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Environmental Indicator Report, Sabah, Malaysia

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Preface

In Sabah, we are blessed to have inherited a spectacular environment, abundant natural resources and a world-renowned assemblage of ecological diversity, which together constitute our home. It is to our home that we turn to provide an environment for recreation, and the natural resources for supporting industry and providing energy and sustaining agriculture. These activities place pressure on the environment and since it is our home, it is vital that we balance our behaviour and live within our means. Living in and with our environment we must take note of what nature can sustain and think ahead and plan what is best for future generations.

The first State Environmental Indicator report sets a baseline for information about our environment in Sabah, our progress towards sustainability, emerging threats to the environment and the challenges ahead.

We have attempted to make the report as readable and non-technical as possible so that everyone can take part in looking after our environment. It shows us the state of the environment now – what is happening, why it is happening and what we are doing about it. It is a snapshot in time against which future changes can be measured.

The Environment Protection Department is working together with communities, industry and business to make improvements, but no one agency can deal with all of the issues or manage all the problems. The environment is everyone's business. It is our responsibility to let our children and their children enjoy and benefit from this same spectacular environment.

Datuk Eric Juin
Director
Environment Protection Department

Table of Contents

Introduction

At the turn of this new century, we find the Sabah of today a place of rapid and dynamic change. Prior to the turn of the 20th Century, the impact of human activities on the environment in Sabah were limited and to a large extent passed unnoticed. In stark contrast, the situation today is characterised by change and transition. Malaysia has experienced consistent economic success with sustained high economic growth rates, making it one of the fastest growing economies in Asia. In Peninsular Malaysia this achievement has been attributed to its success in moving from a commodity based and agriculturally dependent economy to a competitive manufacturing economy through diversification into resource processing, high technology and export industries. However, this development path has yet to take place in Sabah, which still remains largely dependent on natural resources and agriculture as the primary source of income. The growth of oil palm production has significantly contributed to agricultural growth in Sabah. As we in Sabah start along this path of transition, environmental change will unavoidably follow. Development must take place and change will continue, as population growth without economic growth equates to increased rates of poverty, which in turn severely degrades the environment.

Sabah is now at a critical juncture in economic development, at which the environmental consequences are most severe. There is continued reliance upon natural resources and conversion of lands to agriculture, continued rapid population growth and the emergence of urbanisation and industrialisation. These combined pressures will continue to dramatically alter the environment until the land-use development pattern of the State reaches a more stable condition. During this period of growth, important decisions and technology will be required to manage the impact of urbanisation, industry and the ever increasing number of people on the environment.

The human impact on the environment, although disturbing to witness, is an inevitable consequence of us being here, of population growth, urbanisation, land use change and economic development. Although this process is almost unavoidable, the scale of the environmental impact can be managed. If Sabah is to support its rapidly growing population, the landscape of the future will change. More land will need to be converted to agriculture and agricultural land will be converted to housing and other uses as urban centres continue to expand. It seems most likely that in the future, the remaining undisturbed forests will only be found in our protected areas, which will increasingly become sanctuaries for wildlife and recreation.

This does not mean that development can proceed regardless of impact. Responsibilities must be clear and remain in place. Good environmental quality is essential to our well-being, so aspects of the environment that we would like to protect and maintain needs to be identified now and indicators identified to monitor whether or not we are able to protect and maintain the environment in the selected areas.

In its truest sense, the landscape and environment of the future will be governed by what we do today.

Environmental indicators

Indicators are used to assess the state of the environment and to provide an overview of development impacts within specific topics. We have selected a number of topics we would like to follow. Within each topic, selected specific indicators (quantitative data sets) were chosen to provide an impression of the development trend for the topic.

The first group of indicators in this report are concerned with *transition and change* and the pressure this places on the environment (part 1). These indicators cover areas and trends we would like to monitor in order to understand the processes occurring today and when possible, predict future changes to the condition of our environment.

Rates of economic development, population growth, urbanisation, patterns of land-use and our climate set the agenda for the availability, sustainability and quality of almost all natural resources in Sabah. The trends in these five areas provide information about the present and future environmental pressures and the changes we may expect.

It has been experienced in other countries, that after a transitional period of rapid development, a number of development pressures stabilise; population growth will come to a stop, maybe even decline, the size of the cities will more or less find their limits, economic patterns will see less fluctuations, and the use of land will settle in a more stable pattern. This is yet not the situation in Sabah. This indictor report will follow the development within four key areas for the understanding of environmental change.

The second group of indicators concern *aspects of the environment we would like to protect and maintain.* What it is we would like to protect for now and the future. This could, for example, be clean rural and urban rivers, clean seas and beaches, well protected forest areas, mangroves and coral reefs, abundant wildlife, clean cities, beautiful landscapes, and our cultural heritage. In this indicator report we have selected seven areas of environmental importance in Sabah; areas we would like to keep and monitor (part 2).

The seven areas we focus on are; forests, mangroves, rivers, coral reefs, wildlife, marine fisheries and cities.

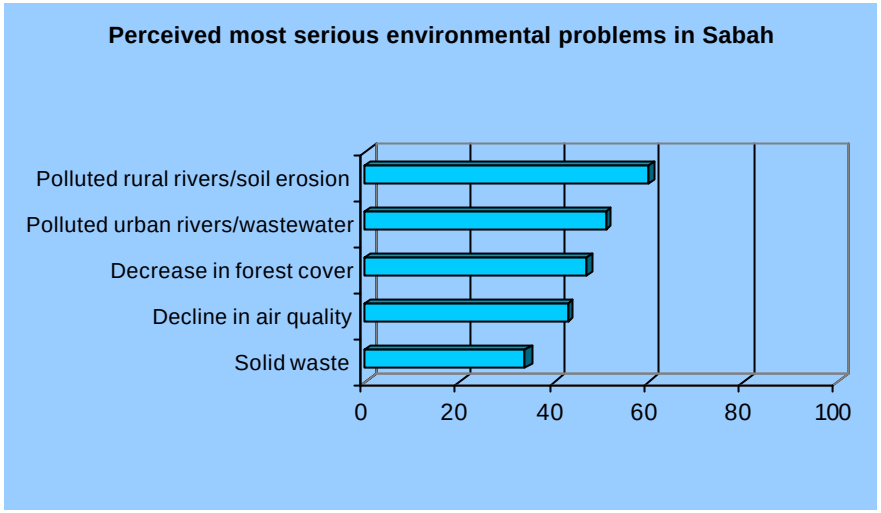
To a large extent the selection of indicators for each topic was influenced by availability of data. A broader range of indicators would provide a more complete sample of environmental trends. Our aim has been to cover the main aspects of environmental concerns in Sabah today, with the data available today. Future reports, may include more.

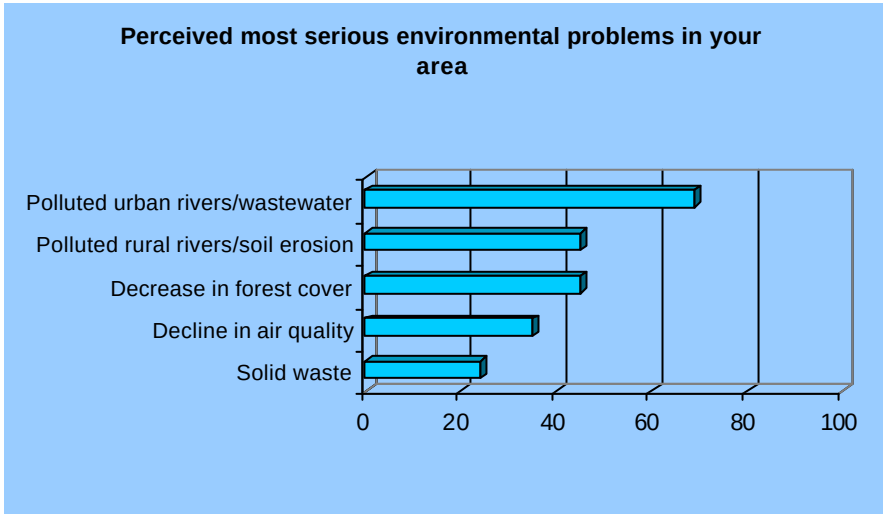
Public opinion

Sabah is often seen as a land of forests and many groups, both nationally and the internationally are concerned with the loss of forest cover and the accompanying loss of biodiversity.

When Sabahans were asked what they perceived as the main environmental problems in Sabah (out of 10 options), the top five were (i) polluted rural rivers/soil erosion (60% of respondents), (ii) polluted urban rivers/wastewater (51%), (iii) decrease in forest cover (47%), (iv) decline in air quality (43%) and (v) solid waste (34%). Issues rated lowest were noise (6%), decrease in marine fishstock (14%), decrease in wildlife population (16%), mangrove destruction (17%) and coral reef destruction (25%)

Asked about the thee main environmental problems in your area, the top five were (i) polluted urban rivers/wastewater (69%), (ii) solid waste (45%). (iii) decline in air quality (45%), (iv) polluted rural rivers (35%) and (v) decrease in forest cover (24%) (Source: Environment Protection Department, 2002. E-mail questionnaire to all government staff in Sabah with an email address registered at Sabah Net. Number of respondents: 161)





PART I

Change and transition

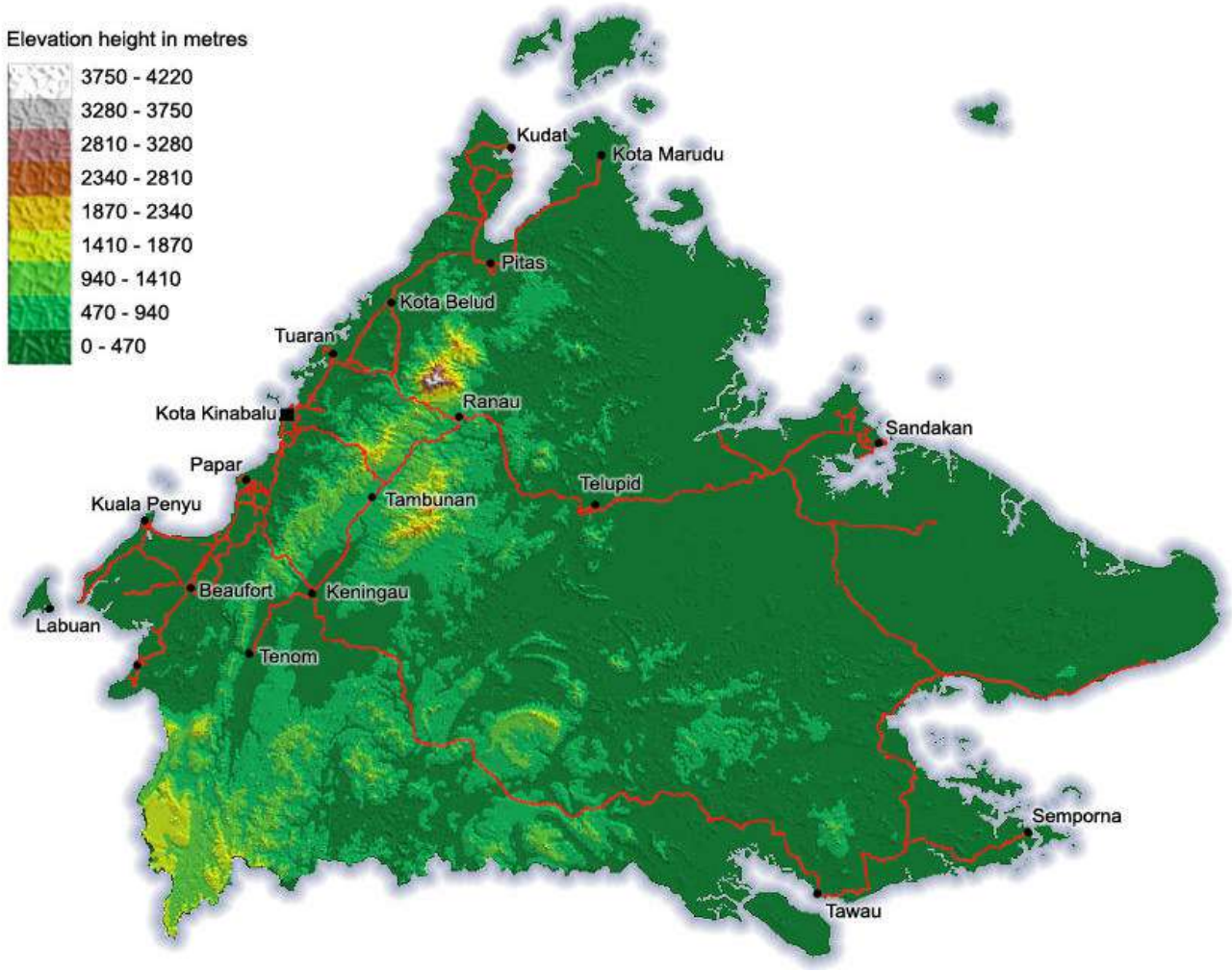
– an overview of trends affecting our environment

