals of sustainable mangrove development.

## CONCLUSIONS

The following are specific recommendations, that may be considered in developing a sustainable mangrove development program of the country, along with the general recommendations discussed above.

### Socio-economic

- mangrove policies and programs, therefore, need to deal with the grinding issue of poverty in coastal areas, at the same time with the conservation and protection of mangroves.
- coastal inhabitants also need to be prioritized in the implementation of development programs, in order to limit the influx of more people into the mangrove areas. The issuance of stewardship agreements, for example, need to prioritize coastal communities who are directly dependent on the resource for survival.

- production sharing or joint-venture programs should be promoted as laudable management schemes. However, long-term economic and ecological viability should be considered in such promotions. Community-based programs promoting localized utilization may be more viable.

**Ecological**

- the utilization of mangrove resources should be limited to fulfil local needs, or should be based on the sustainable limits of a particular mangrove area. They should not be treated as the ultimate source of funds needed in reforesting other denuded mangrove areas.
- to maintain mangrove vitality and integrity, goals of mangrove rehabilitation and reforestation activities should not be limited to area expansion, but also include the maintenance of mangrove stability through the planting of indigenous and diverse species.

**Institutional**

- mangrove programs directed to both alleviating poverty and protection of the resource requires critical government support. Management efforts should first be directed towards winning the hearts of coastal communities, in order to generate acceptance and support towards a particular program. It should be emphasized that sustainable mangrove development can only achieved through collective and sustained efforts by the government and the people concerned.
- mangrove policies and programs should also be based on a comprehensive approach, with long-term goal of providing the needs of present and future generations. They need to consider both the achievement of better life for coastal communities and the integrity and vitality of mangroves.
- it should be stressed that sustainable obligation on governments to conserve and protect coastal resources, such as mangroves on which, people depend for survival.
- lastly, achieving sustainable development of mangrove requires good links from each of the concerned agencies, and their commitment to support and implement a combined program.

Thus, in the management of mangrove resources of the Philippines, it is imperative that any evaluation of policies and programs needs to include an examination of how these issues relate to each other, and how they will affect the resolution of each other. This also needs to be considered through policy and program formulation and during the course of implementing a particular policy or program.

Policy analysis and evaluation, as mentioned in the introduction of this study, needs an empirical examination of the impacts of policies and programs. It also requires integration about quantitative and qualitative information approaches, problems from various perspectives, and the use of appropriate methods to test the feasibility of different program options.

With the potential of policy or program evaluation in natural resource management realized in the study, it is hoped that resource managers, researchers, and other concerned individuals are motivated to undertake program evaluation in order to achieve sustainable development of natural resources, such as mangroves, in other countries.

