Proc. As. Symp. Mangr. Env. - Res. & Manag., 1984: 5-15

THE MANGROVES OF ASIA AND OCEANIA : STATUS AND RESEARCH PLANNING

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INTRODUCTION

Two phenomena have been, and are, independently developing which create a serious conflict relative to management, utilization and conservation of lowland coastal mangroves and mangrove lands. One of these phenomena is the relatively recent scientific appreciation of the value of mangroves for the fisheries they support, the forest products they yield and the role they play in the stability of the coastal zone. The second phenomenon is the increasing exploitation pressures and environmental disruption which simultaneously decreases the availability and value of all resources associated with mangrove forests. The conflict is accentuated by the fact that mangrove resources are limited and the causes of their loss seldom have significant long-term economic value justifying the loss. In fact, most are the result of narrow and nearsighted planning, and an ignorance of the value of mangroves on the part of those who make policy decisions relating to natural resources. To reduce the negative consequences of this conflict, more and better quality information is required concerning mangrove resources and the alternatives for their management and perpetuation. In that regard, the objective of this paper is to give a summary of the status of mangroves in Asia and Oceania and outline a three-part research recommendation plan for acquiring and using data and information requisite to the management of mangrove resources for sustained yield and maximization of value.

MANGROVE INVENTORY

Existing Information

It is only recently that attempts have been made to estimate the world area indentified as mangrove land and mangrove forests, due in part to the worldwide interest and concern for the loss of tropical forests (see Myers, 1980). Rodin, Bazilevich and Rozov (1975) calculated the potential mangrove land area in the world using correlations between

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mangrove dominance and soil type. Based on soil-type maps they estimated the potential world area in mangroves to be 47,800,000 ha of which almost one-half is located within Asia and Oceania, and the remainder distributed between Africa and the western hemisphere tropics. The actual area in mangrove forest is much smaller due both to natural constraints on mangrove growth and the progressive conversion of mangrove forest land to other uses. Based on the various estimates provided in the literature, a conservative or minimum estimate of mangrove forest area has been prepared for Asia and Oceania (Table 1). The SCOR/UNESCO Working Group 60 on Mangrove Ecology is presently working to fill the gaps in the literature and prepare an accurate world inventory of the land area dominated by mangroves.

In addition to a knowledge of mangrove area and in some instances maps of coastal vegetation, other types and kinds of data are available for parts of the region. These are as extensive and detailed as forest management working plans (e.g., Bangladesh, Malaysia, Pakistan) and as specialised and local as inventories and wood volume estimates for specific forested area. In general, most of the detailed inventory work has been done in conjunction with forest management objectives, and usually contain very little information on the other resources and values of a mangrove forest. Concerning the region as a whole, there is probably more information on mangroves and the mangrove environment than for any other region in the world. However, for many of the specific mangrove areas within the countries, parts of the total coverage of information and data may be lacking.

Required Information

It is apparent from Table 1 that a relatively complete land area inventory of mangroves is available for much of Asia and Oceania, and for many countries there exists a supporting knowledge of the species composition, general forest characteristics and other key types of information. This provides a necessary first step and an adequate basis for acquiring and synthesizing additional data for the preparation of a quantitative resource inventory. For the purpose of this paper, a quantitative resource inventory is defined to include:

(1) Resource inventory or base maps of existing forest cover, and plant and animal life, both in the intertidal zone and in the nearshore environment. Such maps can be patterned after vegetation, community or life zone maps, and prepared at a scale which allows them to be used for other mapping purposes. The mangrove areas of New Zealand, for example, have been mapped on this basis.

(2) Quantitative inventory maps showing such parameters as forest height, basal area and age structure, species abundance and densities, topographic relief, tidal or flooding frequency, and productivity for such information to be maintained in tabular report form and indexed or keyed to the appropriate base map.

(3) Economic-use maps showing the kind and extent of existing human uses and the variety of potential economic uses based on national development policies.

These kinds of maps and the associated and supporting data are requisites for management of all resources in the coastal zone and could become the bases for a national coastal resource atlas. This type of thematic mapping has been initiated in the Philippines using Landsat satellite imagery and has already proved to be of use in policy decision making.

HABITAT REQUIREMENTS

Although each country in the region can claim extensive areas in mangrove land and forests (Table 1), the areas are small relative to the total land areas in each country. Furthermore, there are a variety of exploitation pressures being exerted on the mangroves which serve to reduce both the area and the value of remaining resources. It is thus important that a full understanding be developed concerning how direct and indirect actions affect the existing and future resource values of the mangrove forest and contiguous environments.