LAND

LAND

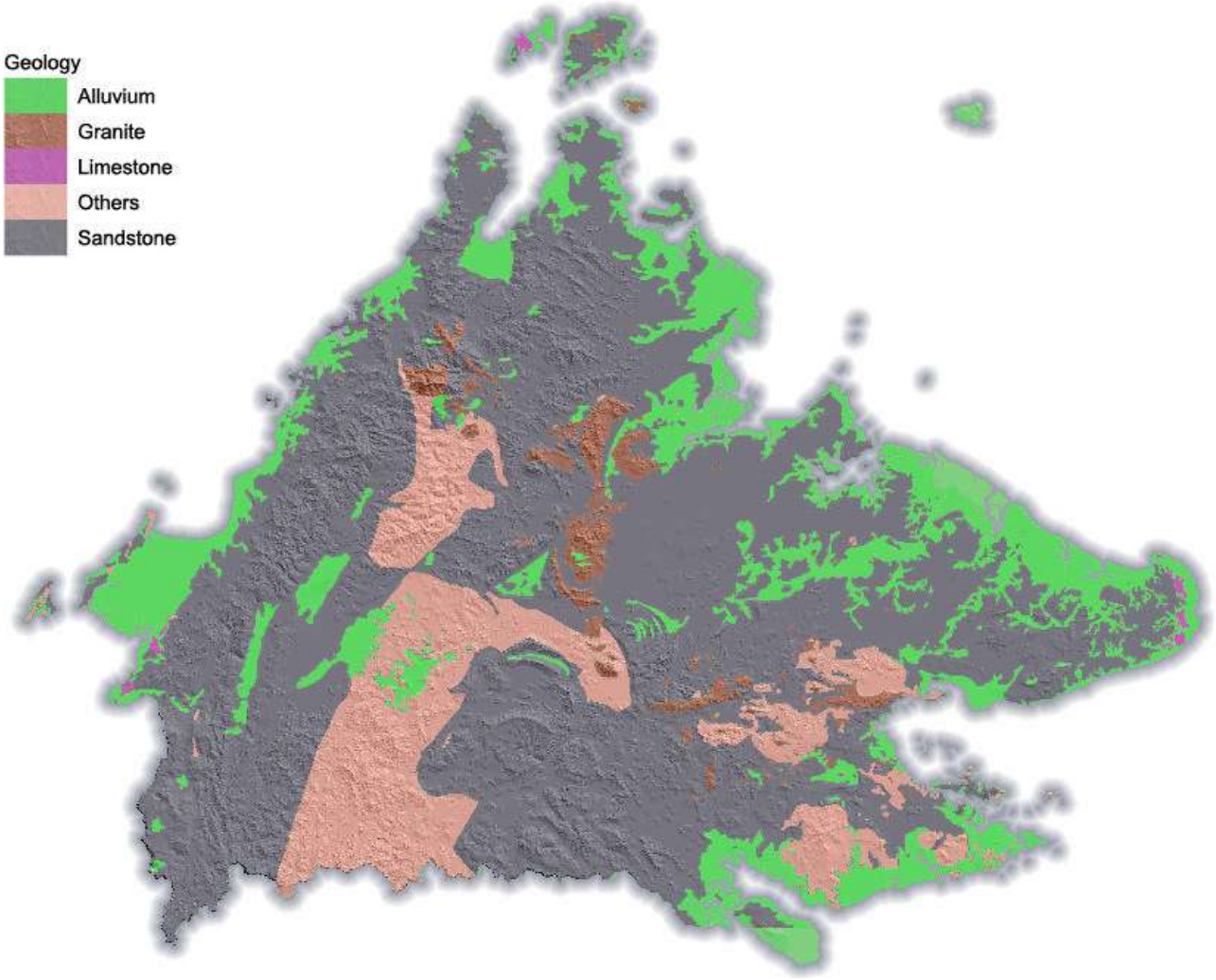
Nature, environment and land use development patterns in Sabah are closely linked to its geographical attributes. Within a land area of about 73,7 million hectates Sabah exhibits a remarkable range of physical landscapes and an accompanying assemblage of rich ecological diversity. The deltas and lowlands in the north-east and east consist of extensive areas of flatland just above sea level. In contrast the highlands of west, central and southeastern Sabah are characterised by rugged hill and mountain ranges with elevations predominantly between 300-1200m above sea level, including the highest mountain in Southeast Asia, Mount Kinabalu, which peaks at about 4,105m. Much of the coastline is bordered by coral reef, and fringed by mangroves, particularly near river mouths.

While the physical attributes of the landscape provide much beauty, the many hills and ridges constitute a serious limitation to agricultural development, while the flat lying coastal areas, particularly areas close to the sea, are poorly drained and periodically flooded, which may give rise to saline conditions in the soils and poor nutrient status.



The physical environment of Sabah (Source: Environment Protection Department)

Sabah is characterised by a highly irregular coastline, particularly along the east coast where some of the softer sedimentary rocks have been eroded. Erosion, combined with high sedimentation rates has created an environment of shallow seas and many deep indentations - bays. Inland, more resistant sedimentary rock types form higher ground and long strike ridges. In the north-east, even harder crystalline rocks are responsible for stretches of rugged, shoreline.



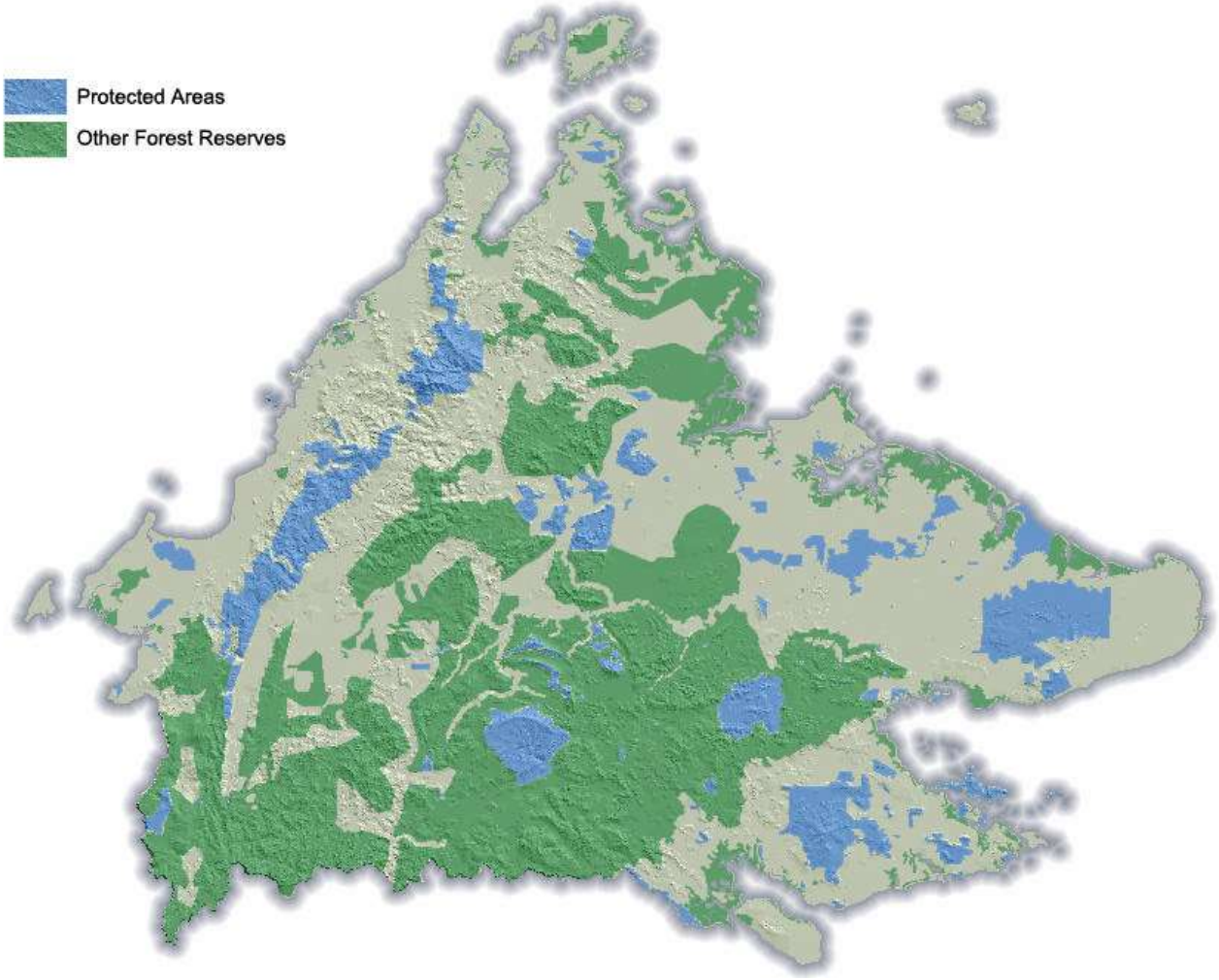
Alluvium is a form of sedimentary deposit, comprising of material eroded, transported and deposited by rivers. Alluvium is found along the coast line and valleys, adjacent to higher land from where the material was eroded. Thick layers of sediments; mainly sandstone but with some silts, muds and occasional coal, cover the main parts of the interior, while igneous rocks, mainly granite, is found in the interior at the Mt. Kinabalu

LAND

Of the 7.37 million hectares land area, about 3.9 million hectares are classified as reserved land such as forest reserves, parks and wildlife sanctuaries. The reserved land occupies mainly interior regions of the state and has the potential to provide important protection for extensive areas of steep lands.

Land outside of these reserves, mainly lowland areas, is available for private or state development. Apart from some mangrove reserve areas, much of the coastal zone of Sabah has already been developed or will soon be developed. About 3.2 million hectares have been alienated, while the rest remains as State Land.

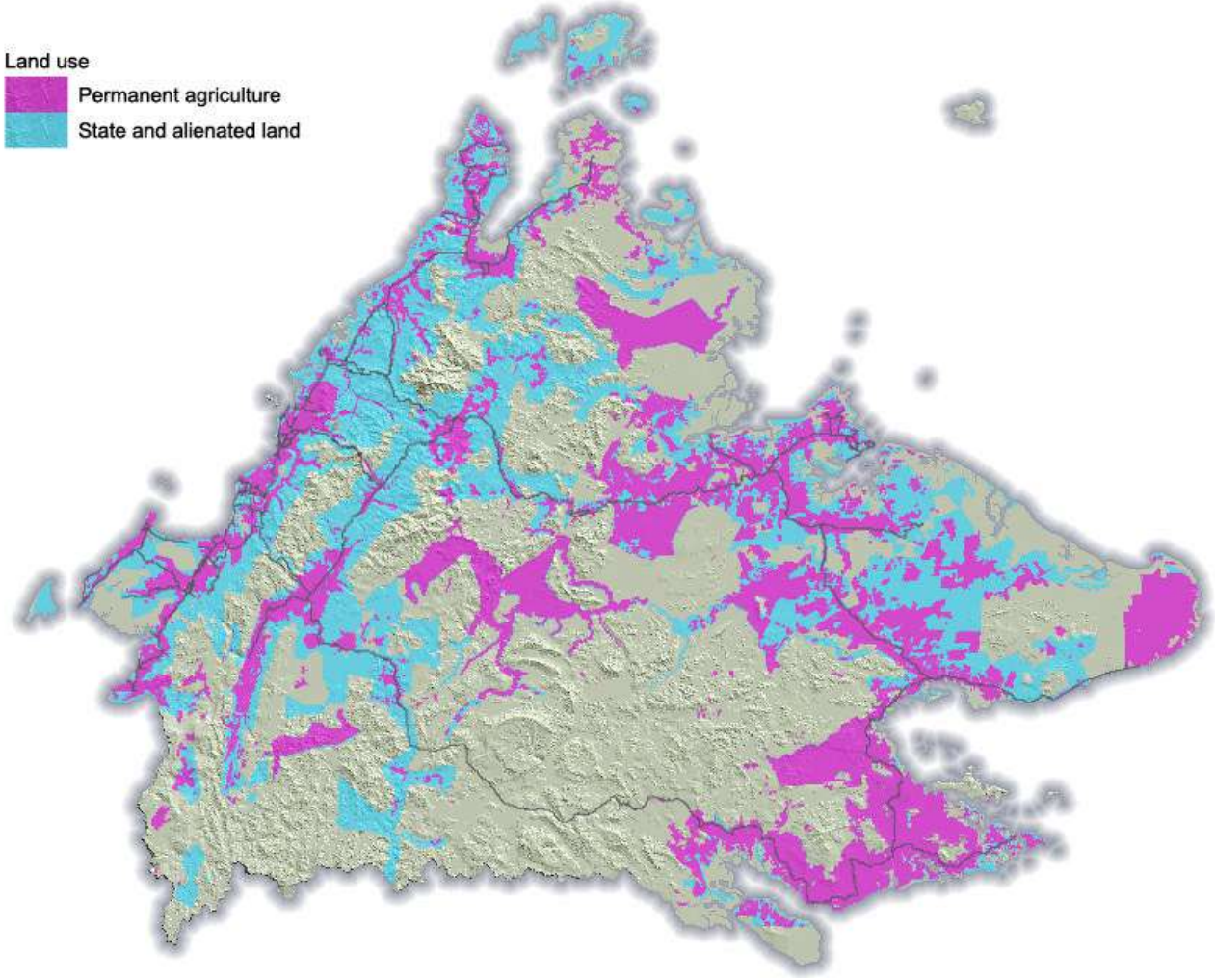
Lowland areas, which are the richest in terms of biodiversity, are today vulnerable due to pressure from agricultural and urban development.



The reserved land, marked red and blue, occupies mainly the interior steep areas of Sabah, while alienated and state land, marked grey, occupies the coastline and the low-lying parts of the interior (Source: Environment Protection Department, adapted from Sabah Forestry Department, 2001)

About thirty per cent of the Sate is suitable for agriculture of which most has already been alienated. About 16 per cent of Sabah has already been converted to agriculture, a figure, which is small compared to other states in Malaysia and countries in the region. The State still retains about 60 per cent of land under some sort of forest cover. Given the continued and projected demand for land, and the decreased economic importance of forestry to the economy, the future may see a need to review of existing land classifications.

Outside of the Permanent Forest Reserve most available land is already undergoing development. In the long term, this will place increased development pressure on the remaining reserved lands.