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## FIGURES

**Figure 1 Sustainable Development Process**

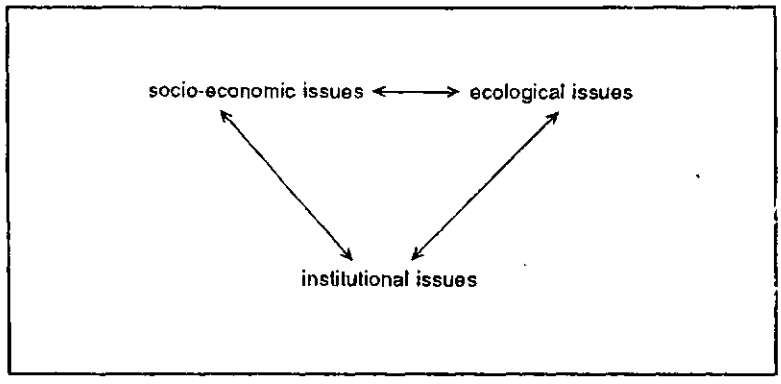



**Figure 2 General Goals for Sustainable Development of Natural Resources**

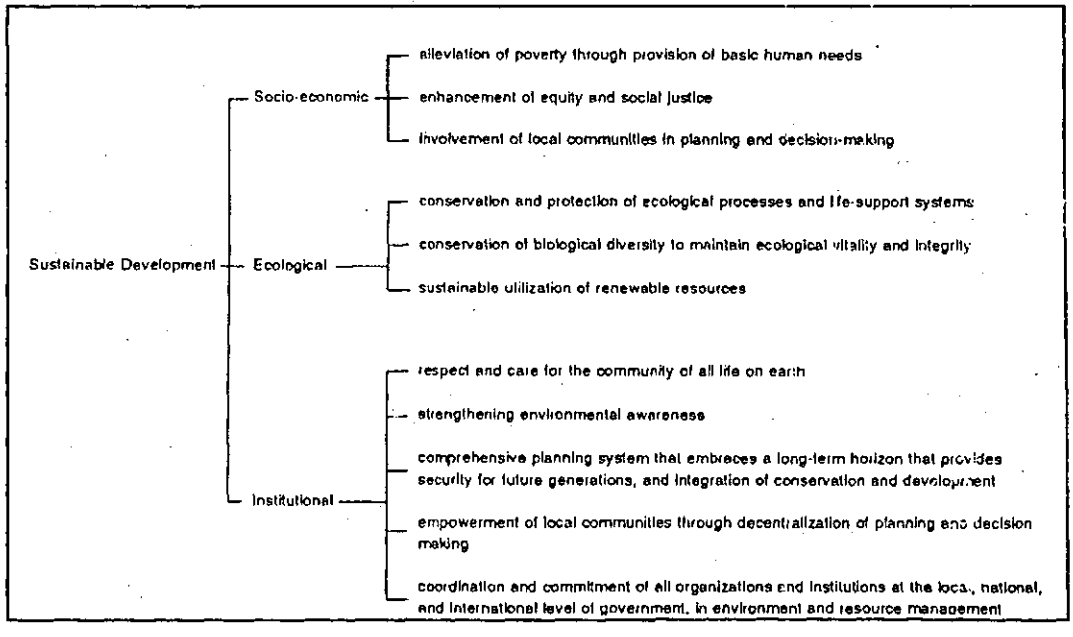
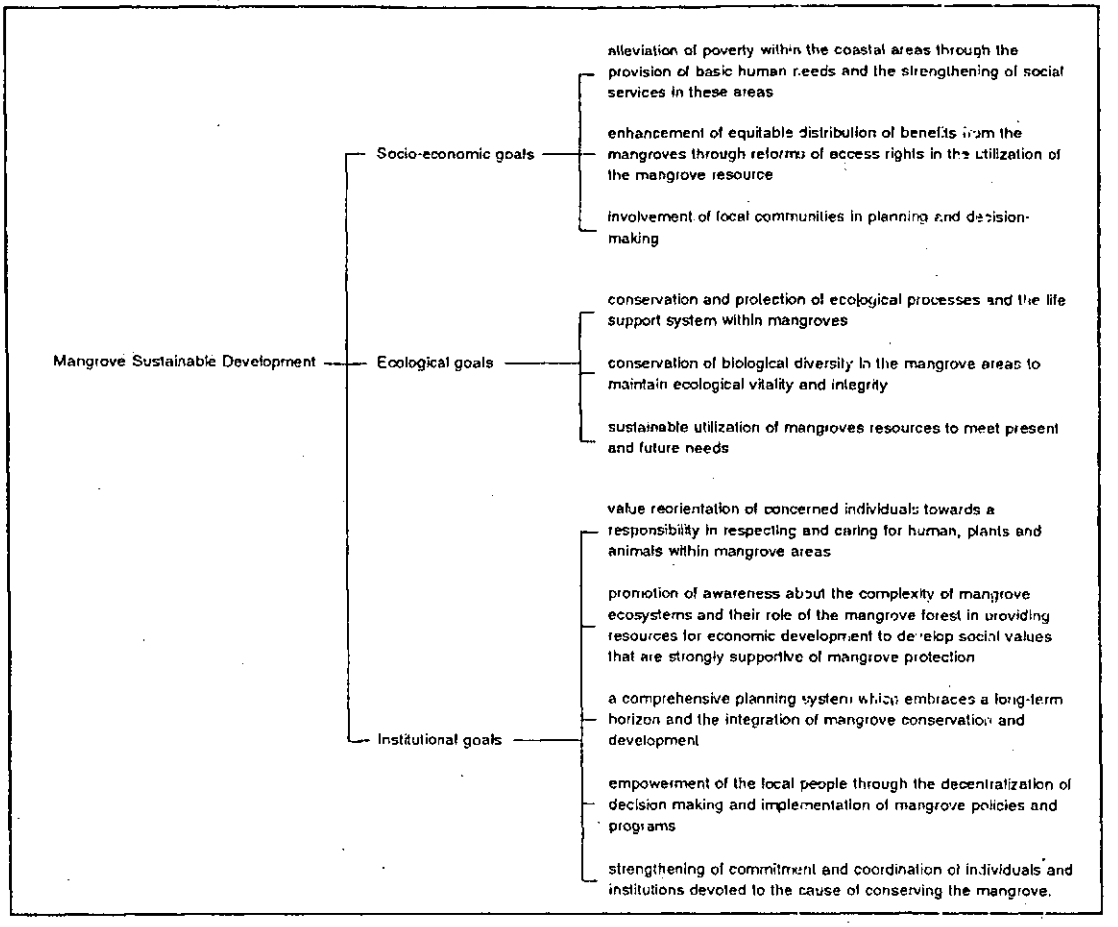