The overall status of mangroves and the mangrove environment within Asia and Oceania ranges from stable, but threatened, to rapid deterioration or disappearing. In general, the primary reasons are economic and related to the development of national resources. The actual causes resulting from economic decisions, however, are direct and observable and in other instances, indirect and insidious. Some of the direct actions include: commercial clear-felling (e.g. Indonesia), charcoal production (e.g. Thailand), subsistence exploitation (e.g. India), conversion to pond culture (e.g. Philippines and Indonesia), conversion to agriculture (e.g. Burma), urban or industrial development (e.g. Australia and Singapore), and use of garbage dumps (e.g. some places in New Zealand). Indirect causes of deterioration include: diversion of freshwater (e.g. Bangladesh, India and Pakistan), nearshore mining (e.g. Malaysia and Thailand), oil pollution (e.g. the Malacca Straits), industrial pollution (e.g. Malaysia and Singapore) and man-accelerated erosion and/or siltation (localized throughout the region). In some instances a thorough knowledge of the habitat requirements of the mangrove community could be utilized to minimize the impacts of these actions, and in the majority of instances the same knowledge can be applied to reclamation and recovery of the mangrove community.

For the mangrove community as a whole, the habitat requirements are extraordinarily simple and can be translated into equally simple rules:

(1) Do not alter the timing and quantity of freshwater runoff entering the mangrove community and its contiguous estuary.

(2) Do not alter the tidal inundation frequencies or otherwise alter the surface circulation pattern of water.

(3) Do not alter the physical structure, chemical properties, biological activity, or elevation, relative to mean sea level, of the sediment substrate.

At the community, or ecosystem level, causes of deterioration can usually be traced ultimately to one or a combination of these factors. In a more practical, management-oriented sense, consideration of these factors in planning, policy and resource development can usually prevent any deleterious impact on the mangroves or the mangrove community. In this regard, of course, they are not applicable to actions such as clear-felling or site conversion which literally removes the mangrove community.

Required Information

Although there is a good general understanding of impacts and effects at the level of the community and ecosystem, there is a relatively poor understanding of how these same (and other) factors affect individual species; that is, we have a weak understanding of habitat requirements at the level of the individual species. For example, the timing and quantity of freshwater delivered to a mangrove ecosystem determines the salinity regime throughout the year and the quantity and timing of inputs of terrigenous nutrients which are made available for uptake and the subsequent stimulation of productivity. However, with respect to any given mangrove species, the exact salinity tolerances (or optimum) are not known and neither are the nutrient requirements at differing stages in the life cycle. If these factors were more precisely understood and recognized, watershed and upstream freshwater management might be planned and executed with fewer disturbances of the euryhaline nearshore environment. It is also well known that circulating surface waters promote the exchanges of gases and mineral ions between the flowing water and the substrate, and between the interstitial water in the substrate and the associated root systems. However, these processes have not been fully evaluated except in the most general sense of frequency of inundation.

Lately, the sediment substrate represents one of the least understood aspects of the mangrove environment particularly with respect to optimum conditions for each of the species. In general the mangrove species appear to be able to grow on a wide variety of soils of differing physical and chemical characteristics, and under both aerobic and anaerobic conditions. What is not known for the majority of the species, are the precise conditions which favour the growth and development of one species over another. This becomes a crucial management question for those who wish to propagate one or several preferred species under a scheme of management designed for sustained and continuing yield. Recently, the role of the sediment substrate following oil spills has been examined as a long-term source of toxic

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aromatics resulting from the breakdown and weathering of the oil. It appears that certain kinds of sediment substrates trap and accumulate toxic breakdown products which results in the mortality of apparently healthy mangroves several years after the spill. In addition, each mangrove species differs in its susceptibility to these breakdown products depending on the type of substrate.

The majority of the experts will acknowledge that we have learned a tremendous amount about mangroves in the past decade, but they will also agree that there is insufficient knowledge about the individual species to be able to manage them with the kind of success associated with other horticultural species. It is believed, although neither proven nor tested, that the key to mangrove management and conservation is the functioning and stability of the sediment substrate.

With respect to the various countries in this region, it is becoming increasingly necessary to understand the habitat requirements of each of the mangrove species, and to be able to apply this understanding to both scientific and management questions.