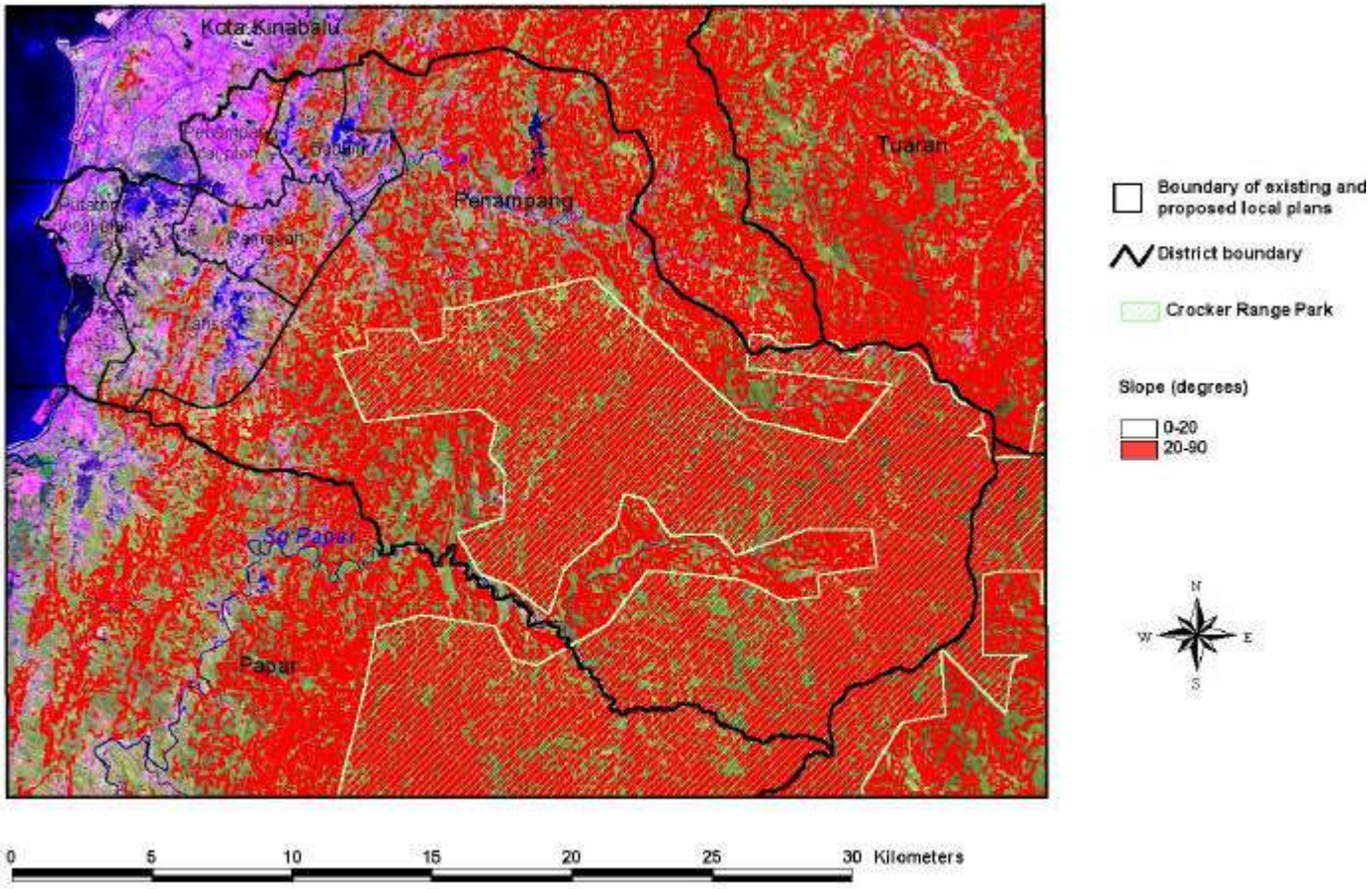


Agriculture, marked red, takes up about 16 % of the total land area. Most of the remaining land suitable for agriculture has been either alienated or classified as State land (Source: Environment Protection Department, Landsat & TM 2002 and Lands and Survey Department Radarsat imagery 1995)

LAND

In Sabah today, many of the land areas under the greatest pressure from development are steep and located in and around urban areas.

The shortage of suitable land for house construction and other development in and around Kota Kinabalu is the greatest driving force for the infilling of wet padi land

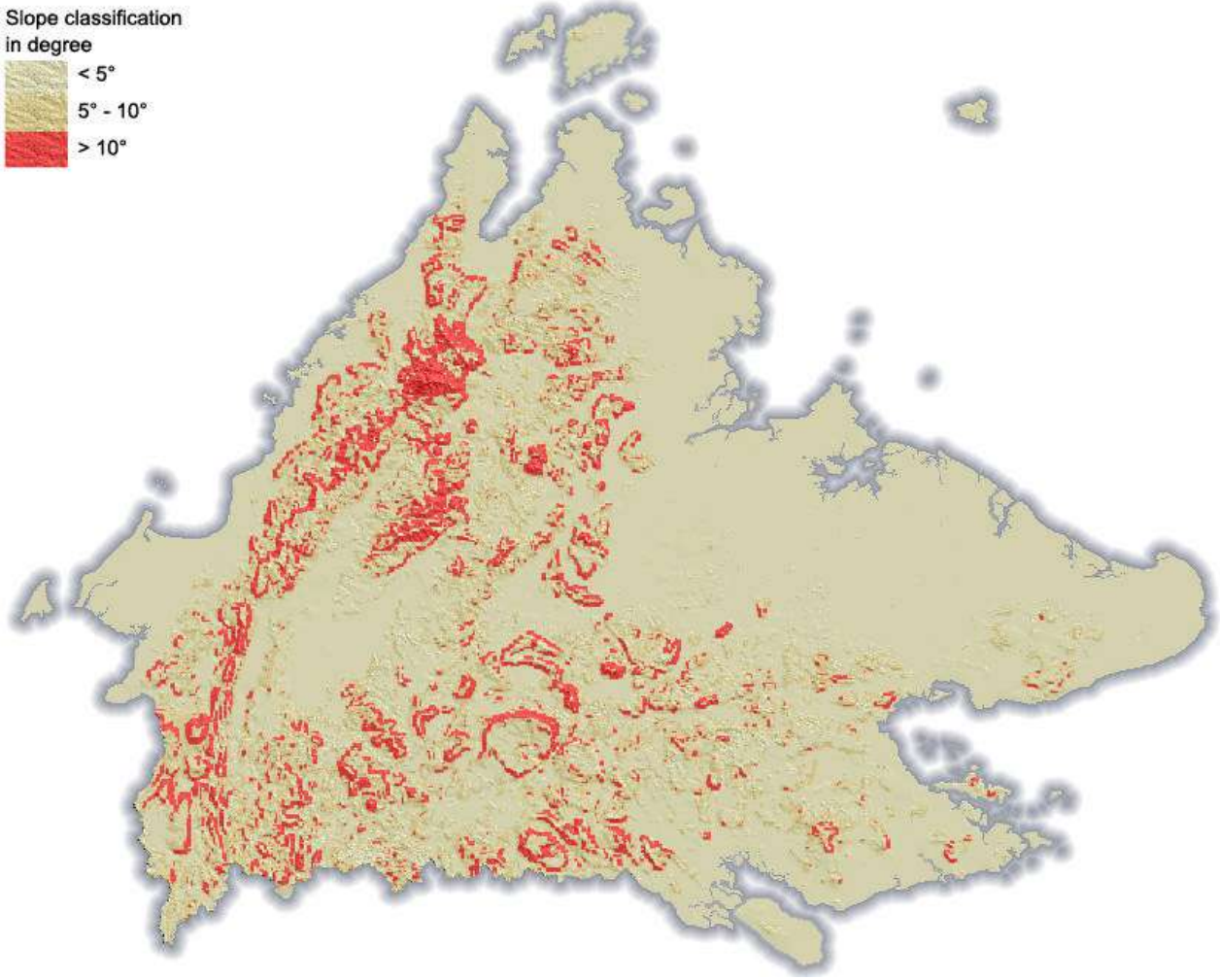


The spread of urban areas in Kota Kinabalu and Penampang Districts (pink colour) is increasingly restricted by steep lands. Red colour shows slopes over 20 degrees (Source: Environment Protection Department, satellite image April 2000)

Most of the interior lands of Sabah consist of dissected and steep slopes where tracts of gentle slopes are scattered and rarely extensive.

Steep slopes limit the type of development that may take place. Inappropriate land development on steep slopes, such as plantation agriculture, leads to environmental problems.

The traditional practice of planting of hill padi on some lands outside of forest reserves is a good management option for such steep land



Steep lands with slopes of more than 10 degree (marked red) are found extensively in almost all areas of the interior (Generalised slope values derived from digitised 500 feet interval contour lines. Source: Environment Protection Department)

LAND

At the turn of the 20th century, Sabah saw the establishment of the first agricultural estates, with crops such as tobacco and coconut palm, marking the start of the copra industry. Rubber cultivation on a commercial scale did not start until the early part of the last century. During the same period a start was made on issuing titles, in the form of leases and native titles, on all land alienated for agriculture. Shortly after, the first government reserves were constituted. The year 1919 marked the first export of manila hemp from Sabah and this crop held an important position until the 1930's. The growth of the timber industry was gradual. In the 1920-30's, British timber companies began the commercial exploitation of forests, and by the mid 1950s, the enormous growth in the timber industry was already having a great impact on land development. Many of the roads built by the timber industry formed the basis for later agricultural and state development. The introduction of oil palm and cocoa as new crops coincided with the opening up of large areas for timber exploitation and agriculture. The success of oil palm coincided with the decline of tobacco and hemp industries.

As states develop, a typical land use development model can be described as that of a period of rapid development and land conversion as state lands are made available, followed by a gradual decline and eventual stabilisation in land use change.






This satellite image taken in 1991 indicates patterns of land use along the west coast of Sabah. Pink areas represent bare land, including the top of Mount Kinabalu in the upper right hand corner of the image, wet areas such as padi and urban areas. The pink coloured coastal waters indicate plumes of sediment being discharged into the sea. This is particularly noticeable on the central-southwest of the image where the Sungai Padas discharges into the sea. Light green colours represent disturbed or altered vegetation cover and darker shades of greens indicate less disturbed or undisturbed forest (Source: Environment Protection Department)

Land use indicators

The economy of Sabah is still based on natural resource development and agriculture and what happens in these sectors strongly dictates land use patterns. More than 50 per cent of our population live in the rural areas and are directly or indirectly involved in the agricultural sector.

Other important patterns of land-use change in Sabah are the expansion of urban areas and the loss of montane forest areas due to a range of different development activities. Forests are described in a separate chapter. The following five indicator areas have been chosen to show changes in the use of our land:

Area 1: Agricultural development indicated through total land area developed for agriculture

Area 2: Development of the oil palm sector, indicated through total land area planted for oil palm

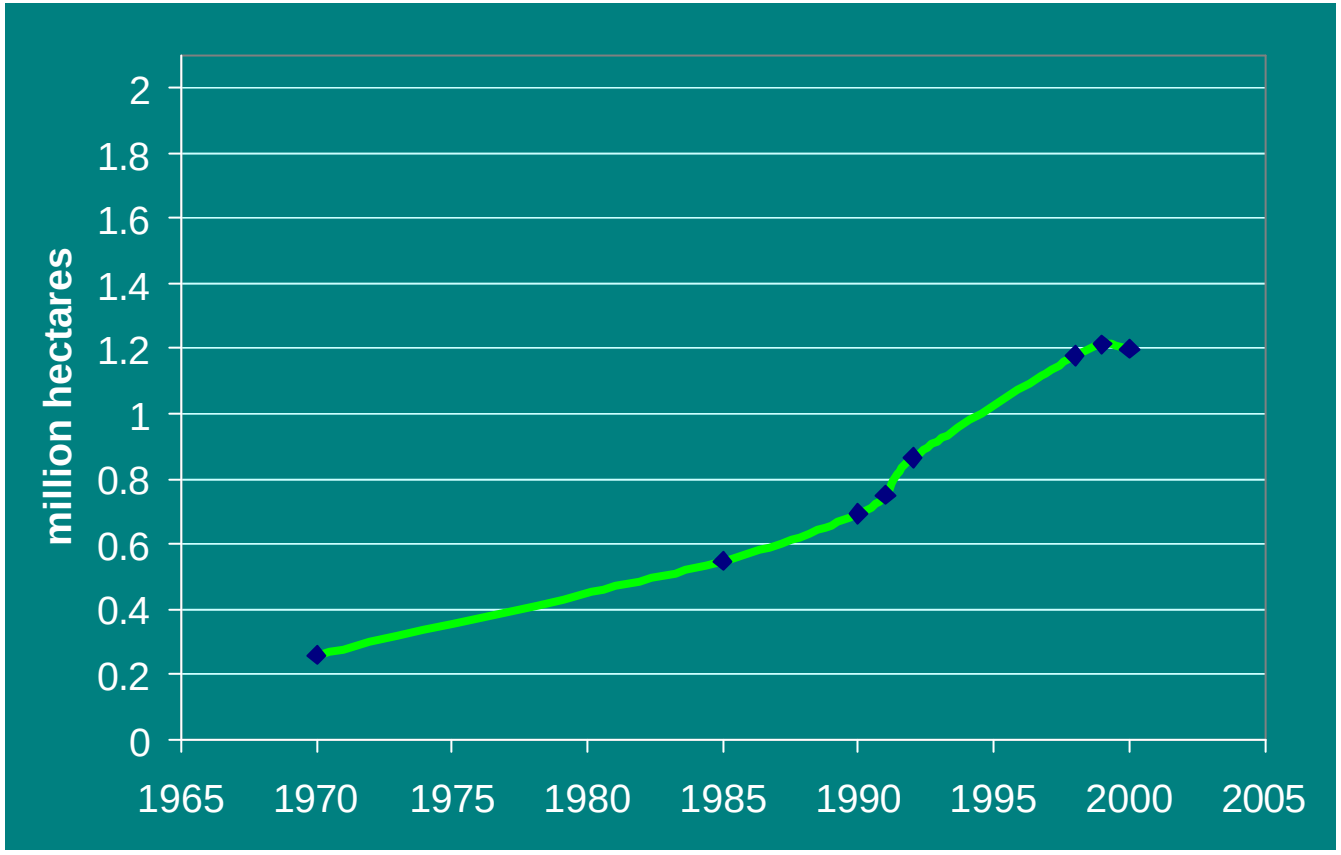
Area 3: Change in land area planted for different types of crops indicated through proportional land areas planted for major crop types – apart from oil palm

Area 4: Development of montane forest lands, the direct result of continued land use pressure even in the difficult remote environments, indicated through total area of remaining montane forests

Area 5: Expansion of urban areas indicated through growth in percentage increase of developed land in and around Kota Kinabalu and the District of Penampang, the foremost urban growth area in Sabah

Indicator area 1: Agricultural development

Changes in agricultural practice, including the expansion of land area put to agricultural use, is a key indicator of the overall development process. Sabah has alienated land at a slower pace compared to other countries in the region and other Malaysian states. With only about 26 per cent of all land alienated, and a continued high degree of land under forest reserve, it can be expected that further dramatic changes in land-use will take place in the coming decades, especially as demand for land for the primary economic activities of agriculture, mining, industry and housing continues to increase. Total land area suitable for agriculture has been estimated as 2,148,000 ha or 29 per cent of total land area.

