State Environmental Conservation Department,
Sabah, Malaysia

A report on the State of the Environment in Sabah, 2000

A Paper Presented at the Environmental Convention held in Kuching, Sarawak, 29-30 June 2000

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Abbreviations

BOD	Biological Oxygen Demand
DANCED	Danish Coorperation for Environment and Development
DO	Dissolved Oxygen
GDP	Gross Domestic Products
GIS	Geographical Information Systems
MOSTE	Ministry of Science, Technology and Environment
RM	Ringgit Malaysian
TSS	Total Suspended Solids
WRI	World Research Institute

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1 Introduction

Sabah commonly known as the Land Below The Wind has a population of about two million and a total land area of 7.362 million hectares. The State is divided into 24 administrative units comprising one city (Kota Kinabalu), two municipal councils (Sandakan and Tawau), one town board (Kudat) and 20 district councils.

Landmarks

Realizing the importance of environmental conservation and protection in the early 1970s, the State Government established an Environment Unit under the purview of the then Ministry of Manpower and Environmental Development in 1976. In 1987, the enforcement of the Environmental Quality Act 1974 was extended to Sabah and administered by the Federal Department of Environment. In 1991, Sabah commissioned World Wide Fund for Nature Malaysia to prepare Sabah Conservation Strategy with funding from the United Nations Development Programme. The report was completed in April 1992 and approved by the State Government in 1995 as guideline in planning. In 1995, Sabah Biodiversity Conservation Project was initiated under the Danish Cooperation for Environment and Development (DANCED) funding, with the purpose to improve and sustain biological resources.

Other landmarks include the Tourism Master Plan that provided the State with a nature-based source of income and the Shoreline Management Plan, 1998 that was conducted and endorsed in order to avoid ribbon developments along the West Coast of Sabah. Finally was the Environmental Conservation Department established in 1998, and the Capacity Building of the Environmental Conservation Department Project (DANCED) initiated in 1999.

1.1 This report

This report on the State of the Environment 2000 concerns the Sabah environment and the Sabah society. One of the main aims of the report has been to emphasize the interplay between environment and society. On one hand, we have an environment and nature that is controlled by a number of natural laws. On the other hand, we have a society that is controlled by a number of economic, social and political conditions.

A description of the state of the environment may begin in the environment – in the aquatic environment, the terrestrial environment, the atmospheric environment – and draw connections to the various societal activities that are the cause of the problems. Or it may begin in society – in agriculture, industry, aquaculture, forestry, households, transports, and cities – and then draw connections to the environment.

In this report an attempt is made to synthesize these two approaches. The aim is high (and the task huge), and has only partially been achieved. However, this report should be seen as the Environmental Conservation Departments initial attempt to produce an integrated overview of the environmental status in Sabah. The attempt will be continued in the coming year through the Capacity Building of the Environmental Conservation Department Project and the development of an Environmental Indicator Report for Sabah.

Chapter 2 in this Report is based on the environmental status and problems – i.e. the state of the environment – and draws connections to the societal activities. Conversely, chapter 3 is based on the society - divided in a number of themes and sectors - and describes the relationships between the technological and economical development and the resultants pressures on nature and the environment.

Chapter 4 outlines an upcoming attempt by the Environmental Conservation Department to develop an environmental indicator system for Sabah, while chapter 5 lists the references used for the preparation of the present report.

2 State of the Environment in Sabah

The following sections describe in brief the environmental status concerning the different environmental medias: The inland and marine waters, the biodiversity (flora and fauna), and the air. The descriptions are based on available data collected by the Environmental Conservation Department.

2.1 The inland waters

Water is a vital resource, which makes possible the survival of all living things. The availability of water often determines the rate of economic development and also set its limit. Rivers, streams, lakes, man-made reservoirs, underground aquifers and wetlands constitute the inland water resources, which are essential for agriculture, industry, human settlements and energy production.

Inland waters are being polluted by both point and non-point sources of pollution. Industries, including mining and communities, are major point sources of pollution. Forestry and agricultural run-off, which contains fertilizers, pesticides and eroded soils, are the major non-point sources of pollution. Silt from eroded soil is contributed primarily by deforested hill areas, sloping agricultural land and poorly designed roads and constructions.

2.1.1 Surface Water

Introduction

Surface water is one of the major sources of freshwater supply in the State. Surface water can be classified as either flowing water such as rivers and streams, or standing water such as lakes and ponds including man-made reservoirs. There are altogether about 19 river basins in Sabah. Of these, the Kinabatangan river basin on the East Coast is the largest covering an area of about 15,385 sq. km. The Padas river basin on the West Coast covers an area of about 8,726 km^2. Most of the other basins cover comparatively smaller areas.

Water quality in both flowing and standing water can be determined by measuring parameters such as the concentration of Dissolved Oxygen (DO), the Biological Oxygen Demand (BOD), the Total Suspended Solids (TSS), pH and the Faecal Coliform Bacteria count. Water is considered polluted if the water system is overloaded with oxygen demanding wastes and when the bacterial activities cause the reduction of DO to a level low enough to kill some species of aquatic organisms.

Impacts and Status

Surface water quality in Sabah is adversely affected by various types of pollutants that enter water bodies.

Run-off from Land-use Activities. The greatest pollution problem in most river basins in Sabah is the high load of suspended solids as a result of sediment pollution from poor soil conservation, runoff from logging, agricultural, plantation, mining and construction activities, and also from natural erosion. Recent findings at the Kinabatangan river estimated soil loss at 7.8 million tons per year. Occurrence of floods is to some extent directly related to levels of sediment loads in rivers. Several river basins such as the Padas, Kinabatangan, Segama and Labuk rivers are prone to flooding during the wet season. These rivers also exhibit high turbidity even during the dry season.

Chemical pollutants such as biocide residues originating from pesticides, insecticides, herbicides and fertilizers applied in agricultural activities are potential threats to water quality in waterways and river basins of Sabah. The Sabah Water Resources Master Plan 1994 reported that the water supply has been affected in Ranau by pesticides and herbicides being washed from vegetable growing areas near Kundasang.

The Environmental Quality Report 1990 published by the Department of Environment reported that 12 of the 17, or 65%, of the rivers monitored in Sabah were heavily polluted with suspended solids which consisted of earth materials eroded from river channels and disturbed soil surfaces in the upstream areas. The Environmental Quality Report 1997 reported that 12 rivers in the State were polluted with NH3-N due to livestock farming and domestic waste in 1997. Six rivers were polluted with suspended solids due to mainly earthworks and land clearing activities. On BOD, there was no pollution reported in Sabah. The Environmental Quality Report 1998 reported that seven rivers in Sabah had been found to be polluted in terms of suspended solids, BOD and ammoniac nitrogen.

Domestic Sewage. Municipal wastewater discharges, especially of untreated sewage, constitute an important source of pollution of inland waters in Sabah. Sewage poses a threat not only to human health, but also increases the load of nutrients in the water, which use up oxygen as they decompose. The more oxygen is consumed, the more will aquatic life is impaired. In certain instances, conditions may become anaerobic, resulting in the mortality of aquatic life. Recent studies have found that the level of coliforms found in selected rivers, estuaries and coasts of Sabah clearly indicated a high degree of sewage contamination along the coast of major towns in Sabah. These include Inanam, Moyog, Tawau, Sembulan and Likas rivers.

Mining. Mining activities either directly release pollutants such as heavy metals into rivers, reservoirs and ponds, or contribute to groundwater pollution through the leaching of mine tailings. The Environmental Quality Report 1994 reported the presence of heavy metal at the Damit/Tuaran River that exceeded water quality standards observed for other rivers in the country. There is indication of heavy metal pollution in the Liwagu river but the source is unclear although there is speculation that it originates from the Mamut Copper Mine.