**Figure 3 Management Goals for Mangrove Sustainable Development**



## TABLES

**Table 1 Mangrove functions and uses**

| Economic | Ecological (for human use) | Recreational/ Scientific |
|---|---|---|
| timber for construction and paper production | coastal protection | tourism |
| pole for fishing | land builder | education |
| fuel wood/charcoal | nursery/feeding ground for fish | scientific research |
| tannin for textile and leather production | source of genetic material necessary for developing salt-tolerant plant species | |
| source of food, drugs, beverages | | |
| fishery resource | | |

**Table 2 Scale of Land Use Impacts within the Mangroves**

| ACTIVITY | SCALE OF IMPACT IN HECTARES |
|---|---|
| Clear felling | 10,000 - 500,000 |
| Diversion of fresh water | 1,000 - 500,000 |
| Conversion to agriculture | 100 - 100,000 |
| Conversion to aquaculture | 100 - 10,000 |
| Conversion to urban development | 100 - 1,000 |
| Conversion to salt ponds | 100 - 100 |
| Mining and mineral extraction | 10 - 100 |
| Waste disposal (liquid and solid) | 1 - 10 |
| Exploitative traditional use | 1 |

Source: Saenger, et. al. (1983).

**Table 3 World distribution of trees and shrubs associated with the Mangroves**

| Exclusive species | Life Form | Distribution | Non-exclusive species | Life Form | Distribution |
|---|---|---|---|---|---|
| *Acanthus embracteatus* | s | 1,2 | *Acrostichum aureum* | f | 1,2,3,4,5,6 |
| *A. ilicifolius* | s | 1,2 | *A. danaefolium* | f | 3,4 |
| *A. volubilis* | s | 1 | *A. speciosum* | f | 1,2,6 |
| *Aegialitis annulata* | s | 2 | *Barringtonia racemosa* | t | 1,2,6 |
| *A. rotundifolia* | s | 1 | *Brownlowia argentata* | t | 1,2 |
| *Aegiceras corniculatum* | s | 1,2 | *B. tersa* | s/t | 1 |
| *Avicennia alba* | t | 1,2 | *Cerbera floribunda* | t | 1,2 |
| *A. bicolor* | t | 3 | *C. manghas* | t | 1,2 |
| *A. eucalyptifolia* | t | 2 | *Clerodendrum inerme* | s | 1,2 |
| *A. germinans* | t | 3,4,5 | *Cynometra mannii* | t | 5 |
| *A. integemedia* | t | 1 | *Dimorphandra oleifera* | t | 4 |
| *A. lanata* | t | 1 | *Dalichandrone spathacea* | t | 1,2 |
| *A. marina* | t | 1,2,6 | *Hibiscus hamabo* | t | 1 |
| *A. officinalis* | t | 1,2 | *H. tiliaceus* | t | 1,2,3,4,5,6 |
| *A. rumphiana* | t | 2 | *Mauritia flexuosa* | p | 3,4 |
| *A. tomentosa* | t | 4 | *Maytenus emaginata* | s | 2 |
| *A. tonduzii* | t | 3 | *Myristica hollrungii* | t | 2 |
| *Bruguiera cylindrica* | t | 1,2 | *Oncosperma filamentosa* | p | 1 |
| *B. exaristata* | t | 2 | *Pemphis acidula* | s/t | 1,2,6 |
| *B. gymnorhiza* | t | 1,2,6 | *Pterocarpus officinalis* | t | 4 |
| *B. hainesii* | t | 1,2 | *Thespesia acutiloba* | t | 6 |
| *B. parviflora* | t | 1,2 | *T. populnea* | t | 1,2,4,5,6 |
| *B. sexangula* | t | 1,2 | *T. populneoides* | t | 2 |
| *Composternon philippinensis* | t | 1 | | | |
| *C. schultzii* | t | 1,2 | | | |
| *Ceriops decandra* | t | 1,2 | | | |
| *C. tagal* | t | 1,2,6 | | | |
| *Conocarpus erectus* | t | 4,5 | | | |
| *Cynometra iripa* | t | 1,2 | | | |
| *C. ramiflora* | t | 1 | | | |
| *Exoecaria agallocha* | t | 1,2 | | | |
| *Heritiera littoralis* | t | 1,2,6 | | | |
| *H. fomes* | t | 1 | | | |
| *Kandelia candel* | t | 1 | | | |
| *Laguncularia racemosa* | t | 3,4,5 | | | |
| *Lumnitzera littorea* | s/t | 1,2 | | | |
| *L. racemosa* | s/t | 1,2,6 | | | |
| *Nypa fruticans* | p | 1,2,5 | | | |