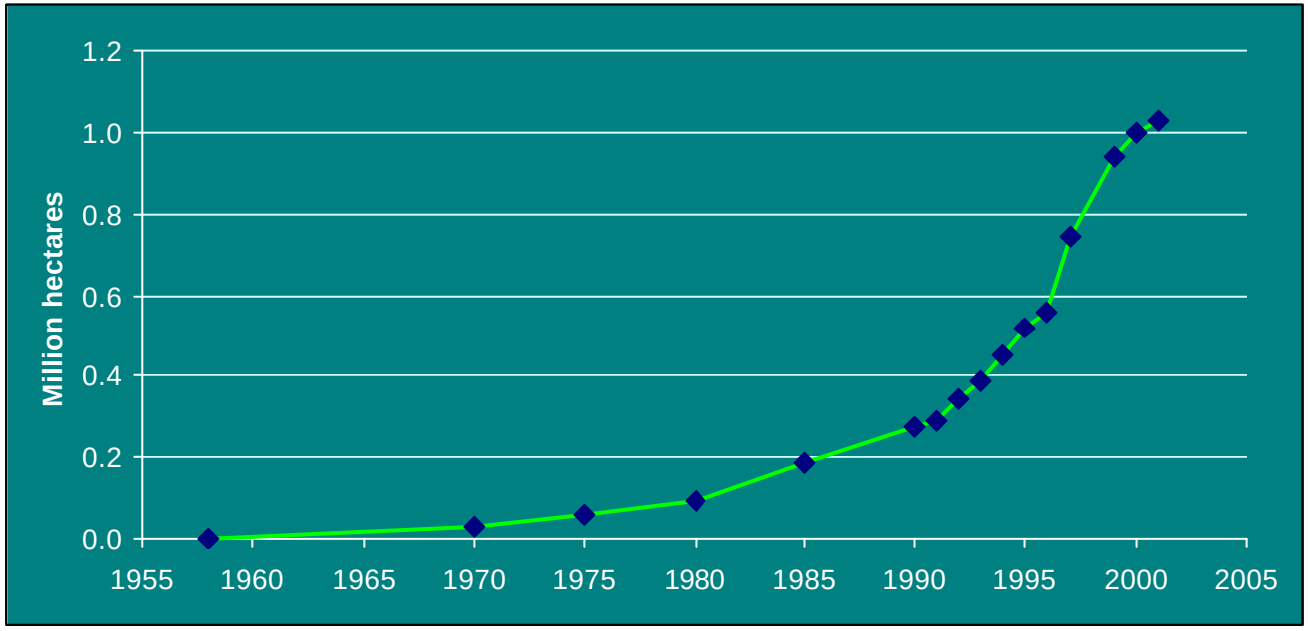


Out of a total land area of 2.1 million hectares identified suitable for agriculture, around 1.25 million hectares had been developed by year 2000 (Data includes all crop types, Source: Sabah Department of Agriculture, 2002)

Indicator area 2: Oil palm plantations

Large tracts of land have been converted to oil palm plantations, particularly along the flat lying east coast of Sabah

The conversion of forested land to oil palm plantation dominates the trend of land-use change at this point in time. The planting of around 1 million hectares of oil palm during the last decade has resulted in the loss of many millions of tonnes of soil and is one of the main reasons for the distinctive yellow colour of the rivers in Sabah.



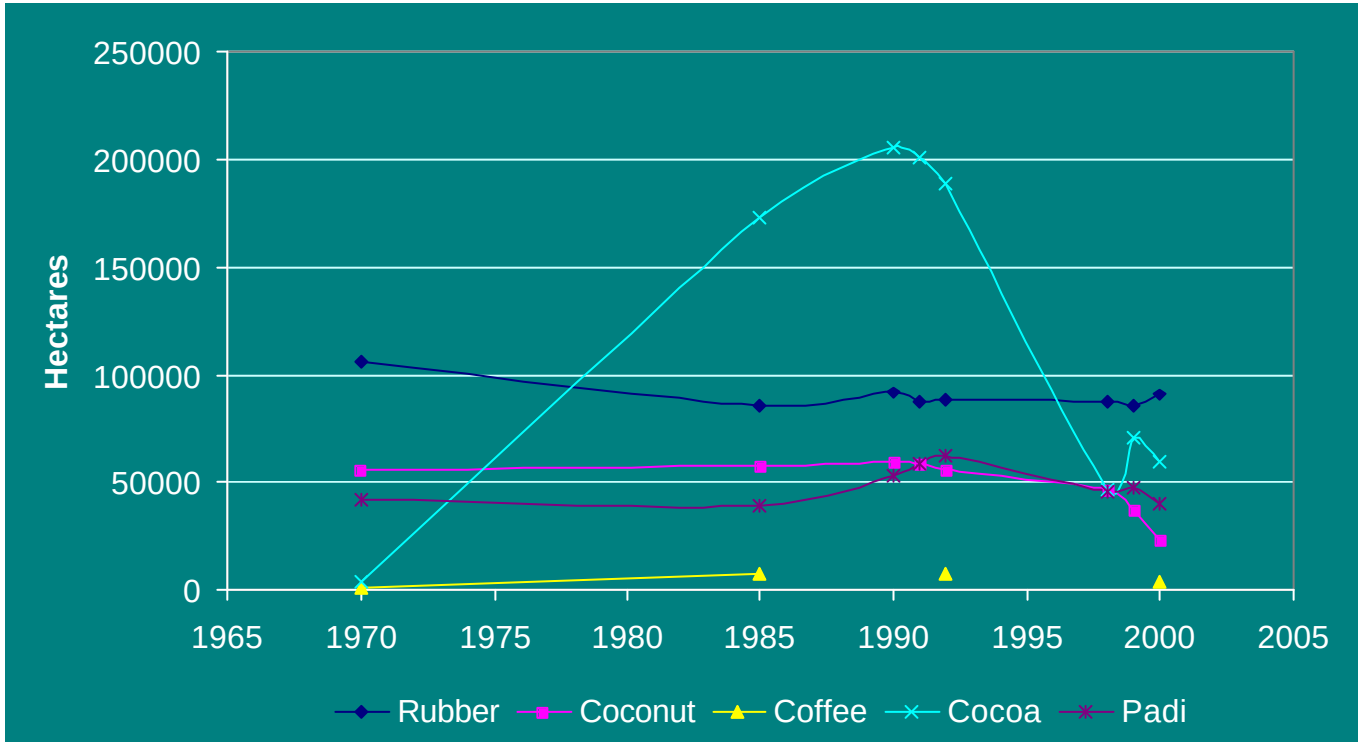
Planted area of oil palm in Sabah increased from 14 hectares in 1958 to almost 1 million hectares in 1999 (Source: PORLA/Sabah Department of Agriculture)

Indicator area 3: Change in crop types

The nature of commercial cash cropping and plantation agriculture is that it is sensitive to market demands and vulnerable to pests and diseases. This is reflected in the changing patterns of land areas put to specific crops.

The most noticeable change is the rise and fall of cocoa which developed rapidly in the 1970-80s to about 200.000 ha, only to collapse again in the 1990s to 50.000 ha in 2000. The main reasons being low market prices and diseases

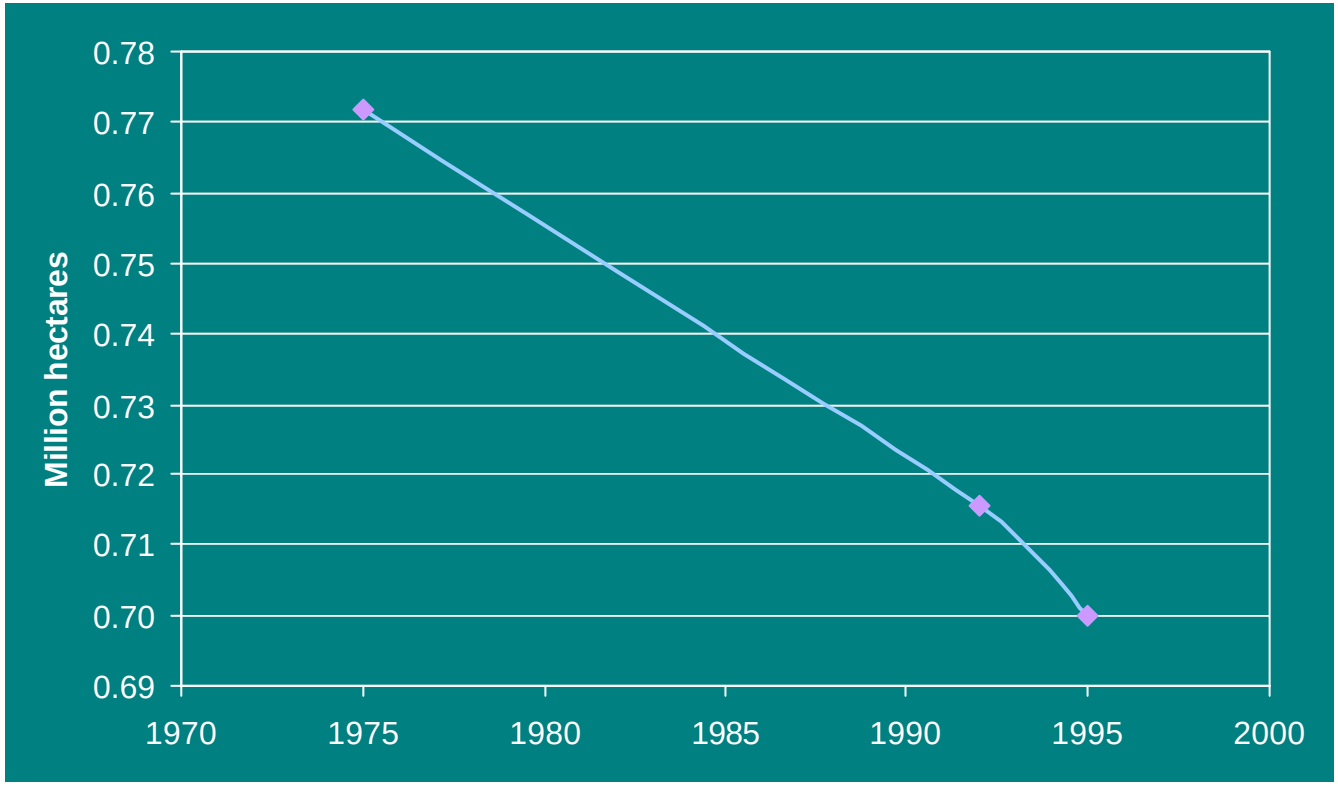
Rubber and padi has remained quite stable land users during the last three decades, at 100.000 and 50.000 ha respectively, while coconut dropped from about 50.000 ha in the mid 1990s to around 25.000 ha in 2000. Coffee has remained stable, however on a small scale, at around 5.000 ha (Source: Department of Agriculture, Sabah, 2002)



Indicator 4 : Montane forests

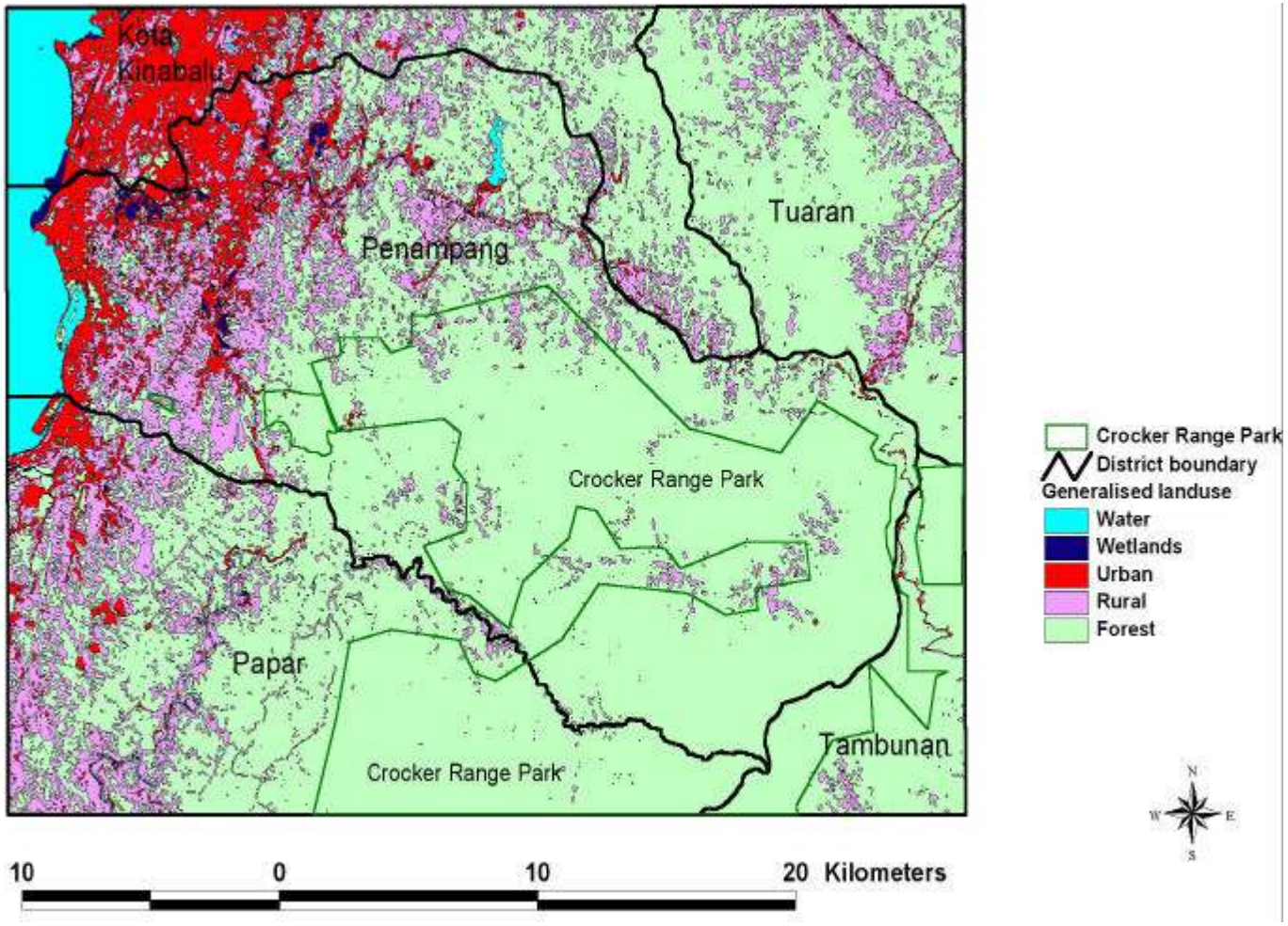
In the past, the cool and wet conditions of the tropical montane cloud forests were not readily exploitable and many of the montane forest area remained intact until recently. The traditional environment for agriculture was restricted to upper lowland terrains, the highest being at about 1,200–1,400 m above sea level, corresponding to the lower limits of the lower montane forest where cloud cover descends daily and the daily minimum temperature is 18°C. Under these conditions, fruits of some important crops abort, such as bananas and coconuts. However, more recently, cultivation has rapidly invaded the upper montane forest zone. This became possible through the combination of the introduction of temperate crops such as cabbage, asparagus and modern cultivation skills i.e. the use of fertilisers and pesticides and road accessibility. Consequently, temperate vegetation cultivation has now reached 2,100 m. In addition, other modern activities have impacted this forest type including dairy farming, golf course development, tourism and the incursion of logging activities to the very limit of harvestable forest. Montane forests comprise about 10 per cent of Sabah's total land area.