Continuous monitoring of water quality is therefore essential to provide data for formulation of appropriate rehabilitation measures. Research should also be conducted into biological indicators such fish population to further support the monitoring program.

River Sand and Gravel Extraction. There is a concern on the adverse impacts of river sand and gravel extraction such as erosion of riverbanks and increased turbidity downstream, particularly during low flows as fine material is distributed by excavation work. The Shoreline Management Plan 1999 for the west coast of Sabah indicated that river aggregate mining in the Padas, Papar, Tuaran rivers is presently affecting the characteristics of the flood hydro graphic of these rivers. The impact is arising not only from local modification to the flow resistance but also from the use of heavy machines to maximize extraction potential. Presently, there is very little data on bed-load transport rates and other relevant aspects of riverine processes on which to base decisions. There is therefore an urgent need to formulate an extraction policy and guidelines, which will provide specific and consistent framework for decision-making, and to guide the industry particularly in respect of suitable and unsuitable locations for extraction.

2.1.2 Groundwater

Introduction

Groundwater supply in Sabah is utilised largely as a supplementary supply, which is confined to only to nine water supply systems throughout the State. Several potential groundwater storages have been identified (Natural Resource Office, 1994). These include beach, alluvial and coral deposits, and sedimentary and igneous rocks. Storage volume from each of these different storage areas varies considerably depending on the thickness of the aquifer and the deposits. Although, the beach deposits occupy an extensive area in the coastal zone, groundwater storage in this deposit tend to be relatively small due to the shallow deposit above sea level, and bounded by sea, tidal creeks and estuaries. Alluvial deposits are known to have larger groundwater storage due to the deeper alluvial fill.

Impacts and Status

The quality of groundwater is under threat due to leaching or seepage into groundwater storage of chemical or oil spills; biocides and fertilizers residues from agricultural farms; organic wastes from animal farms; and heavy metals from mining wastes, rock tailings, and industrial wastes. To date, there is no groundwater quality monitoring data available in Sabah for any of the groundwater under investigation. Present monitoring programs carried out are only to monitor yield, the pressure and potential leaks. The Environmental Quality Report 1998 reported the monitoring wells in Peninsular Malaysia showed that the level of some parameters exceeded the acceptable value for raw water quality especially those located near the solid wastes dumping sites. No significant levels of pollutants were observed at monitoring wells for other land use categories.

2.1.3 Wetlands

Introduction

Swamps, marshes and other wetlands once regarded as useless obstacles to agricultural and industrial development are now recognized for their great values in recycling chemical and biological materials, and especially for their rich biological diversity. Wetlands filter pollutants, act as reservoirs of nutrients in food chains, produce forage for domestic animals and fuel for humans, provide aesthetics, recreational and cultural benefits to society and are habitats for thousands of unique species of plants and animals.

Impacts and Status

In Malaysia the number of known sites is estimated to 37, whereof 86 % is regarded moderately to highly threatened (United Nation, 1990), the highest in South-East Asia. The main threat to wetlands are drainage to create land for crops, conversion to aquaculture, pollution by toxic materials from agricultural and industrial wastes, eutrophication caused by run-off water loaded with fertilizers and wastes, flood protection and housing developments, commercial logging, hunting and fishing.

In Sabah, the Kinabatangan floodplain is one of Malaysia's most treasured wetlands. The wetland ecosystem provides the varied vegetation types that are home to a diverse concentration of wildlife. The Kinabatangan river is the source of water supply for villages and Sandakan town and also an important mode of transportation for the local settlements as well as the agriculture sector. However, much of the wetlands is destroyed by unsustainable logging practices and land conversion for agricultural expansion and contaminated by pesticides and discharge of industrial effluents. Realising the importance of this area, in 1999, the State Government of Sabah has declared its commitment to fully gazette and protect this area of 27, 000 hectares as a wildlife sanctuary.

2.2 The marine environment

The marine environment comprises coastal waters, estuaries and the high seas. It includes the water, seabed and a vast range of flora and fauna, which constitute an invaluable source of food. The marine environment constitutes a major component of the natural environment and has many dynamic interactions with other components such as air, coastal land and inland water.

2.2.1 Marine Water Quality

Introduction

Data on marine water quality in Sabah are limited, and normally only confined to those areas where development is on going and where environmental impact assessment studies have been carried out.

Impacts and Status

All types of contaminants found in rivers and streams will finally be discharged into marine waters. These includes the following:

Suspended Sediments. Suspended sediment loading from rivers is one of the most severe threats to the natural nearshore habitats around the coastline of Sabah, and in particular the West Coast region. Suspended sediment affects the light and sedimentation conditions over static marine habitats such as corals

and sea grasses affecting factors such as growth rates and respiration. The sediment loading can also cause problems with fish spawning as deposited silts provide unfavourable conditions for adhesive eggs, and can cause an out migration of fish, crustaceans and invertebrates from affected areas due to respiration problems. Suspended sediment cannot be addressed as a shoreline issue. They must be tackled at source.

Bacterial Pollution. Bacterial pollution is presently not a major problem due to the relatively low level of loading at the immediate mouths of the main rivers compared to the rate of dispersion and decay. However, in isolated areas, hygienic water quality problems are encountered and this trend will increase in future due to increased domestic and other loading. For instance, the water at Likas Bay, which is in the immediate vicinity of the City of Kota Kinabalu, has been found to have a high level of E. coli count exceeding the standards set by the Department of Environment. Combating this problem requires an integrated approach, which includes tackling the problem at source, and relocating squatters dwellings with direct discharge of wastes into coastal areas and riverine areas.

Floatables. The most visible of the water quality issues are the floatables such as plastics, cans, bottles and a host of other solid wastes, which are commonly found in the coastal and riverine areas. Not only floatables have a direct impact on soft bottom communities, coral reefs and other static habitats, they also have a very serious effect upon marine beach aesthetic, which is directly related to the tourism industry. The issue of floatables can be tackled through the use of debris collectors along coastal areas and at the mouth of the major rivers. Debris collection is, however, an expensive intervention, which has to be borne by the Government through the Local Authorities. An integrated approach to reduce the loading is therefore preferable which may include for instance imposing environmental tax on plastic bags; building more low cost houses for the relocation of squatters away from water ways; and conducting environmental education and awareness programs.

2.2.2 Mangroves

Introduction

About 317,000 hectares of the mangrove areas in Sabah have been constituted as Mangrove Forest Reserve. The ecological importance of mangrove areas can hardly be overestimated; they form the feeding and nursery grounds for prawns, fish and other invertebrate species and mangrove vegetation protects the coastal areas from erosion and acts as a buffer zone against tidal currents, floods and storms. Mangrove forests are also important to many local communities in Sabah with products ranging from firewood, fishing stakes to construction of small structures.

Impacts and Status

The main threat to mangrove areas is alienation for various development purposes. The depletion of mangrove forests is primarily associated with its exploitation for its timber products, land reclamation and aquaculture activities. Examples of such activities are in the west coast region of Sabah where areas of

mangroves have already been turned over to coastal resorts (including golf courses) and brackish water fish and shrimp farming.

Presently, mangrove timber harvest and aquaculture activities do not pose a significant threat to mangrove areas. Mangrove timber harvesting in Sabah is localised and is carried out in small scale and thus, preventing adverse effects on mangrove forests. The conversion of mangrove forest to aquaculture ponds is also a minor activity. The increasing marketing problems anticipated in cultured shrimps (environmental groups in importing countries are advocating consumer boycott on shrimps grown in mangrove areas) coupled with the unsuitability of mangrove areas as shrimp farms (due to poor soils and pond drainage difficulties), has lead to a limited aquaculture development within mangrove areas.