| *Osbornia octodonta* | s | 1,2 | | | |
| *Pelliciera rhizophorae* | t | 3 | | | |
| *Phoenix paludosa* | p | 1 | | | |
| *Rhizophora apiculata* | t | 1,2 | | | |
| *R. harrisonii* | t | 3,4,5 | | | |
| *R. x lamarckii* | t | 2 | | | |
| *R. mangle* | t | 2,3,4,5 | | | |
| *R. mucronata* | t | 1,2,6 | | | |
| *R. racemosa* | t | 4,5 | | | |
| *R. x selala* | t | 2 | | | |
| *R. stylosa* | s | 1,2 | | | |
| *Scyphiphora hydrophyllacea* | t | 1,2 | | | |
| *Sonneratia alba* | t | 1,2,6 | | | |
| *S. apetala* | t | 1 | | | |
| *S. caseolaris* | t | 1,2 | | | |
| *S. griffithii* | t | 1 | | | |
| *S. ovata* | t | 1,2 | | | |
| *Xylocarpus australasicus* | t | 1,2 | | | |
| *X. gangeticus* | t | 1 | | | |
| *X. granatum* | t | 1,2,6 | | | |
| *X. moluccensis* | t | 1,2,6 | | | |
| *X. parviflorus* | t | 1 | | | |

Legend: S - shrub, T - tree, P - palm, F - fern. Geographical zones used to describe distribution of mangrove forest: 1, Asia; 2, Oceania; 3, West Coast of the Americas; 4, East Coast of the Americas; 5, West Coast of Africa; 6, East Coast of Africa and the Middle East. Source: Saenger, et. al., (1983).

**Table 4 Goals and criteria for sustainable mangrove development**

| DEVELOPMENT PERSPECTIVE | GOALS | CRITERIA |
|---|---|---|
| Socio-economic | Alleviation of poverty | Increased income earning opportunity and social services (e.g. education, health, etc.) |
| | Equity and justice in resource use | reformed access rights or security of tenure in resource use (e.g issuance of stewardship contract) |
| | Local participation in planning and decision making | Increased involvement of local people in planning and decision making |
| Ecological | maintenance of mangrove ecological processes and life support system | maintenance of extensive mangrove area and structural pattern (e.g. sustainable utilization of the estuarine, basin and dwarf mangrove forest; protection of fringe mangrove forest or strips of vegetation near the coast, and areas which are susceptible to storms and are considered relevant in protecting marine species; and, rehabilitation or reforestation of already degraded areas) |
| | conservation of mangrove diversity | maintenance of diversity and species composition (e.g. absolute preservation, sustainable utilization or replacement of indigenous mangrove tree species) |
| | sustainable utilization of the mangroves | maintenance of organic matter and sediment accretion (e.g. sustainable utilization of mangroves, reforestation of denuded portions, and limitation of destructive land uses which disrupt mangroves ecological processes and life-support system) |
| | | maintenance of mangrove community organization and species composition (e.g. presence of uneven-aged mangrove forest trees) |
| Institutional | Respect and care for the community of life | increased individuals' inclination in caring and protecting human, plants and animals |
| | Environmental awareness | increased individuals' perception on the importance of mangroves |
| | Comprehensive planning system | increased recognition of basic human needs and ecological needs in planning |
| | Administrative decentralization | devolution of mangrove management responsibility to coastal communities |
| | Integrated mangrove management | increased coordination and commitment of concerned individuals and agencies in mangrove development |