Montane forests decreased from about 770,000 ha in 1970 to about 700,000 ha in 1995 (*Source: Sabah Department of Forestry, 2002)*



Indicator area 5: Urban areas

Terrain poses restrictions to urban development in and around Kota Kinabalu and along the west coast of Sabah. The eastern three-quarters of Penampang District falls on the steep and hilly terrain of the Crocker Range, while the remainder, extending west to the coastline, has a predominantly low relief and comprises of broad alluvial plains and low hills. As a result of these constraints most of the population is concentrated on the coastal strip and inland along the river floodplains and lower hill ridges.

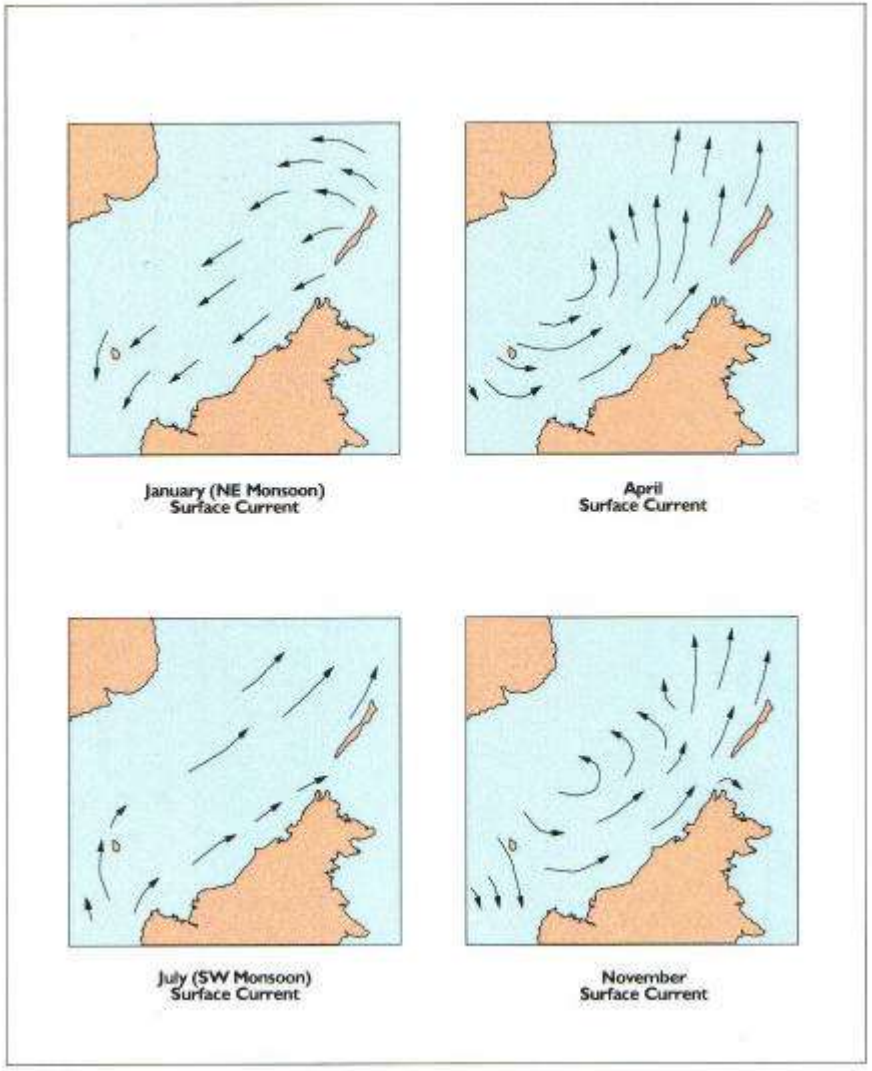


Developed urban areas in Kota Kinabalu and Penampang amounted to 8% in 2000, rural areas took up 18% and forest and scrub forest areas 74%. It can be noted that while the Park does provide important protection for some of the steep lands, there is increasing pressure on the park and its boundary (the pink areas indicating disturbance within the park boundary, marked in green) (Source: Environment Protection Department, Penampang District generalised land use as derived from a SPOT 4 satellite image - April 2000)


CLIMATE

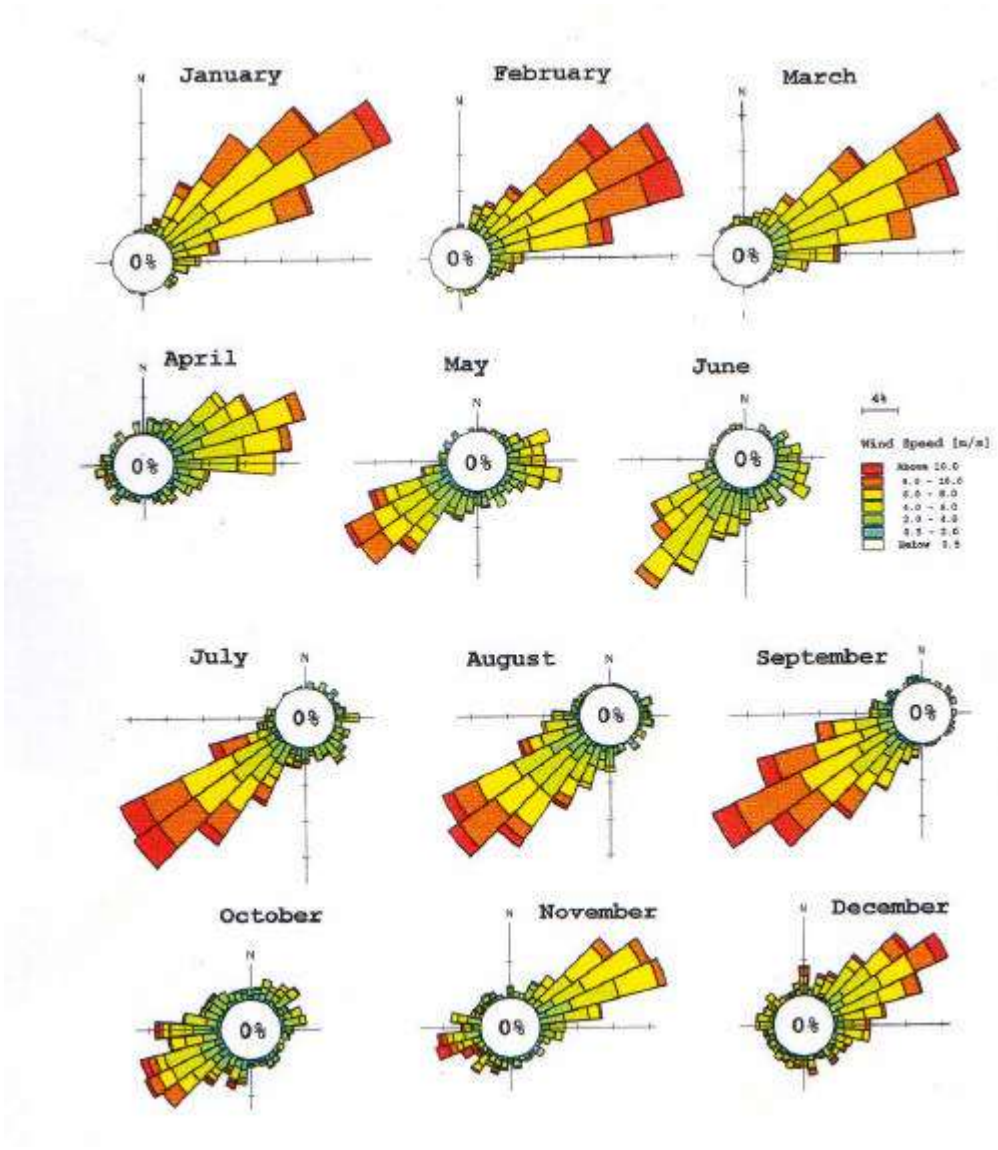
CLIMATE

The whole of Sabah experiences a wet tropical climate, which is controlled largely by the edge effects of the Indo-Australian monsoon system. Although the wind over the country is generally light and variable, there are some uniform periodic changes in the wind flow patterns. Based on these changes, four seasons can be distinguished, namely, the southwest monsoon, northeast monsoon and two shorter inter-monsoon seasons.



The northeast monsoon usually commences in early November and ends in March. During this season, steady easterly or north-easterly winds of 10 to 20 knots prevail (upper left map). The southwest monsoon is usually established in the later half of May or early June and ends in September. The prevailing wind flow is generally southwesterly and light, below 15 knots (lower left map). The winds during the two inter-monsoon seasons of May-June and October are generally light and variable. During these seasons, the equatorial trough lies over Malaysia (upper and lower right maps) (Source: Shoreline Management Plan for the west coast of Sabah, Ministry of Tourism, Environment, Science and Technology)

Although locally referred to as the land below the wind, Sabah is clearly affected by seasonal wind effects and wind speeds exceeding 10 m s^{-1} are not uncommon during the monsoon periods. The effect of land and sea breezes on the general wind flow pattern is very marked especially over days with clear skies. On bright sunny afternoons, sea breezes of 10 to 15 knots often develop and reach up to several tens of kilometres inland. On clear nights, the reverse process takes place and may develop land breezes of weaker strength over the coastal areas.

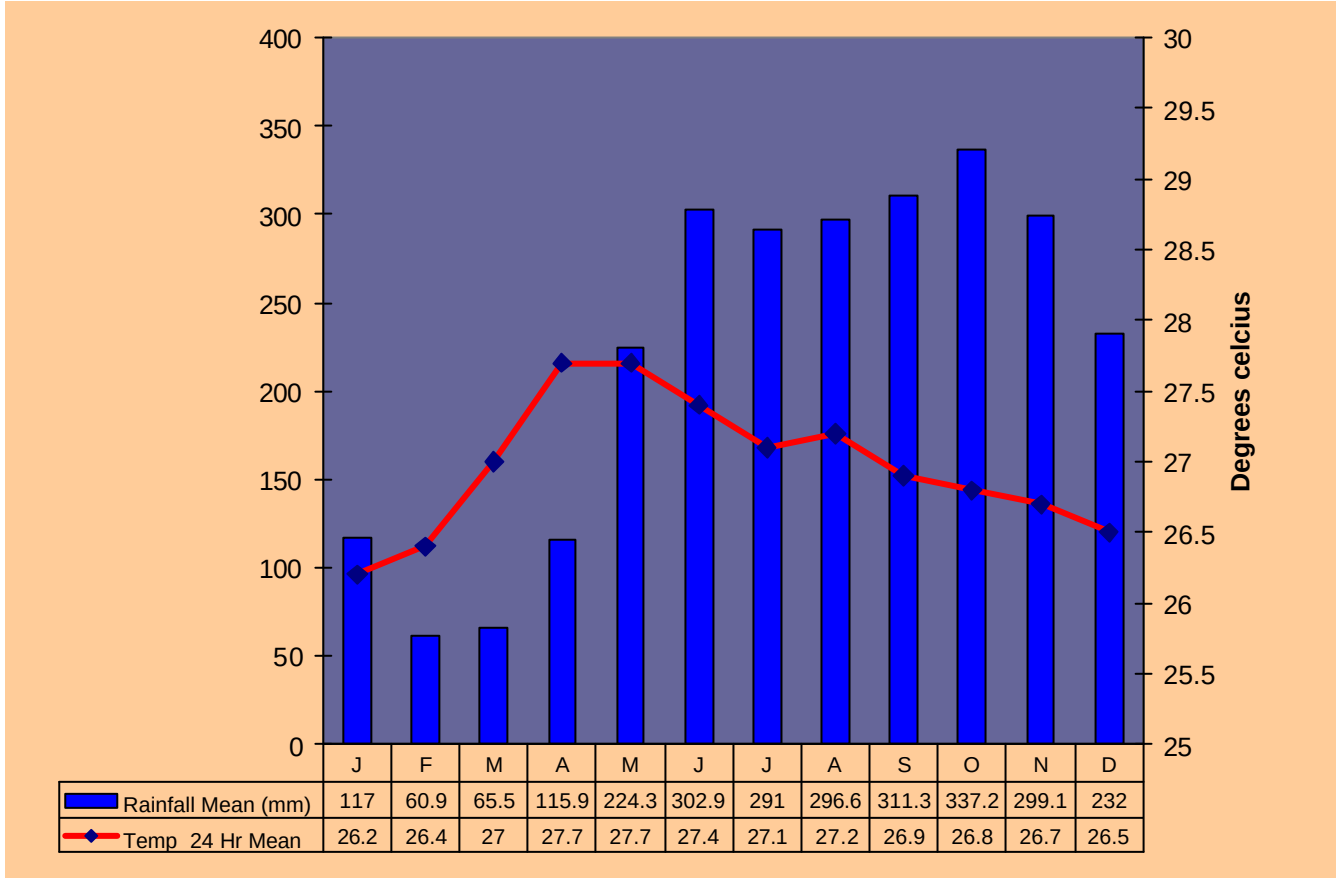


Monthly wind speed and direction off the west coast of Sabah is closely linked to the four seasons, namely, the northeast monsoon from November to April, the southwest monsoon from June to September, and two shorter inter-monsoon seasons of May-June and October (Source: ERM Consult, 1999, based on data collected by the British Meteorological Office UKMO 1993 –1997)

CLIMATE

The mean monthly relative humidity falls within the range of 70 to 90 per cent, varying from place to place and from month to month. As in the case of temperature, the daily variation of relative humidity is much greater as compared to the annual variation. The mean daily minimum can be as low as 42 per cent during the dry months and reaches as high as 70 per cent during the wet months. The mean daily maximum, however, does not vary much from place to place.