The rapidly decreasing yields of wood available from dry land forests in Sabah and the increasing human population and declines in wild fish catches, might however lead to extended use and conversion of mangrove forests for forest produce and aquaculture purposes.

2.2.3 Coral Reefs

Introduction

Coral reefs are extremely fragile ecosystems. They are breeding and feeding grounds for a high diversity of specialist coral reef fishes and invertebrates. They are also important economically for the tourism and recreational sector, and are a potential storehouse of medical resources. Coral reefs also prevent coastal erosion by acting as wave breakers. Sabah has established a number of marine parks, reserves and sanctuaries to prevent exploitation and to provide protection to marine life and resources.

Impacts and Status

The major threats to the coral reef ecosystems in Sabah are unplanned and ad hoc development activities along coastal areas, and reclamation activities. Other threats include coral mining for construction materials; destructive fishing methods such as fish bombing and cyanide fishing; and marine pollution. Several reports have revealed that eutrophication through discharge of sewage have led to profusion of algae overgrowing and killing the corals. It has also been reported that sediment erosion from improper development activities, and sediment discharge from rivers has caused coral mortality from turbidity and burial.

There are indications that nearshore aquatic life is now threatened. Sand mining in the sea, sediments from the rivers and bombing of fish constitute a serious threat along the 1600-kilometer long coastline of Sabah. Surveys and monitoring of coral reefs conducted by UMS, Unimas and Sabah Parks revealed that most reefs along the coast of Sabah are in good condition but are seriously threatened by destructive fishing methods, excessive sedimentations and over fishing. Another study that was carried out by the same institutions proved that fish bombing is a fundamental factor in the destruction of coral reefs in Sabah. A total of 762 cases of fish bombing were reported between the years 1990-

1999 and 444 persons were detained. In 1999 alone, 32 persons were caught and detained (Fisheries Department, Sabah, 1999).

The state of Sabah through its agency, Sabah Parks, has identified new marine areas that merit protection. Apart from Tunku Abdul Rahman Park, Pulau Tiga State Park and the Turtle Islands Park (a combined area of 20, 622 ha of coral reef), Semporna Islands has been proposed for protection.

2.2.4 Coastal Erosion

Introduction

In Malaysia it is estimated that 27 % of the shoreline are subjected to erosion, and Drainage and Irrigation Department has identified 53 areas where coastal erosion is threatening important facilities. Erosion has destroyed beaches, damaged coastal roads and houses and posed danger to beach resorts and buildings.

Impact and Status

Coastal erosion on a regional scale has been reported to be presently not a serious issue in Sabah. Although the existing situation is not serious, the trend is however clearly towards increasing erosion due to human's intervention both directly due to construction on the coastal areas and indirectly to hinterland activities or also due to natural coastal processes.

The Shoreline Management Plan report 1999 indicated that out of 1600 km coastline of Sabah, approximately 63 km is eroding at a significant rate. The coastline areas in Papar and Kimanis on the West Coast, and in Sandakan on the East Coast have been found to suffer moderate to severe coastal erosion.

2.3 Biodiversity

Introduction

Biodiversity includes the full complement of plants and animals, both individually as species and collectively as components of ecosystems. The existence of biodiversity is a symbol of ecological balance, which serves humanity in a variety of ways. It directly provides a sizable fraction of the human diet, and moreover, the utility of diverse species is increasing, not only as a source of materials, but also as a new genetic resource that can contribute to the improvement of breeds and to the development of biotechnology.

Impacts and Status

Reduced biodiversity or the loss of species is the most graphic indicator of the plight of wild plants and animals. However, measuring a decline in biodiversity is not easy. Only 1.5 million of the estimated 5-30 million species on earth have been identified (World Research Institute, 1989).

Human beings are the main agents of extinction causing it by altering habitats (mainly forests, but also fresh waters and wetlands), overexploiting and introducing exotic species to places where they out-compete or eat the native species. Habitat degradation, loss or modification is the most comprehensive indicator of the predicament of wild flora and fauna. The key area of concern is the tropical forest where species diversity and endemism are unusually high. The need for economic growth to alleviate poverty, habitat destruction and the advancement of agricultural frontiers are the main causes for the destruction of

biological diversity. Larger animal species are being drastically reduced in number.

Habitat Degradation and Loss. The heavy intensity of logging prevalent in Sabah, and relogging after brief periods, is the major contributing factor to the rising loss of sensitive species, both plants and animals. The overall threat to Sabah's biodiversity is loss of natural forests, both through land use conversion and through random and indiscriminate degradation and destruction. This loss can be attributed to the processes of land alienation, unstable shifting agriculture and fire. In Malaysia the original wildlife habitat of 356,000 sq km has been reduced to 210, 000 sq km by 1986, a loss of 41 % of the wildlife habitats (United Nation, 1990). In Sabah, four large mammals are under serious threat and potentially endangered with extinction on world basis. These animals are Asian elephant (>1000), Asian two-horned rhinoceros (a few tens), orang-utan (between 10, 000 - 20, 000) and tembadau or wild cattle (status is incompletely known).

Habitat Fragmentation. As forested lands are cleared to make way for plantations and other development activities, the continuous forest areas are often fragmented into smaller units of forestlands. Such fragmentation is believed to have great impact on wildlife species and populations than on plants (Latiff and Zakri, 1998). In Sabah, there have been reports of elephants attacking and destroying substantial areas of oil palm plantations. This is probably attributed to the fact that animal species, in particular the large mammals require large territories to sustain their food supply and continue to survive in the wild. It is also believed that through forest fragmentation, sexually mature and actively breeding populations may not be able to come into contact with each other resulting in no reproduction of the species. Prolonged isolation in the reproductive process may ultimately result in sterility, which can lead to extinction of the species.

The key towards conservation of biodiversity of both flora and fauna in Sabah is to create totally protected areas of specific sites of natural habitat where exploitation and destruction of forest in any way are prohibited. It has been estimated that approximately 10 % of the land area has to be conserved in order to protect habitats and biodiversity in Sabah. In Sabah, land gazetted as Parks, Protection Forest Reserves and Virgin Jungle Reserves make up of approximately 5.8% of Sabah's land area.

2.4 The air

Introduction

Significant sources of air pollution are from stationary sources, mobile sources and open burning activities. Among these, emission from motor vehicles is the main contributors. In Sabah, there are only two automated air quality monitoring stations, each located in Kota Kinabalu and Tawau. Another two manual air quality-monitoring stations are located around Kota Kinabalu area. Monitoring programme for air quality is undertaken by Department of Environment.

Impacts and Status

In general, air quality standard in Sabah is good except for the occasional periods of forest fires outbreak during the dry season that contributes to high

concentrations of particulate matters (PM10), carbon monoxide (CO) and ozone (O_3). Otherwise, all these concentrations as well as concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and ambient lead remain relatively low, and thus low Air Pollution Index readings, throughout the year.

In 1997 Sabah experienced serious haze mainly due to the forest and land fires in plantations in Kalimantan and Sumatra, Indonesia. In 1998 the total area burnt in Sabah was between 130-150.000 hectares (Henry Solibun, 1999), resulting in substantial ecological and economic losses, and contributing to the haze problems in the region. Forest fire was seen as a single biggest threat causing the haze phenomena and lost of biodiversity.

There were 291,472 motor vehicles registered in 1997 in Sabah and a total of 1,177 stationary sources of air pollution were recorded. Complaints of air pollution resulting from tailing dust being blown by wind at the site of the Mamut copper mine at Lohan, Ranau have been reported.