**Table 5 The Goals Achievement Matrix**

| Development Criteria → | Weights ↓ | Socio-Economic | Ecological | Institutional |
|---|---|---|---|---|
| Weights → | | wa | wb | ... |
| Resource Users ↓ | | | | |
| | w1 | IS1 = eixwaxw1 | ... | ... |
| | w2 | IS2 = eixwaxw2 | ... | ... |
| | w3 | ... | ... | ... |
| | ... | ... | ... | ... |
| Goal Achievement Score (GAS) | | GASa = IS1 + IS2 + ... | GASb | GASc |
| % Goal Achievement (%GA) | | GASa/PGS | GASb/PGS | GASc/PGS |
| Goal Achievement Score Based on Weight (GASW) | | %GAaxwa | %GAbxwb | %GAcxwc |
| Program Sustainability Score (PS) | | %GAa + %GAb + %GAc | | |
| % Sustainability | | PS/PGSW | | |

where:

wa, wb, ... = relative weights of each development criterion

w1, w2, ... = relative weights of each resource user group

ei = the estimated impact of certain programs to each development criterion and interest group

IS = reflect the extent of impact of a certain policy to each development criterion and by a particular resource user group (high score = high achievement)

GAS = reflect the extent of impact each program alternative to each category of development criterion and by the resource user groups (high score high achievement)

%GA = reflects the ratio of the goal achievement scores to the perfect goal score that may be achieved in a particular criterion

PGS = the perfect goals score that may be achieved in a particular criterion

GASW = reflects the goal achievement score based on the weightings assumed for a particular development criterion

PS = reflects the overall goal achievement score of particular program based on weightings

PGSW = reflects the perfect goal score based on weightings

% Sustainability = reflects the ratio of the program score to the perfect goal score based on the weightings. It provides an indicator on how a particular program achieves the goals for sustainable mangrove development. The higher the ratio is, the more a particular program is sustainable.

**Table 6 Result of the GAM Evaluation**

| Mangrove Policies/Programs → | ISFP | FSP | NFP | CFP |
|---|---|---|---|---|
| Sustainability Goals/Criteria ↓ | | | | |
| increased income opportunity and basic services | 100 | 100 | 66.3 | 50 |
| reformed access rights/security of tenure | 100 | 100 | 83.3 | 100 |
| increased involvement of local people planning/decision making | 100 | 100 | 83.3 | 100 |
| maintenance of extensive mangrove area and structural pattern | 100 | 100 | 22.2 | 33.3 |
| maintenance of diversity and species composition | 100 | 100 | 22.2 | 33.2 |
| maintenance of organic matter and sediment accretion | 100 | 100 | 22.2 | 33.3 |
| maintenance of mangrove community organization and species composition | 100 | 100 | 22.2 | 33.3 |
| increased individuals' inclination for caring human and other living things | 100 | 100 | -33.3 | 11.1 |
| increased individuals' perception on mangrove importance | 100 | 100 | -33.3 | 100 |
| confronting both basic human needs and ecological needs in planning and decision making | 55.6 | 77.8 | -33.3 | 11.1 |
| devolution of mangrove management responsibilities to local communities | 55.6 | 77.8 | 44.4 | 55.6 |
| increased commitment and coordination in mangrove management | 100 | 100 | 44.4 | 66.7 |
| % Sustainability | 92.6 | 96.3 | 24.8 | 52.3 |
| Ranking | 2nd | 1st | 4th | 3rd |