ECONOMIC VALUES

Probably the most important aspect of the management, utilization and conservation of the mangrove ecosystems is the determination of their values as forest crops, sustainers of nearshore fisheries, and as a stabilizing influence in the coastal zone environment. Too often, we find that economic planners and resource engineers use the forest products value of mangroves in decisions involving alternative use. Because the forest products value at any given time is relatively small (true of most forest crops), they are not competitive with values generated by alternative uses such as agriculture and pond culture. Thus, a usually-easy decision can be made in favour of the alternative use or uses. It should be apparent, however, that if all values generated by the mangroves and mangrove lands were to be taken into consideration, then there would be few competitive uses of higher value. This applies both to direct and indirect actions which affect the mangroves.

Required Information

There are several approaches in considering the values of mangroves and the most important criteria is that in each case all values and benefits be taken into account. The simplest approach is to develop a correlation between area in mangroves and the value, for example, of the fisheries captured in the contiguous nearshore environment. This method has been employed in the region (Martosubroto and Naamin, 1977; Turner, 1977), but as yet, has not been attempted for a specific mangrove area and the total associated fisheries. This is clearly one type of required information that would be of use to planners and policy makers. At a more sophisticated level, the relationship between fisheries production and mangrove production (e.g. productivity, growth

rate, litterfall) could be used to introduce a time dimension and thus permit integration and the calculation of future value. Turned around and calculated for an area to be clear-felled, the value of the unrealized productivity can be compared to the expected value of the harvested timber and wood products. In other types of conflicts, the unrealized-productivity value can be used to assess the economic impact of damage to mangroves, or to its associated fisheries, for example as resulting from an oil spill.

There is a critical need for this type of economic information and its acquisition will necessarily involve natural resource economists and sociologists, the latter to assist in the determination of the equivalent values of traditional uses. Within this region, one can find numerous government reports that show the annual values of certain products harvested or extracted from the mangrove environment, but it is extremely difficult to find quotations of the economic value of the traditional or subsistence uses. If that information was available, it could be used to estimate the equivalent values of the same services/ products if they had to be provided from some other source, rather than being provided "free" by the mangrove environment. Too often, traditional and subsistence activities are not taken into account as real values associated with natural ecosystems particularly those of mangroves.

In parts of this region with drier climates, there is an increasing demand for freshwater as existing and convenient supplies diminish. Water resource engineers have an overwhelming tendency to view the freshwater that flows into the coastal zone, as freshwater wasted. As a result, recommendations are made for dams, barrages and diversions to prevent the water from being wasted and instead use it for irrigation and other purposes. From a short historical perspective, it appears that the value of the freshwater "saved" is usually less than the fisheries, and, mangrove forests "lost" by the deprivation of freshwater in the coastal areas could also be correlated with the value of both forests and fisheries, and used in policy decisions concerning the highest and best use of freshwater resources.

It should be apparent at this point in the paper, that the most important objective of research planning is government and public education. Scientific knowledge has its own reward for scientists, but for those involved in the management of mangrove resources, it has no reward until it is considered and used for better management, utilization and the conservation of the mangrove environment.

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Table 1. Regional area of mangrove forest

Geographic Region Country Locality Other	Area in Mangrove Forest hectares	(acres)	Reference
INDIAN SUBCONTINENT			
BANGLADESH			
Sundarbans (Gangetic Delta)	407,313	(1,006,500)	Taher (pers. com.)
Chakaria Sundarbans	8,500	(21,000)	Karim (pers. com.)
Sonadia Island	800	(2,000)	"
Naf River	1,000	(2,500)	"
INDIA	356,000	(881,000)	Blasco in Chapman 1977
Andaman and Nicobar Islands	100,000	(247,000)	"
West Bengal (Gangetic Delta)	200,000	(12,400)	"
Mouth of Mahanadi	5,000	(24,700)	"
Mouth of Godavari and Krishna	10,000	(3,700)	"
Cauvery Delta	1,500	(3,700)	"
Bombay Region	20,000	(49,400)	"
Kathiawar: Saurashtra and Kutch Coasts	20,000	(49,400)	"
PAKISTAN			
Indus Delta	249,489	(616,749)	Khan 1966
Seer	11,207	(27,692)	"
Shah Bunder South Range	52,582	(129,929)	"
Keti Bunder South Range	95,141	(235,091)	"
Keti Bunder North Range	42,272	(104,453)	"
Korangi Range	48,286	(119,314)	"
Open water and bare area	221,893	(548,289)	"
SRI LANKA	3,200	(7,900)	Seneviratne 1978
SOUTHEAST ASIA			
INDONESIA	3,600,000	(8,896,000)	Soemodihardjo 1978
Sumatra			
East Sumatra	206,500	(510,300)	Schwaar 1972 and
North Sumatra (Eastern)	81,250	(200,800)	Martosubroto and
Riau	348,750	(81,800)	Naamin 1977
Jambi	67,500	(159,400)	"
South Sumatra	102,500	(253,300)	"
Lampung	6,875	(17,000)	"
Aceh	48,125	(118,900)	"
Java			
North and East Coast	58,700	(145,000)	"
South Coast	26,250	(64,900)	"