3 Society's impact on the environment

This chapter is based on the society - divided in a number of themes and sectors - and describes the relationships between the technological and economical development and the resultants pressures on nature and the environment. The descriptions are based on available data collected by the Environmental Conservation Department.

It is assessed that the following four key features will set the agenda for society's impact on the nature and environment in Sabah in the near future:

- The high population growth rates (see section 3.1)
- The high economic growth rates (see section 3.2)
- The substantial changes in the land use patterns (see section 3.3)
- The increased urbanisation rate (see section 3.4)

A short overview of the key sectors in Sabah having an impact on the nature and environment in Sabah, namely forestry, agriculture, tourism and fisheries, are finally given in section 3.5-3.8.

3.1 Population

Overview

The population of Sabah is expected to grow from approximately 1 million in 1980 to 3,3 million in 2006, see Table 3.1. The growth rate from 1991-95 was 6.2 % annually, which is among the highest population growth rates in any human population in the world. At this rate, the number of population will double in every 12,5 year. The population density per sq km was in 1991 25, while the predicted density in 2006 is 115, and increase of not less than 460 %.

Table 3.1. Population and growth rates.(7th Malaysian Plan) '000

Year	1980	1991	1995	2006
Population	1,055	1,867	2,389	3,343
Growth rate	80-91: 5,2 %		91-95: 6.2 %	

Environmental impact

The population growth and increased population density will substantial influence the availability, quality and sustainability of almost all natural resources in Sabah. High population growth places continuous pressure on agricultural land and the need for conversion of forests to agricultural purposes. High population growth increases consumption and the generating of all kinds of wastes. Population growth (and urbanisation) furthermore increases the demand for domestic and industrial water (see Table 3.2), which again stresses the need for sustainable water catchment management including controlled logging and deforestation activities in the catchment areas.

Table 3.2. Projected demand for domestic and industrial water (MOSTE, 1997). Mill litres/year

1980	1985	1990	2000
58	82	103	259

3.2 Socio-economic development

Overview

Malaysia experienced an 8 % growth rate in GDP from 1991 to 1997. This was slightly higher that in Sabah, where the growth rate was 5,0 % in 1991-96 and predicted to be 6.0 % in 1996-2000, both growth rates the lowest in Malaysia compared to other states (7^{th} Malaysia Plan).

Malaysia furthermore experienced a general development path from an agricultural and commodity based dependent economy to a manufacturing economy. This development path was however not mirrored in Sabah's economic performance. Sabah is still dependent on natural resources (primarily timber) and agriculture (primarily oil palm) as its primary sources of income. Throughout the years, the forestry sector remains the backbone of the economy. The manufacturing industry remained small throughout the 1970s but has increased slightly in the 1980s and 1990s. The GDP and 1970-90 growth per sector for Sabah can be seen in Table 3.3.

Table 3.3. Total GDP per sector in Sabah (MOSTE, 1997). Million RM

Sabah	1970	1990	1990 %
Forestry, agriculture, fishery	738	2,436	37.4
Mining	10	1,279	19.6
Wholesale, retail, hotel, restaurants	137	682	10.5
Manufacturing	44	489	7.5
Govt services	101	475	7.3
Transport, storage, comm.	47	394	6.1
Finance, insurance, etc.	129	383	5.9
Construction	81	251	3.9
Utilities	10	66	1.0
Other services	37	62	1.0
Total	**1,332**	**6,517**	**100**

Other key socio-economic data can be seen in Table 3.4. The Table shows that Sabahs on most socio-economic indicators are placed relatively lower that Malaysia in general. The reasons are many and complex, but an accelerating socio-economic development in Sabah in the coming period can be expected.

Table 3.4 Socio-economic data (7th Malaysia Plan)

	Registered cars/motor-cycles per 1,000		*Telephones per 1,000*		*Television licences per 1,000*		*Literacy rate (%)*		*Population provided with piped water*		*Population provided with elec-tricity (%)*		*Infant mortality rate rer 1,000 live births*		*Number of doctors per 10,000*	
	'90	*'95*	*'90*	*'95*	*'90*	*'95*	*'90*	*'95*	*'90*	*'95*	*'90*	*'95*	*'90*	*'95*	*'90*	*'95*
Sabah	109	101	63	82	65	51	72	78	64	77	48	78	32	38	2	2
Mala ysia	273	339	89	164	99	109	85	89	80	89	84	96	13	10	5	5

Environmental impact

Even though the socio-economic rates for Sabah has remained slightly lower that the rest of the country, the actual socio-economic growth rates are still high compared to other regions and countries in the world, and it can be expected that the socio-economic growth rates will continue at a relatively high level during the coming decades.

High socio-economic growth rates sets, like the population growth rates, the agenda for the availability, quality and sustainability of almost all natural resources in Sabah. High socio-economic growth places continuous pressure on the land use patterns, urbanisation rates, consumption rates, waste generating rates and demand for domestic and industrial water and energy.

3.3 Land Use

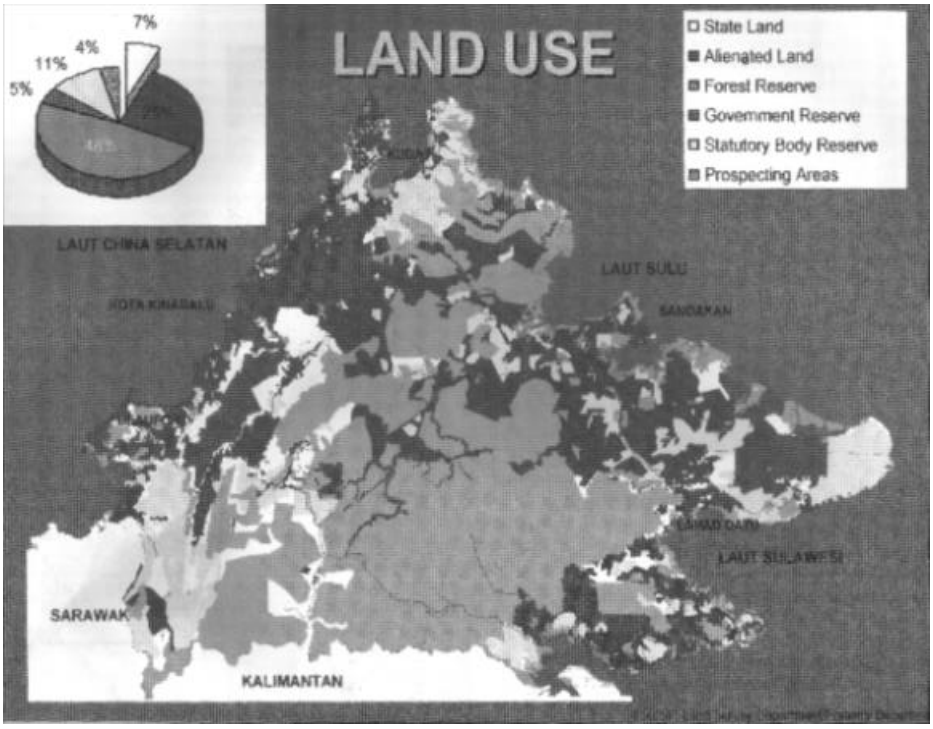
Overview

The most important land ecosystems in Sabah are the forests and croplands, and the general trend in land use patterns is characterised by deforestation and expansion of cropland.

Out of the total land area of 73,7 thousand sq km or 7.3 million hectares, about 3.9 million hectares are classified as reserved land (forest reserves, parks and wildlife sanctuary), 3.2 million hectares have been alienated, and about 0.3 million hectares still remain as State Land, see Figure 3.1.