Being close to the equator, there is abundant sunshine and thus solar radiation. However, it is rare to have a full day with completely clear skies even in periods of severe drought. The cloud cover cuts off a substantial amount of sunshine and therefore solar radiation. On average, Sabah receives about six hours of sunshine per day. There are, however, seasonal and spatial variations in the amount of sunshine received.

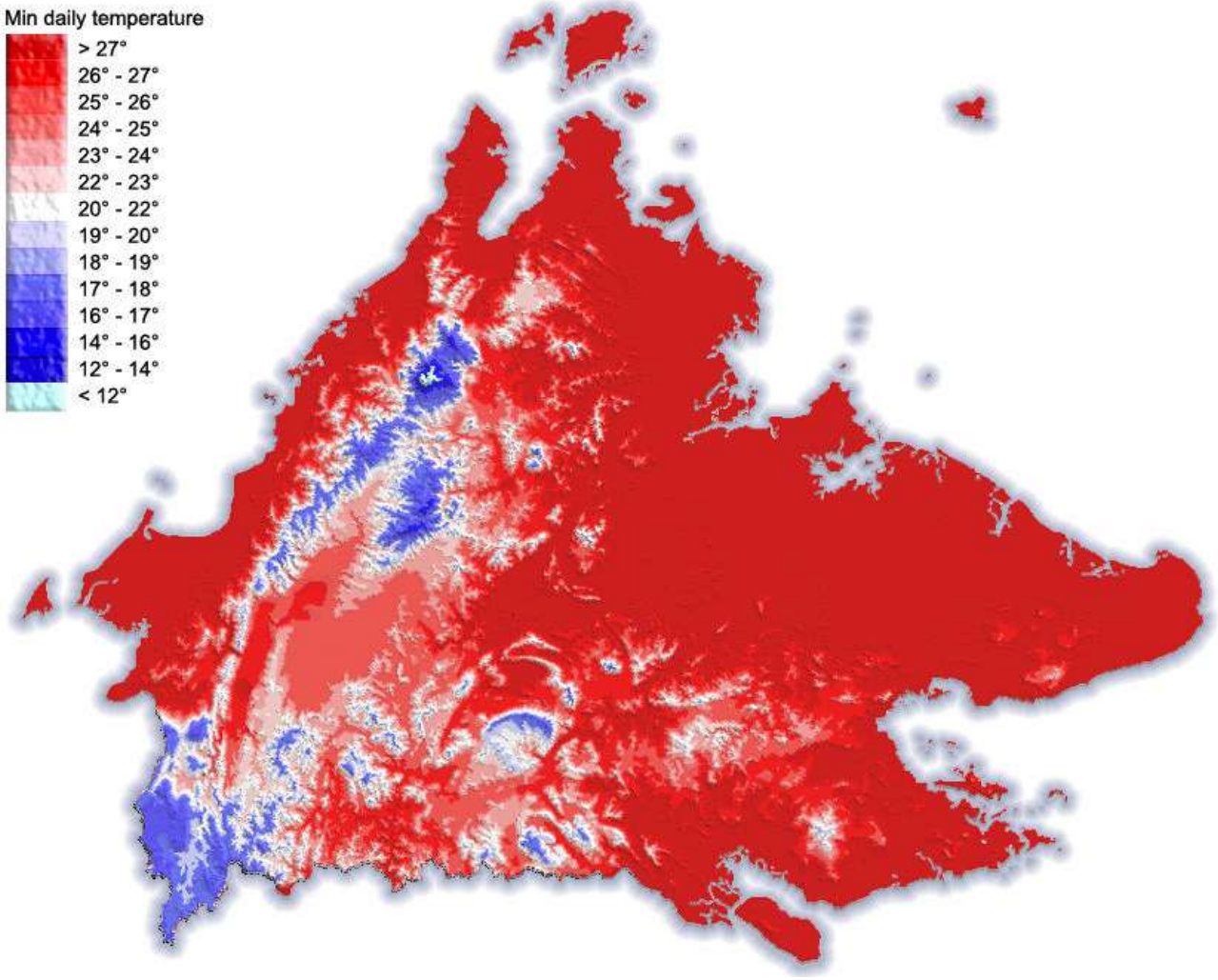


	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall Mean (mm)	117	60.9	65.5	115.9	224.3	302.9	291	296.6	311.3	337.2	299.1	232
Temp 24 Hr Mean	26.2	26.4	27	27.7	27.7	27.4	27.1	27.2	26.9	26.8	26.7	26.5

Daily temperature and monthly rainfall profile for Kota Kinabalu from 1968-1995 (Source: Meteorological Department Malaysia)

Being an equatorial state, Sabah has uniform temperature throughout the year, with the annual variation being less than 2°C. The daily range of temperature is larger, being from 5-10°C at the coastal stations and from 8-12°C at the inland stations, but the excessive day temperatures, which are found in continental tropical areas, are never experienced. Daytime temperatures under the shade in the lowlands average about 27°C and occasionally rise to a maximum of about 34°C. Night-time temperatures in the lowlands rarely fall below 20°C.

Although the seasonal and spatial temperature variations are relatively small, they are nevertheless fairly definite and linked to the monsoons. April and May are the months with the highest average monthly temperature in most places and December, January and February are the months with the lowest average monthly temperature.



Variation of mean daily temperature in Sabah, as derived from elevation. There is a decrease in temperature of approximately 1°C for every 100m increase in altitude above sea level up to the cloud cover zone of about 1200m (Source: Environment Protection Department)

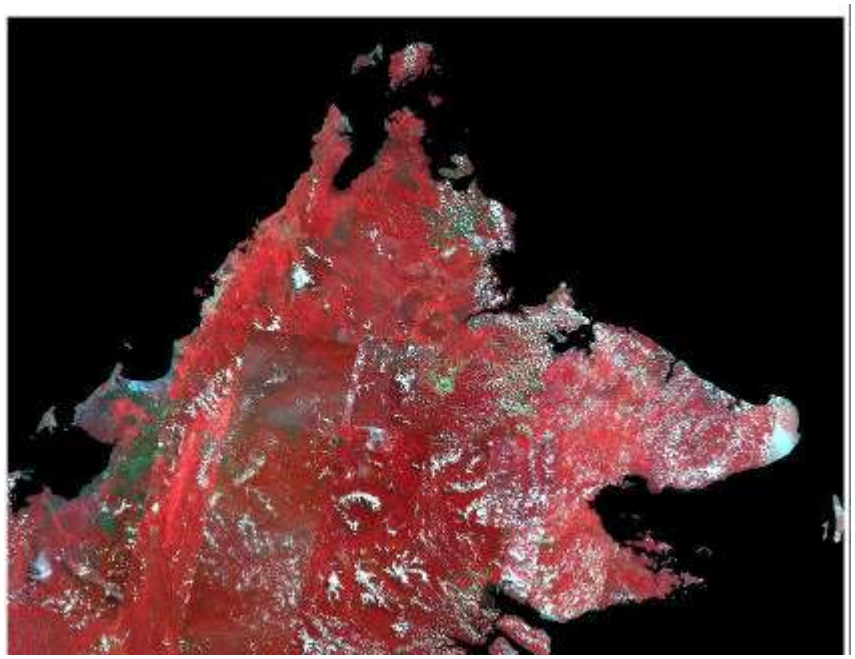
CLIMATE

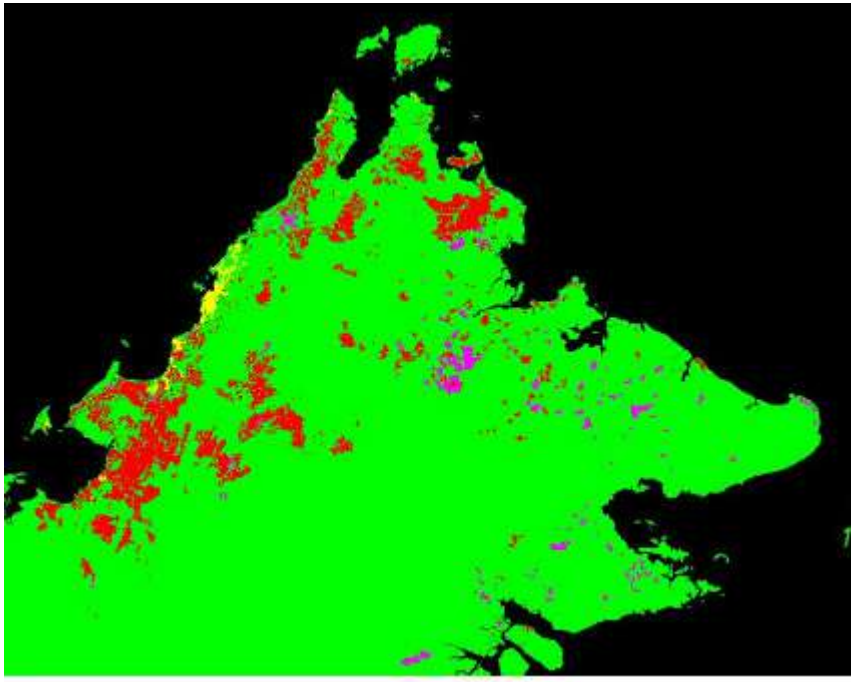
Periods of drought in Sabah are infrequent. However, there has been a statistically significant increase in the frequency and severity of droughts since the 1960s. Some aspects of these droughts have been linked to the global environmental phenomena such as El-Nino Southern Oscillation Event (ENSO), which results in extended dry periods usually lasting 6-18 months and occurring cyclically at intervals from two to 10 years, averaging about once every four years.

At the end of an uncommon, but not unprecedented 18 months drought in 1982-3, one million hectares of forest was lost to fire, most of which had been selectively logged. Similar devastation was caused as a result of the 1997-1998 fires, also the result of a drought period. The economic and ecological losses associated with such fires are enormous.

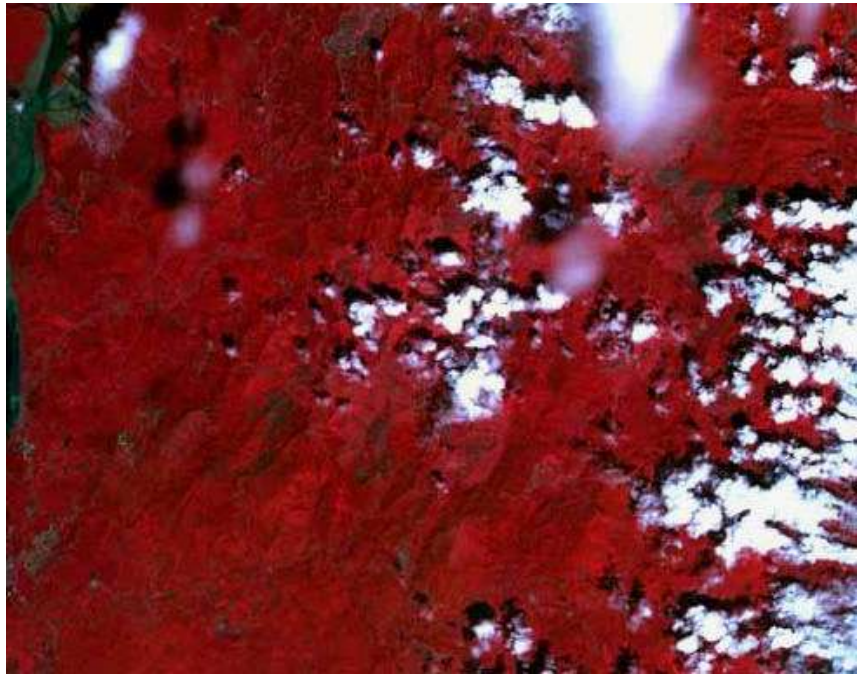
A composite satelitte image of Sabah after the 1997-98 forest fires (Source WWFM, 1999, image mosaic comprises of SPOT satelitte images, April-July 1998)

Burn scar map derived from the above image showing forest areas burnt by fire are (marked in red). The southwestern Sabah, including extensive areas of secondary forest near Beaufort and Sipitang, suffered the worst fire damage (Source: WWFM,1999)