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Kalimantan			Schwaar 1972 and
West and Central Kalimantan	181,250	(447,900)	Martosubroto and
South Kalimantan	68,125	(168,300)	Naamin 1977
East Kalimantan	447,500	(1,105,800)	"
Sulawesi			
North Sulawesi	37,500	(92,700)	"
South Sulawesi	58,750	(145,200)	"
Maluku			
Aru	70,625	(174,500)	"
Irian Jaya	898,125	(2,219,300)	"
MALAYSIA	625,307	(1,611,274)	Ong 1978
Sabah	365,345	(902,402)	"
Sarawak	173,614	(429,000)	"
Peninsular Malaysia	113,348	(279,872)	"
Perak	41,360	(102,200)	Mahmud 1978
Selangor	31,400	(77,600)	"
Johor	26,020	(64,300)	"
PHILIPPINES	251,577	(621,658)	Juliano and Chan 1978
Mindanao	39,810	(98,372)	"
Palawan	34,853	(86,123)	"
Luzon	10,924	(26,994)	"
Vizayas	13,845	(34,212)	"
Mindoro	6,701	(16,558)	"
PEOPLE REPUBLIC OF CHINA	67,000	(165,500)	Bao-Chan (this symposium)
Taiwan			
Taipei County	65	(160)	Ming-Yih Chen (pers. com.)
Shinchu County	6	(15)	"
Miauli County	11	(27)	"
Taichung County	5	(12)	"
Chiayie County	14	(35)	"
Tainan County	6	(15)	"
Kaochung County	10	(25)	"
Pintung County	6	(15)	"
THAILAND	163,349	(403,780)	National Research Council of Thailand 1977
Chumphon	3,185	(7,870)	
Ranong	22,661	(55,996)	"
Phuket	2,420	(5,980)	"
Krabi	22,743	(56,199)	"
Phangnga	38,387	(94,856)	"
Songkhla	589	(1,455)	"
Trang	22,409	(55,374)	"
Satun	28,466	(70,341)	"
Pattani	752	(1,858)	"
Rayong	1,290	(3,188)	"
Chanthaburi	12,319	(30,441)	"
Trat	8,128	(20,085)	"

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VIETNAM (SOUTH)	250,000	(617,800)	Vu Van Cuong 1964
Rung Sat	40,000	(98,800)	"
Ca Mau Peninsula	150,000	(371,000)	"
	40,000	(98,800)	"
Miscellaneous Areas	20,000	(49,400)	"
VIETNAM (SOUTH)	286,400	(707,700)	Ross 1975
OTHER REGIONAL COUNTRIES			
AUSTRALIA	1,161,700	(2,870,600)	Galloway 1979
Queensland	462,900	(1,143,800)	"
Mainland	446,900	(1,103,800)	"
Islands	16,200	(40,030)	"
Northern Territory	413,000	(1,020,500)	"
Mainland	314,900	(778,100)	"
Islands	98,100	(242,400)	"
Western Australia	251,700	(662,000)	"
Mainland	243,000	(600,500)	"
Islands	8,700	(21,500)	"
South Australia	23,000	(56,800)	"
New South Wales	9,900	(24,500)	"
Victoria	1,200	(2,970)	"
FIJI	19,684	(48,640)	Marshall n.d.
FIJI	49,777	(123,000)	Government est. n.d. In Richmond and Ackermann 1975
JAPAN			
Kagoshima Prefecture	12	(30)	Nakasuga (pers. com.)
Okinawa Prefecture	388	(960)	"
NEW CALEDONIA	20,000	(49,400)	Morat (pers. com.)
NEW ZEALAND			
North Auckland Lands District	17,706	(43,750)	Chapman (pers. com.)
South Auckland Lands District	2,124	(5,250)	"
PAPUA NEW GUINEA			
Gulf Province	389,000	(960,000)	Haines 1978
Great Delta	22,600	(550,100)	Cavanaugh 1950 In Chapman 1976