Forest reserves (protective forest, commercial forest, domestic forest and other forest areas) constitutes 48,8 % of the total land area, alienated land 25,6 %, other reserves 15.3 %, mining prospecting area 3,8 % and State land 6,5 %.

Figure 3.1. Land use in Sabah (Sabah State Government, 1998)



Environmental impact

The nature and environment of Sabah is closely linked to and determined by the geographical attributes and the development in the land use patterns as depicted in Figure 3.1.

Sabah has converted forest to cropland and state reserves and state land to alienated land at a slower pace compared to other Malaysian states and countries in Asia. With only 25,6 % of all land alienated, and a continued high degree of land under forest reserves, it can be expected that further major changes in the land use patterns of Sabah will take place in the coming decades. As the State progress, competition for land for primary economic activities of agriculture, mining, industry and housing increase, and the land use patterns will undoubtedly undergo dramatic changes in Sabah in the coming decades. In order words, Figure 3.1 will most likely look substantial different in 10 and 20 years from now.

The expected change in land use patterns will substantially influence and change the nature and environment of Sabah. Habitat loss or modification is regarded as the primary cause of biodiversity loss in Sabah as elsewhere.

A universal and effective strategy in the protection of Sabahs natural resources is conservation. Recognising the importance of the forests and other natural resources, conservation efforts in Sabah have been placed under the direct responsibility of the Government, and are being carried out by e.g the State For-

estry Department, Sabah Parks, Sabah Wildlife Department, Fisheries Department, Yayasan Sabah and the Environmental Conservation Department. Table 3.5 shows the relative importance the Sabah Government has placed on the establishment of national parks.

Table 3.5. Protected Areas 1991. Million ha. (MOSTE, 1997)

	National Parks	Wildlife/bird sanctuary	Total
Sabah	0.25	0.14	0.39
Sarawak	0.08	0.18	0.26
Peninsula	0.43	0.31	0.74
Malaysia	0.76	0.63	1.39

Figure 3.2 shows the major conservation areas in Sabah, while Figure 3.3 and 3.4 shows the areas specifically controlled by Sabah Parks and the Wildlife Department.

Figure 3.2. Major conservation areas in Sabah (Sabah State Government, 1998)

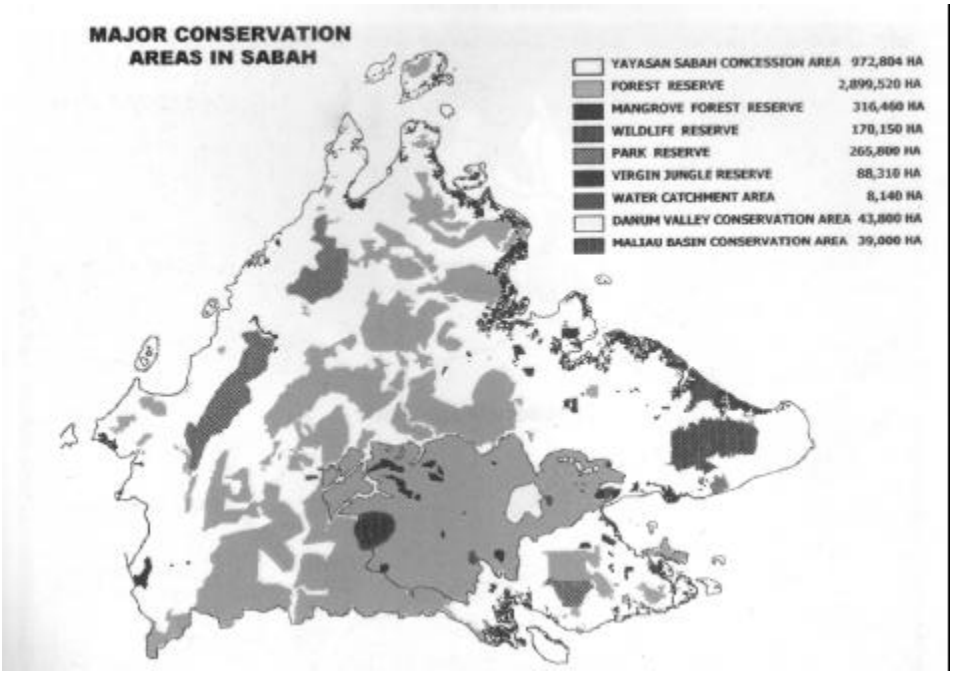
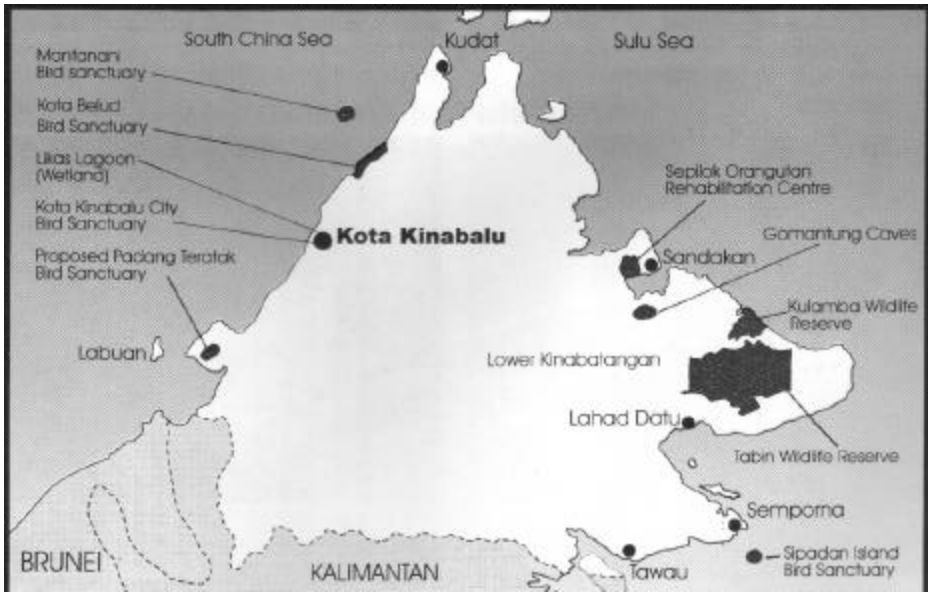


Figure 3.3. Conservation areas under Sabah Parks (Sabah State Government, 1998)

Figure 3.4. Conservation areas under Sabah Wildlife Department Parks (Sabah State Government, 1998)



3.4 Urbanisation

Overview

Asia encompasses some of the world's most urbanized countries, including Malaysia. As can be seen in Table 3.6, has the urbanisation process in Sabah however taken off later, and it can be predicted that the urbanisation process in Sabah will increase considerable in the coming decades. The majority of Sabah's population is still rural with a gradual but steady shift towards urbanisation.

Table 3.6. Urbanisation rates in Sabah, Sarawak and the Peninsula (MOSTE, 1997 and 7th Malaysia Plan)

	Peninsula			Sabah				Sarawak			
	'70	'80	'91	'70	'80	'91	'00	'70	'80	'91	'00
Urban	-	37	86	17	20	33	38	16	18	38	50

Environmental impact

The urban environment is characterized by a high concentration of population and a high intensity of human activity, and its relative importance economically, politically and socially can hardly be overemphasized. Urbanization however also creates a number of environmental problems, including encroachment of rich agricultural land, deforestation, solid wastes, heavily polluted urban rivers, air pollution and increased risks in mounting chemical and hazardous wastes.