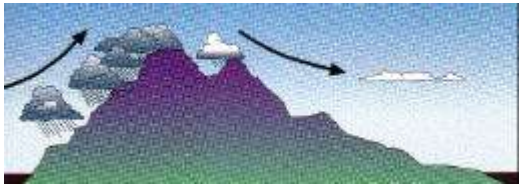


A satellite image covering about 40km by 30km over the west coast of Sabah acquired in 1997. The town of Sipitang is located to the left of the image. Healthy vegetation is represented by red colours, showing that most of the area comprises of full forest cover, although some of the forests are disturbed i.e. logged over. The white patches represent clouds (Source, WWFM, 1999, SPOT satellite image, 1997)

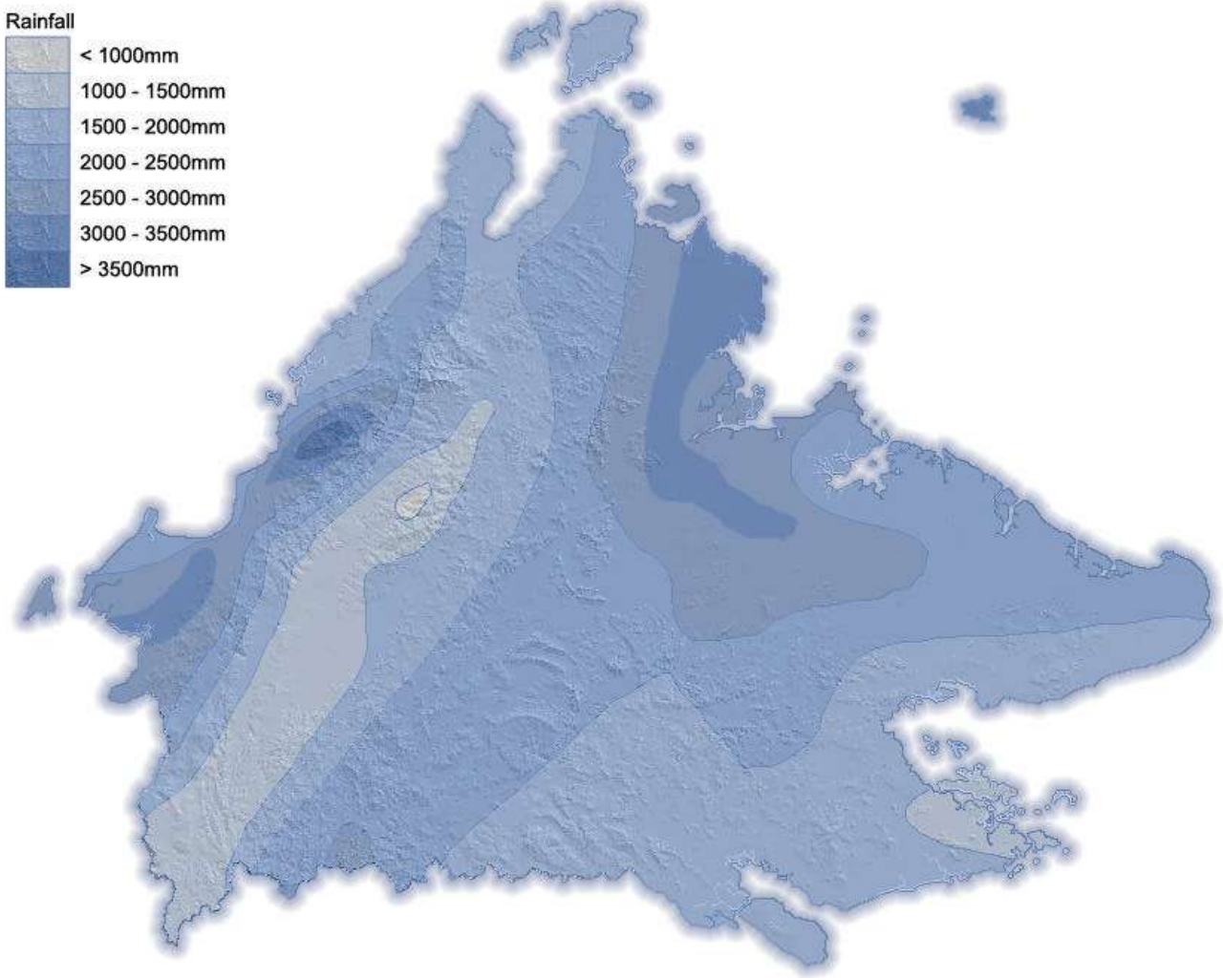


The same area on 4 April 1998. The black and grey areas represent the remnants of forests that have been burnt. Smoke can still be seen in some areas (Source: Courtesy of SPOT CNES. Satellite images acquired and processed by the Centre for Remote Imaging, Sensing and Processing, National University of Singapore, 1998)

Average total annual rainfall varies considerably in different parts of Sabah and Borneo. The lowest annual rainfall amount recorded to-date by the Meteorological Department throughout Malaysia was 1151 mm in Tawau in 1997, while the highest annual rainfall recorded fell in the same year; 5293 mm in Kuching.



Moisture laden air moving inland from the sea is blocked by the Crocker Range hills and mountains. As the air rises it cools and moisture condensates, resulting in frequent and heavy rainfalls on the seaward side of the range. Little moisture is left once the air arrives along the Tambunan-Keningau valley, inland of the Range



Mean average rainfall exceeds 3000 mm over much of Sabah, although totals fall below this in the sheltered Tambunan-Keningau valley and a few localities on the east coast (Source: Environment Protection Department, adapted from Sabah Water Resources Masterplan, Department of Irrigation and Drainage, Sabah, 1994)

Climate indicators

The climate generally provides for an abundance of water and sunshine producing an ideal environment for plant growth and high crop productivity. The terrestrial potential primary production rates are amongst the highest in the world. Sabah falls below the true monsoon belt therefore seldom suffers from serious flooding, although rare storms may impact locally. In addition, Sabah is located beyond active earthquake and volcanic activity zones.

However, our environment in Sabah is still vulnerable to some climatic events. Natural climatic phenomena in conjunction with present day land use practices, renders our forested land prone to the outbreak of forest fires.

We have therefore chosen the following two indicator areas to measure our vulnerability to climatic impacts:

Area 1: Forest fires and haze indicated through the number of incidents of forest fires and reports of haze

Area 2: Haze and air quality indicated through API readings in Kota Kinabalu

Indicator area 1: Forest fires and haze

The wet humid tropical environment fosters a view that the rain forests of the region are permanently wet and therefore difficult to burn. To a certain extent this is true; however, the characteristics of the forest change due to opening up of the canopy as a result of logging activity. The forest floor and logging debris become prone to drying up, particularly during periods of drought. As a consequence of logging and forest clearance activities, forests are now more vulnerable to droughts and therefore prone to catch fire, resulting in the damaging haze, which now shrouds the region from time to time. Forest fires and drought elsewhere in Southeast Asia may result in a haze that impacts Sabah, which itself may not be experiencing drought conditions.

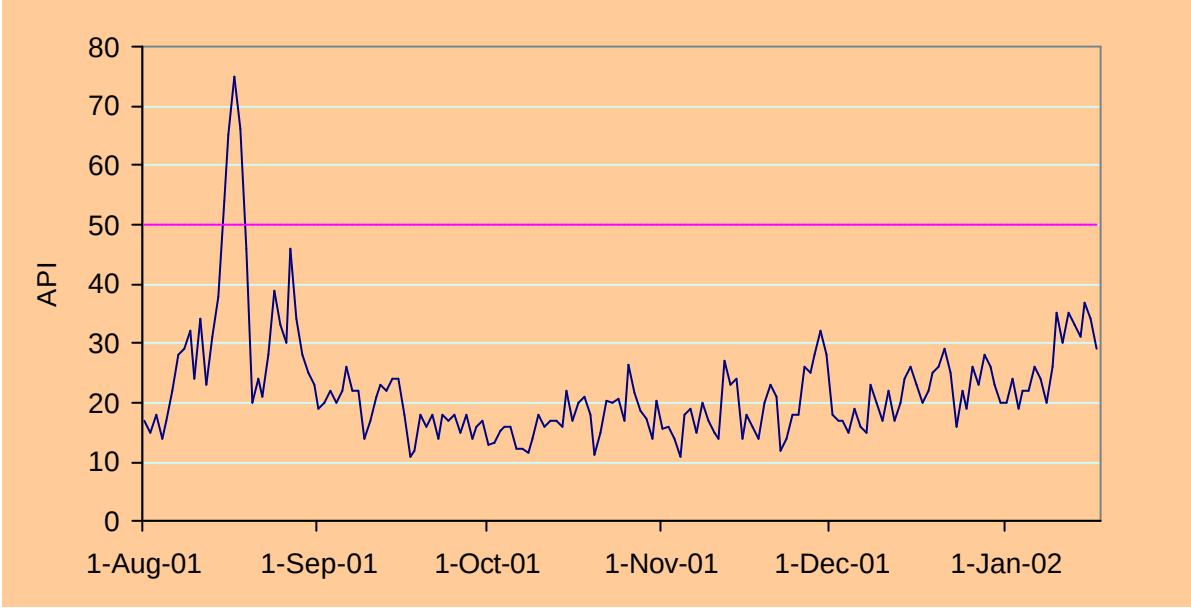
The periods 1878-1915 and 1967 to date were subject to longer and more intensive droughts than the intervening 1916-67 period. The 1982-83 drought was equalled or exceeded in severity in Sabah by droughts in 1877-78, 1903 and 1915. (Walsh, 1996, and Environmental Protection Department)

Forest fires and haze incidents in Sabah

Year	Approx. forest area lost (ha)	Haze	Comments
1877-78	-	-	Forest fires reported along the coast
1885	-	-	Reported, but poorly
1888	-	-	Forest fires reported (6 months)
1891	-	-	Forest fires reported (5 months)
1902	-	-	Forest fires reported (6months)
1914	< 25,900	Widespread	Sook Plain forests burnt and have subsequently remained as Imperata grassland (25,900 hectares). First clear evidence of haze and forest burning in Borneo. Fires reported in west central Borneo. Reports of peat swamp forest burning, which then destroyed the forest complex. Mar-May particularly severe in Sabah, elsewhere Feb-Dec
1940-41	-	-	Reported, but poorly
1965	-	-	Reported, but poorly
1972	-	-	Reported, but poorly
1982- 1983	1,000,000	Extensive	One million hectares of forest burnt of which eight five per cent of burnt areas were logged over forest. Feb-May 1983, but fires continued until Aug in northern parts
1991-1992	5.000	Extensive	Small areas in Sabah, extensive in Borneo. Aug-May
1994	< 5.000	Present	Small areas in Sabah, extensive in Borneo
1997	163,000-500,000	Extensive	Estimates vary. Forest Department reports 163,000 ha of Permanent Forest Reserve burnt
2001 –02	-	Periods	Aug-Sep, and Feb

Indicator area 2: Haze and air quality

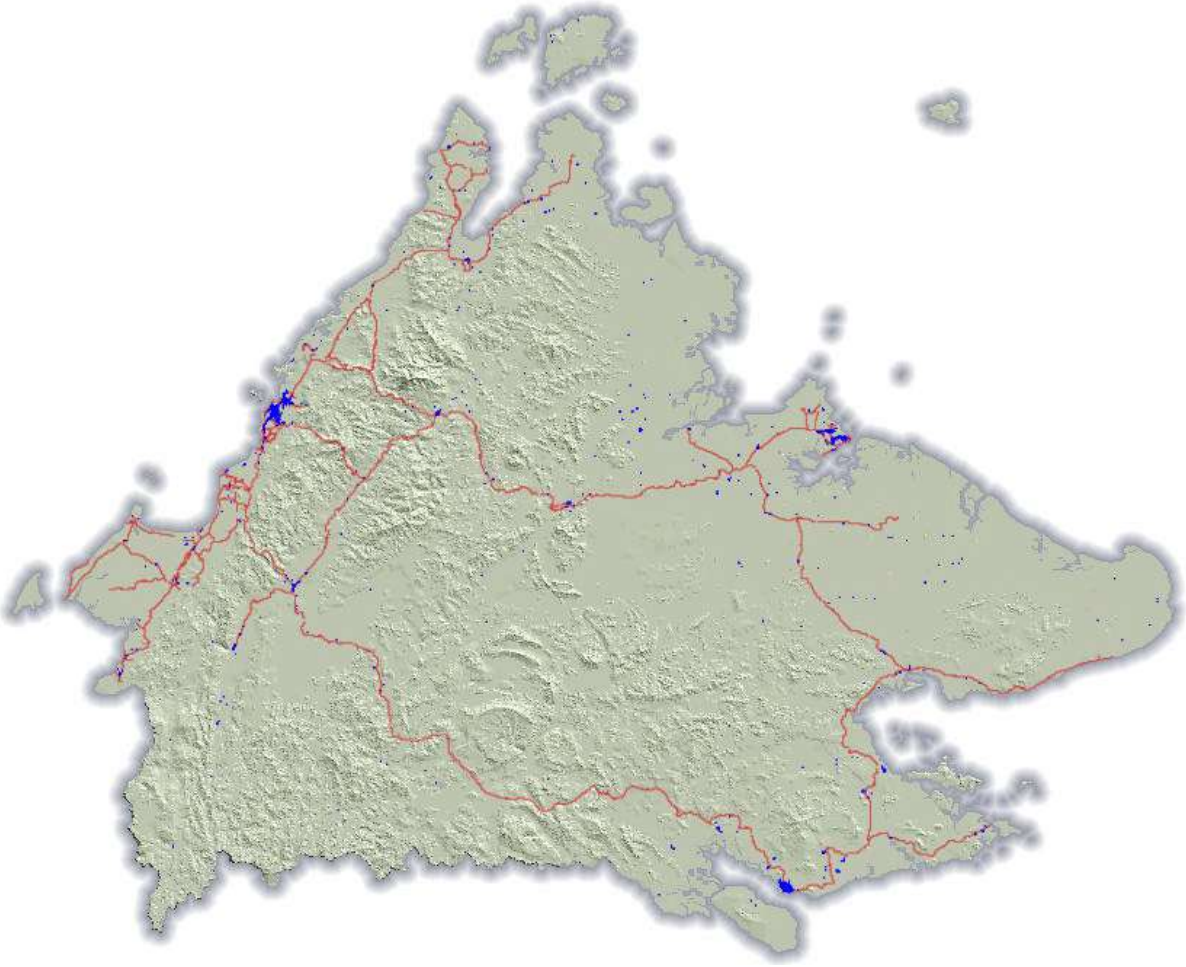
While the overall air quality in Sabah remains generally good, quality is periodically impacted by smoke haze related to seasonal forest fires. The fires may be of local origin, but the source may also be trans-boundary and originate as far away as Sarawak, Kalimantan and Sumatra. Other factors may influence Air Pollution Index including industrial emissions and pollution from car exhausts.