Urbanisation and land. The *conversion of natural and agricultural ecosystems* to provide urban infrastructures, such as houses, roads, and factories is typical examples of the increased use of land. In Sabah considerable alteration and deterioration of the landscape in the areas surrounding the larger cities have taken place through hill cutting, road construction, quarrying, land clearance and industrial and housing developments. Another environmental effect is the considerable *damage to forests* in the surrounding areas of the cities due to the increased pollution pressure from the cities (demand for land, fuel, etc.). Finally do the *urban shelter problems* for the urban poor contribute to aggravated urban environmental problems. Many cities in Sabah, Kota Kinabalu and Sandakan in particular, suffer from the spread of slums, marginal and illegal settlements. These marginal settlements are characterized by absence or severe lack of basic infrastructures and environmental services like water supply, solid waste collection, sewerage and drainage. It has been estimated that 20 % of the population in Kuala Lumpur consists of slum inhabitants (United Nations, 1990). The figure for some of the cities in Sabah might be even higher causing an additional stress to especially river pollution and proper handling of solid waste.

Solid Waste Disposal. Solid waste disposal is found to be a major problem in most districts in Sabah. The City of Kota Kinabalu is the only local authority that operates solid waste disposal facility based on the sanitary landfill system situated at Kayu Madang, Telipok. The rest of the districts operate open-space dumping grounds, where the accumulated wastes are either covered with soil or pushed into a valley, depending on its location. These open-space dumping grounds in some cases not only emit foul smell and cause nuisance to the

nearby local residence but also provide operating centres for scavengers and breeding grounds for rodents and other pests that could be potential disease carriers. There is a danger of toxic waste materials from these dumping sites spilling into rivers and streams or seeping into the ground water storage system. Indiscriminate dumping of waste by local residents both in towns and villages is rampant especially in squatter settlements. The problem is further aggravated due to the limited rating areas in some districts resulting in indiscriminate waste disposal in places such as backyards, roadsides, and in waterways. Another contributing factor to this waste disposal problem is the negative attitude as well as the lack of awareness on the importance of maintaining a clean environment for healthy living.

Air pollution. The deterioration in air quality in urban areas is mainly the result of increases in manufacturing and industrial activities and in the number of motor vehicles.

Water pollution. Urban rivers become typically heavily polluted with domestic sewage, industrial effluents and solid wastes, mainly in terms of phosphates, biochemical oxygen demand (BOD), coliform, alkalinity and turbidity.

Industrial, toxic and hazardous waste. The majority of industries are located around the cities in Sabah, why most environmental problems related to effluents and emissions are more visible felt by the urban populations. Only few data on toxic and hazardous waste in Sabah (for example acid wastes, asbestos dust sludge, alkaline wastes, mineral oil, hydrocarbon wastes, paint sludge, photographic wastes) exists today.

Noise pollution. Urban noise and traffic congestion are emergent problems in some of the cities in Sabah, but still on a relatively low level. It can however be predicted, that as the standard of living improves, people will become more sensitive to the level of noise in the environment.

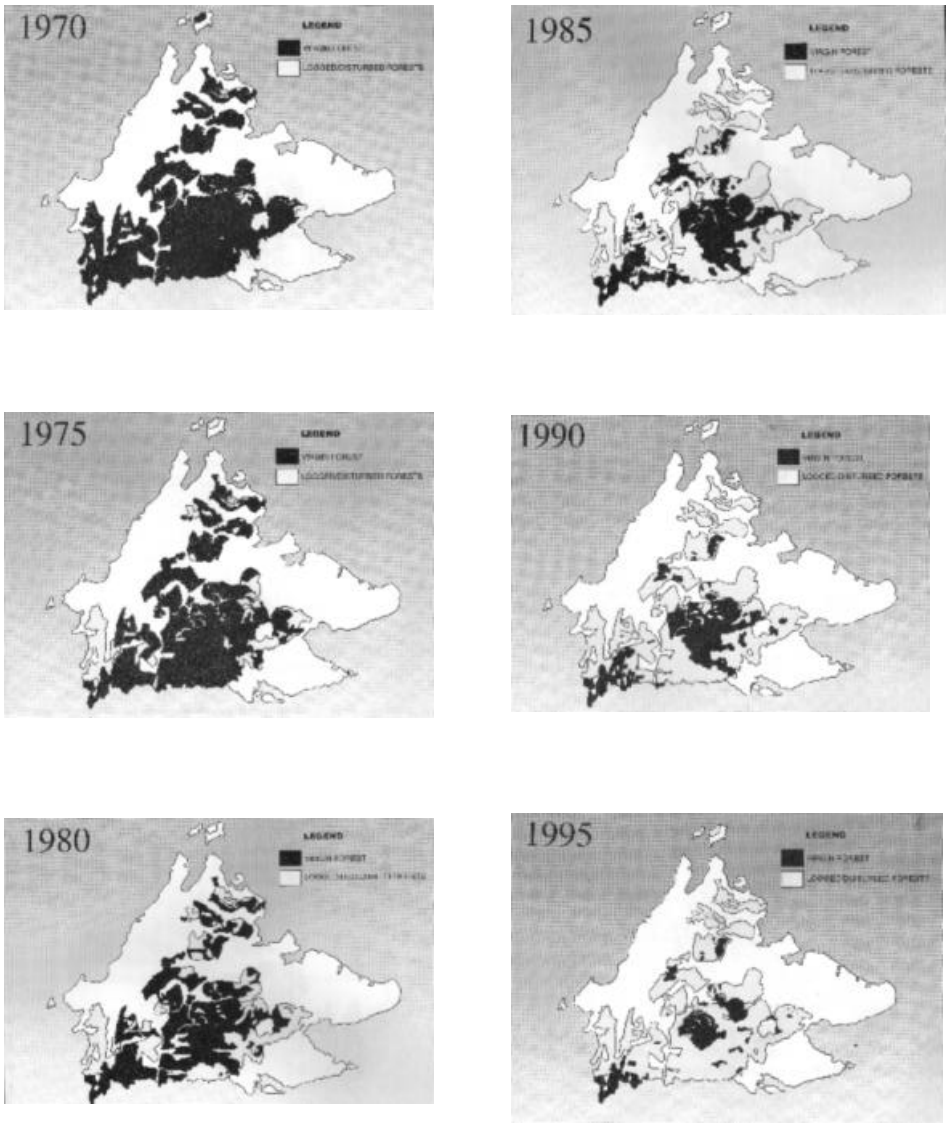
3.5 Forestry

Overview

Since independence, the State has been dependent on forest resources for generation of revenue. Forest resources contributed with 40-50 % to the State revenue in the 1990's compared to 60-70 % in the 1970s and 1980's. Logging has been carried out both on Commercial Forest Reserve and State Land Forests. About 2.744 million hectares of the total land area of Sabah have been constituted as Commercial Forest Reserve.

Forests (mangrove, swamps, lowland and hill dipterocarp and montane forests) constitute the bulk of non-agricultural land in Sabah with 60.1 % in 1992. Deforestation of almost 90 % of the Sabahs undisturbed dipterocarp forests during the last decades resulted in a high GDP growth by the forestry sector in Sabah. Figure 3.5-3.10 shows that from 1970 to 1996, virgin forest areas dwindled by 90 %. According to projections, by the year 2010, almost all virgin forest areas will be gone (Sabah State Government, 1998).

Table 3.5-3.10. Virgin forest reserves and logged disturbed forest 1970-95 (Sabah State Government, 1998)

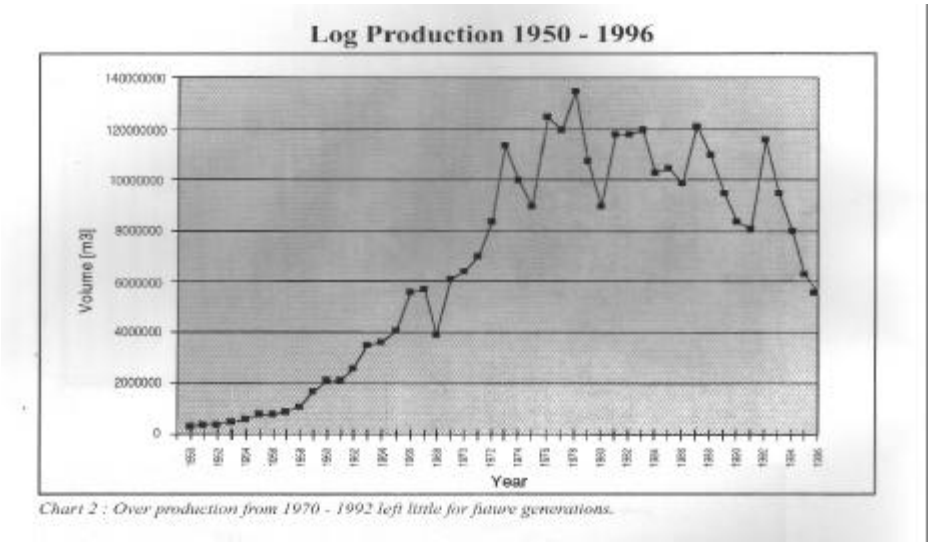


Environmental impact

Excessive cutting and indiscriminate logging practices in the past has taken its toll. Unsound logging practices have not only caused danger of gradually forest resource depletion, but it also has led to substantial ecological destruction. The various adverse environmental impacts due to bad logging practices have been widely documented. The high dependence on heavy logging machinery such as the iron-wheeled tractors, and the unplanned construction of logging road networks have helped to accelerate erosion and movement of earth and other debris downhill. This has caused siltation and sedimentation of rivers, streams and other water bodies.

The high logging rates in the last decades have resulted in a decreasing (and unsustainable) forest harvesting yield, see Figure 3.11. Taking 1970 as the base year, production leaped from 6.0 million cubic meters to almost 14.0 million cubic meters in 1978, an increase of 133 %. This rate was maintained until 1992, where a drop in production was seen to less than 6.0 million cubic meters in 1996.

Figure 3.11. Log production 1950-1996 (Sabah State Government 1998)



3.6 Agriculture

Overview

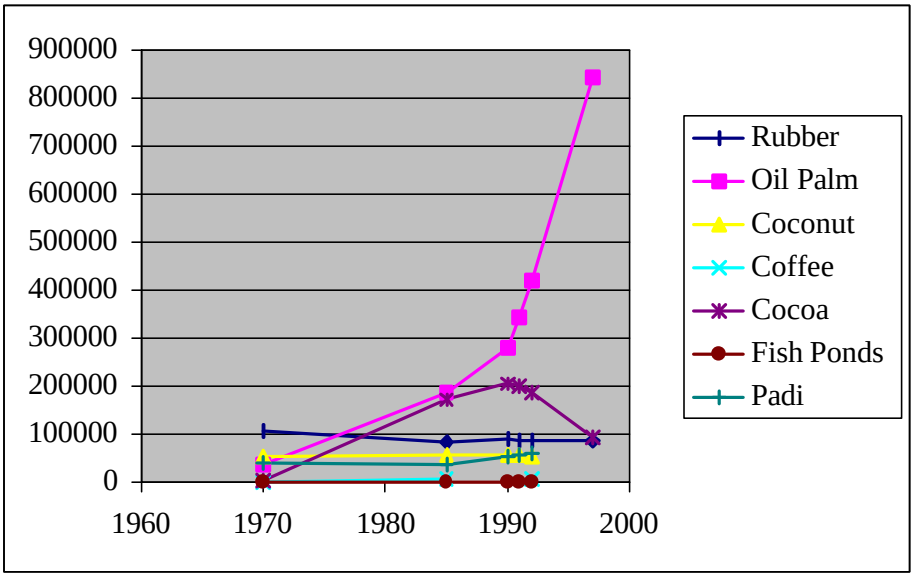
Agricultural land comprised in 1992 only 12 % of the total land area (compared to 28 % for Sarawak). Oil palm plantations were the major land user at 5.7 % of Sabahs total land area with an annual growth rate at 10 % between 1970 and 1992, see Table 3.7.

The development from 1992-97 shows that 843,952 hectares in 1997 were planted with oil palm, which were almost a doubling since 1992, see Figure 3.12. Felda Oil Palm Plantations, located in the district of Lahad Datu, is managing about 638,000 hectares of oil palm plantations, and is among the largest oil palm producers in the world. Cocoa on the contrary had decreased with almost 50 % to 94,331 hectares, while rubber maintained approximately the same level with 86,109 hectares.

Table 3.7. Agricultural land use Sabah 1970-91 (MOSTE, 1997)

	1970 %	1985 %	1992 %	1992 ha
Oil palm	0.5	2.5	5.7	421,958
Cocoa	0.1	2.3	2.6	188,841
Rubber	1.4	1.2	1.2	88,022
Padi	0.6	0.5	0.9	62,284
Coconut	0.8	0.8	0.8	55,337
Other	0.1	0.1	0.7	47,640
Total agriculture	3.5	7.4	11.7	864,082
Non-agriculture	96.5	92.6	88.3	6,507,018
Total	100.0	100.0	100.0	7,371,100

Figure 3.12. Agricultural land use 1970-97 (MOSTE 1997, Daily Express 2000)



Environmental impact

The major environmental concerns associated with the agriculture sector are suspended solids from soil erosion as a result of massive land clearing, and industrial effluent discharges from oil palm refineries and rubber factories, which can be harmful to diverse life forms in aquatic and marine environment. In addition, the application of biocide and fertilizers may spill into rivers and other water bodies, which can be detrimental to human, and the aquatic ecosystems.

Continued conversions. The regional soil surveys for the State of Sabah indicated about 29% or 2.2 million hectares of the total land area are suitable for agriculture, see Table 3.8, and future high land conversions rates to agricultural purposes can be expected in the coming decades making considerable impact on land use patterns, environmental habitats and biodiversity. Plantations will continue to supersede forests, especially along the East Coast of Sabah.

Other important environmental impacts of plantations are related to the construction phase, for example through planting on the riparian reserves, and the utilization of pesticides and chemical fertilizers. The widespread use of monocropping will substantial influence and change the nature, environment and species diversity in Sabah.

Table 3.8. Extent of soil suitability in Sabah. 1996 (MOSTE 1997)

	Class 1	Class 2	Class 3	Class 4	Class 5	Total
Ha	7,461	606,406	1,532,383	762,004	4,313,200	7,221,454
%	0.1	8	21	11	59	100

Agrochemicals. Gains in agricultural productivity results largely from the use of high yielding crop varieties requiring the intensive use of inputs such as irrigation water, chemical fertilisers and pesticides. Monocropping adds to the agrochemical problems, in that planting only one crop, season after season, gradually drains soil nutrients and then requires increased application of chemical fertilizers and use of pesticides to prevent and control outbreaks of diseases and pests. In Asia the use of fertilizer doubled from 1977 to 1987 (United Nations, 1990) and the rate of use increased by 7,5 % per annum. The adverse impacts of the use of fertilizers include the accumulation of phosphates and heavy metals in soil, leaching into groundwater of nitrates, phosphate and postasium and the run-off of agricultural surface water causing eutrophication of lakes and pollution of rivers. Pesticides used include insecticides, herbicides and fungicides. In Asia the use of pesticides increased by 57 % per annum in the 1980s (United Nation, 1990).

Shifting Cultivation. Shifting cultivation has created some impact on the general landscape of Sabah. It involves land clearing by burning the existing vegetation, and replanting with fast growing crops such as hill padi, maize, tapioca and various types of vegetables. The crops produced are normally just sufficient to meet the annual needs of the farmers and their families. It is estimated that around one million hectares of land in Sabah have been subjected to some kind of shifting cultivation activities. Shifting cultivation is normally sustainable due to the long fallow period, which allows for the rejuvenation of soil. However, if practiced on steep mountainous areas, the problems of soil erosion and land degradation can be potentially serious. In Sabah, these practices are now on the decrease as more and more of the rural populace are being resettled in new villages in an effort by the Government to bring them into the social mainstream.

3.7 Tourism

Overview

Since the 1980s, tourism has become an increasingly important industry both worldwide and in Sabah. Tourism is the worlds largest and most dynamic industry with 10.7 % of worlds GDP, and the industry's gross output is predicted

to double from 1995 to 2005. In 1995, 1996 and 1999 approximately 7,5 million tourists visited Malaysia each year, while 1997 and 1998 experienced a drop in visitors to 6,2 and 5,5 million respectively (Adlin, 2000). No tourist arrival statistics is available for Sabah. According to the Sabah Tourism Masterplan approximately 100,000 tourists visited Sabah yearly from 1980-94. The arrival growth rate was considerable smaller in Sabah compared to the rest of Malaysia, in that arrivals to Sabahs increased by 29 % from 1980-94, as opposed to Malaysia's 220% growth in the same period (Ministry of Tourism and Environmental Development, 1995). The tourist revenue estimated for 1994 was 187 million RM.

Sabah, with a number of world class tourism products like Mt Kinabalu, nature and wildlife, soft and tough adventure activities, ethnic cultural experiences, diving, snorkelling, rafting, jungle trekking, mountain climbing, islands, beaches and golfing, has in the last 5 years experienced a rapid investment growth in the tourism industry and has today 255 hotels with more than 10,000 rooms. Approximately 9,000 people are employed in the industry today (Adlin, 2000).

Environmental impact

The impacts of tourism to the environments are diverse. The tourism industry supports and encourages the conservation and protection of nature resources and the establishment of protected areas for tourism purposes.

However, in case of over-exploitation or unplanned tourism activities, damage to marine parks, corals and associated marine life, clearing of forested land for transport and access routes and buildings, increased solid waste, adverse effects on wildlife, removal of mangrove trees for construction of boardwalks and littering can be experienced. Over-exploitation of some of the most attractive islands in Sabah has been reported.

3.8 Fisheries

Overview

The total fisheries production in Sabah in 1994 was approximately 170,000 tonnes with marine fisheries contributing 161,000 tonnes or 95 % and aquaculture 9,000 tonnes or 5 % (Fisheries Department, 1996) with an annual growth rate at 6.6 from 1990-94. Difficulties in maintaining these growth rates - sustainable yields – have been experienced in the recent years. The total value was estimated at 360 million RM in 1994, whereof aquaculture contributes with approximately 21 %. Approximately 22,000 full-time fishermen are employed in the fisheries industry.

Environmental impact

The problems faced by the fishery industry includes destruction of important breeding and feeding areas, destruction of aquatic habitats and the degradation of the aquatic environment. Mangrove forests are increasingly being cleared for agricultural, aquacultural and other purposes and degraded by pollution or the diversion of drainage water. Coastal areas are threatened by coastal erosion. Effluents from industrial and domestic discharges, land reclamation, illegal dumping, accidental spillage of oil wastes also contributes to degradation of the

aquatic environment. Other problems include over-exploitation; unsustainable fishing practices e.g. the use of spear guns, fish poisons and fish bombing

Studies by Universiti Malaysia Sabah, e.g. a study in 1998 on the status of the coral reefs of Darval Bay off Lahad Datu, has shown that fish bombing activities in Sabah has resulted in serious damage to coral reefs and declining catches. A study made of the Institute of biodiversity and environmental conservation of Unimas revealed that on average 2 ½ blasts of fish bombing were recorded per hour from Mabul, Ligitan, Silam, Kunak, Mantanani and Sipadan islands off the coast of Semporna.

According to the Fisheries Department, an overall reduction from 1996 to 2000 in fishing by blasting with explosives has taken place. In 1999, 91 cases of fish bombing in the 16 districts of Sabah were reported, and 15 of these cases were brought to court.

4 Environmental Indicators

Instead of attempting a summary of the State of the Environment in Sabah, this chapter focuses on one of the attempts the Environmental Conservation Department will undertake in order to manage and direct the future of the environment in Sabah, namely the development and implementation of an information system on the status of the environment in Sabah.

As the previous chapters have indicated a number of key environmental issues exists in Sabah. At the same time it is also clear that today a general overview of the environmental status and development in the state do not exits. Environmental information is scattered, is gathered but not used or disseminated and is in general not widely shared between the key environmental players in Sabah. Environmental issues are in general not systematic monitored.

It is therefore one of the aims of the Environmental Conservation Department to establish an overview of the development in key environmental parameters for Sabah. This is expected to be done through establishing an environmental indicator system and based on this system to continuously report and disseminate environmental data through an Environmental Indicator Report.

It is expected that the Environmental Indicator Report will be structured in approximately the same format as the present Report focusing as well on the state of the environment as on society's impact on the environment.

A key issue for the development of the indicator system will be the selection of indicators on which data can be collected on a regular basis and that reliable can indicate or monitor the environmental status and development of the selected environmental issues and impacts.

Table 4.1 outline initial and very preliminary issues, indicators and measurement methods that could be applied in an Environmental Indicator System for Sabah. The *first* column outlines some of the key environmental issues resulting from the natural resource related environmental development and land use change on the environmental systems in Sabah, namely in-land water, marine, biodiversity, landscape and air quality.

The *second* column gives possible indicators that could be established in order to monitor the status and development for the system impacted. An important feature for the environmental indicators is their 'value loaded-ness'; they must

be of interest to the Environmental Conservation Department, to the key environmental stakeholders and to the people of Sabah. Appropriate indicators should be able to detect changes and trends over time.

The *third* column indicates possible methods of measurements. An important feature of good indicators is their 'measurability' i.e. that they economical, technical and logistical are possible to monitor and measure. If not, other indicators for the system impacted have to be found.

It is expected that the environmental indicator monitoring system will be elaborated and fine tuned during the coming year. All relevant environmental stakeholders in Sabah will be involved in the development of the system.

Table 4.1 Examples of environmental systems impacted, possible indicators and methods of measurement

System Impacted	Examples of indicators	Examples of measurement methods
In-land water	A clean Sungai Kinabatangan	(i) Suspended sediment, (ii) Indicators of the biological status e.g. dissolved oxygen, pH
	Use of fertilisers in Sabah	(i) Presence of fertilisers in river system, (ii) import of fertilisers, (iii) information on fertiliser distribution and use
Marine	Healthy corals at Tunku Abdul Rahman National Park	(i) Area of healthy coral coverage, (ii) diversity of coral and related life
	Water quality in the vicinity of Kota Kinabalu	(i) Presence of selected elements (pollutants) e.g. phosphate/nitrate
Biodiversity	Extinction rates	(i) Known rates of species extinction
	Change in status of individual species e.g. Orang utan	(i) Estimates of species population
Landscape	Changes in forest cover	(i) Mapping
	Status of mangroves Status of protected areas	(i) Mapping, (ii) quality data (i) Mapping
	Disturbed hills	(i) Number and amount of disturbed hill area
Air	Open burning	(i) No of reported cases, (ii) pollution measurement

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