Air Pollution Index as measured at Wisma Budaya, downtown Kota Kinabalu. As the result of a prolonged dry period, outbreak of some small forest fires occurred locally and more extensive as far away as Southeastern Kalimantan during August 2001. The red line marks the index for good air quality - 50 API. (Source: Environment Protection Department, 2002)


PEOPLE

Sabah has a long trading history with records of maritime visitors dating as early as the 14th Century, when it was recorded that merchant vessels from China would visit North Borneo on the way to, and back from India. Trade primarily consisted of selected timbers, birds nests, damar and other specialised forest commodities. The locations of the main urban centres are all concentrated along the coast, which reflects the trading history of the state.



Urban areas in Sabah comprise of 25 or so towns and one city. The main urban centres are Kota Kinabalu/Penampang on the west coast and Tawau, Sandakan and Lahad Datu on the east coast. Apart from Keningau, all other urban areas are relatively small. Anomolous blue patches in the interior can be attributed to areas of bare land (Source Environment Protection Department, adopted from Department of Lands and Survey, 1995)

There are presently more than 2.5 miillion people living in Sabah. In addition to these are expatriates and immigrant workers. Sabah has, due to the limited number of local people, always had a shortage of manpower - mostly felt in the agricultural and forestry sectors – and has ever since the early stages of economic development, brought in substantial numbers of immigrant labourers in order to satisfy the ever increasing workforce requirements.

Generally speaking, increased numbers of people means increased pressure on the environment. More land is required for agriculture and to accommodate the expansion of rural and urban areas. Population growth also implies a range of indirect pressures on the environment; for example increased use and consumption of materials, the generation of all kinds of wastes, and increased demand for domestic and industrial water.

Sunday market, Kota Belud

Urbanisation and population indicators

Sabahs diverse population has undergone large changes in relation to size and composition during the last decades. Also the urban areas have developed tremendously in the last decades. The size, growth and location of the population is inevitably linked to environmental impacts. How many are we, are we getting more and at what rate, and where are we living, is important for the understanding of environmental change and pressures. However, as population size, growth rates and urban areas, may not be evenly distributed throughout the State, this will provide for different scale and content of pressures placed upon the environment in the different districts.

We have therefore chosen to use the following three indicator areas for population and urbanisation transition and change:

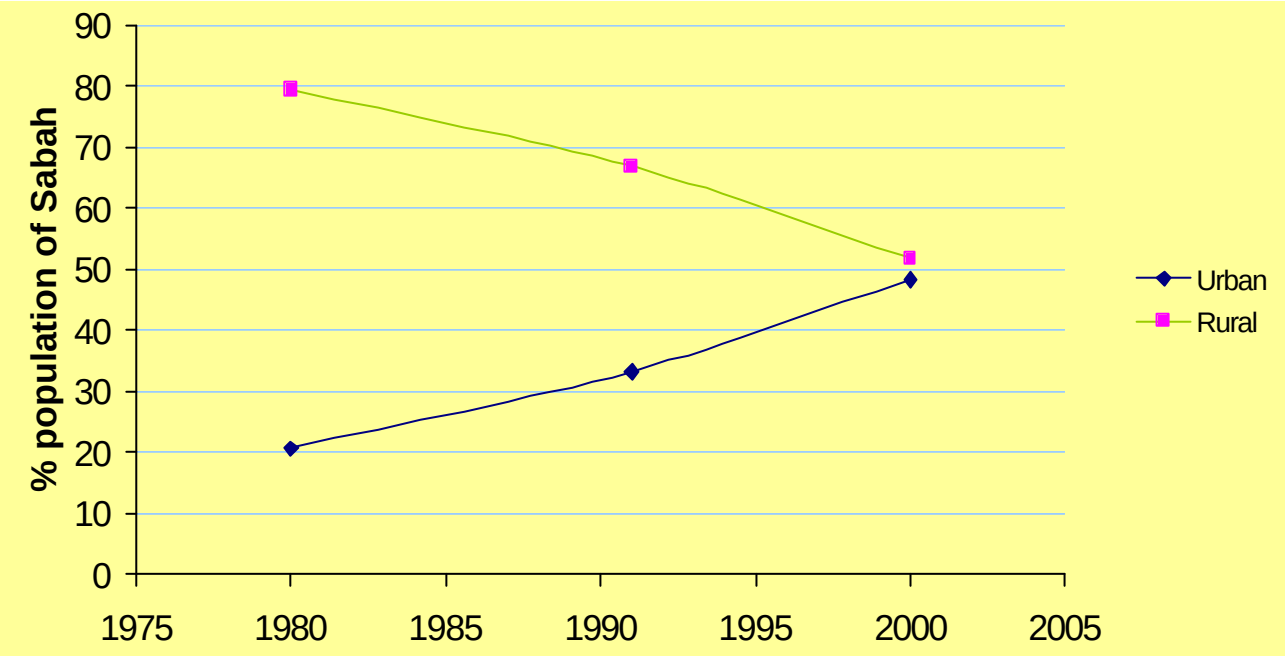
Area 2: The overall number and growth of the population indicated through total number of people and growth rate of the total population as per census

Area 1: The number of people living in urban areas indicated through the percentage of people living in urban areas as per census

Area 3: The size and growth rate of the population in the different districts indicated through total number of people per district and growth rate per district as per censu

Indicator area 1: Urbanisation rate

The proportion of people in Sabah living in urban areas is likely to continue to increase in tandem with continued development and population growth. As the state progresses along its development path the competition for land for the primary economic activities of agriculture, mining and industry will increase. In Peninsular Malaysia, the shift towards industrialisation was marked by land use change during the years 1966-1990, which saw a decline in the annual growth of agricultural land, while at the same time there was an almost three fold increase in total area of urban and industrial land use. A similar trend is currently taking place in Sabah.



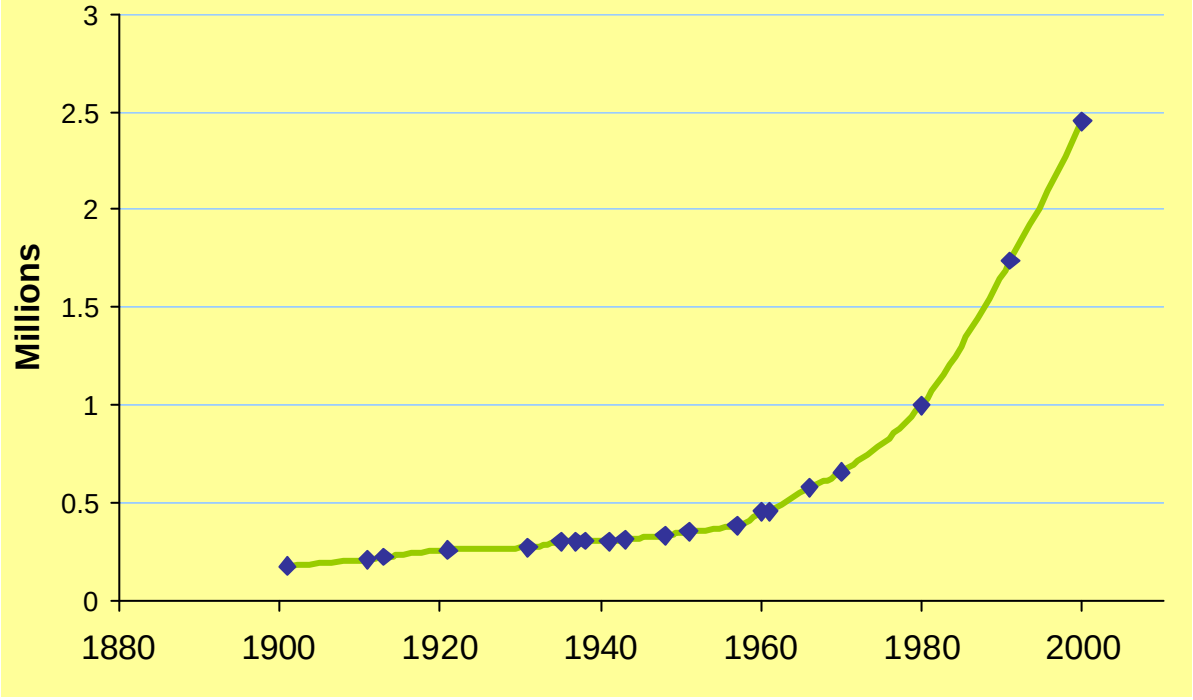
Around half of the population in Sabah live in urban areas today. This is a rapid increase from the early 1980s, where only 20 percent of the population lived in urban areas (Source: Department of Statistics, Malaysia, 2002)

Indicator area 2: Population size and growth

The present population growth rate in the State is about 4 per cent per year, which is the second highest growth rate in Malaysia and one of the highest growth rates in the world. The latest 2000 census, however, shows that the growth rate is slowing. This would follow population growth trends seen elsewhere in Malaysia and the world: A long period with low growth rates is followed by a period with very high growth rates – a period which lasted 100-150 years in many European countries, but shorter in countries that has developed in the last century. The main reason for the high growth rates in this period is that birth rates by far exceed death rates. The high growth rate period, however, is then again followed by declining growth rates, which eventually will stabilise around 0-2 per cent, resulting in a stable, or even declining, size of population.

The population density per square kilometre increased from 25 in 1991 to 35 in 2000.

The number of people in Sabah has increased dramatically in the last four decades. From the start of the century until about 1960 the population increased slowly from about 250.000 to 500.000. Then after 1960 the size of the population increased rapidly to about 2.5 million in 2000 (Source: Department of Statistics Malaysia and www.library.uu.nl/wesp/populstat/Asia/malaysia.htm)



Indicator area 3: Population size and growth per district

In a period with a general high population growth rate in a country, the highest growth rates would normally be concentrated in districts where the main urban areas are located. These districts would also be where the main part of the population would be located.

*The population of Sabah is concentrated in the urban areas of Kota Kinabalu and Penampang, Tawau, Sandakan, Lahad Datu and Keningau. The remaining districts are still quite sparsely populated. The highest population growth rates can be found around Kota Kinabalu/Penampang on the west coast, on the east coast around Sandakan and in the interior around Keningau. Districts with the highest growth rates in the recent decade (more than the average of 4 %) include Sandakan, Kinabatangan, Kota Kinabalu, Penampang, Papar, Keningau and Tongod. Tawau and Lahad Datu on the east coast had both very high growth rates in the 1980s, but fell to under average in the 1990s (Source; Department of Statistics, Malaysia * 1980 and 1991 data were adjusted to the administrative district boundaries as of Census 2000)*

District	Population			Annual growth rate (%)	
	1980	1991	2000	1980-1991	1991-2000
Tawau	113,708	244,728	304,888	7.0	2.4
Lahad Datu*	39,262	118,096	156,059	10.0	3.1
Semporna	52,215	91,828	108,236	5.1	1.8
Sandakan	113,496	222,817	347,334	6.1	4.9
Kinabatangan*	14,683	45,746	86,783	10.3	7.1
Beluran	30,066	54,539	70,900	5.4	2.9
Kota Kinabalu	108,725	209,175	354,153	6.0	5.9
Ranau	28,047	49,358	70,649	5.1	4.0
Kota Belud	45,503	58,259	72,337	2.3	2.4
Tuaran	48,374	63,995	82,212	2.5	2.8
Penampang	37,998	86,941	130,809	7.5	4,5
Papar	40,722	59,473	86,649	3.4	4.2
Kudat	38,397	56,047	68,242	3.4	2.2
Kota Marudu	27,149	42,747	58,841	4.1	3.6
Pitas	16,520	24,240	30,854	3.5	2.7
Beaufort	36,403	48,742	61,698	2.7	2.6
Kuala Penyu	12,565	14,271	16,511	1.2	1.6
Sipitang	12,076	24,349	29,311	6.4	2.1
Tenom	26,353	37,954	46,202	3.3	2.2
Nabawan	8,368	19,999	23,890	7.9	2.0
Keningau	41,204	88,456	145,762	7.0	5.6
Tambunan	14,204	19,726	27,852	3.0	3.8
Kunak*	12,510	39,873	48,571	10.5	2.2
Tongod*	10,751	13,326	20,646	2.0	4.9

ECONOMY

The wealth of a nation is determined by its economic activities. Currently, the economy in Sabah is in a stage of dynamic transition, shifting from dependence upon timber and other natural resources, towards value added processed agricultural products, tourism and other service industries The state's major export commodities are presently palm oil, crude petroleum, plywood, sawn timber, palm kernel oil, uncoated printing and writing paper and hot briquetted iron. Palm oil is the leading export commodity with revenue amounting to about 46 per cent of total exports.

Progress and development usually sees a period of heavy dependence upon natural resources accompanied by general degradation of the environment as natural habitats are converted to other uses. With increased economic reliance on agricultural products, tourism and other service industries, there is less pressure and indeed, less opportunity to impact the natural environment, but pollution associated with people, their wastes, and new activities escalates dramatically. A transition from dependence on raw natural resources therefore reduces the need to further convert natural habitats and stabilise land use patterns. However, the new economic activities will place new pressures on the environment in the form of for example increased urban pollution.

Economic indicators

Sabah's economy has changed its face in the last decades. The main sectors that traditionally contributed to economic growth are declining, while others have areas have grown. The type of economic activity influences directly the pace of environmental pressures and changes. When the State relied predominantly on natural resource development, the pressures on for example, forests, wildlife, and soils were accordingly severe. As the economy changes, environmental pressures placed on the environment will also change.

We have therefore chosen to use the following two indicator areas for transition and change of our economy:

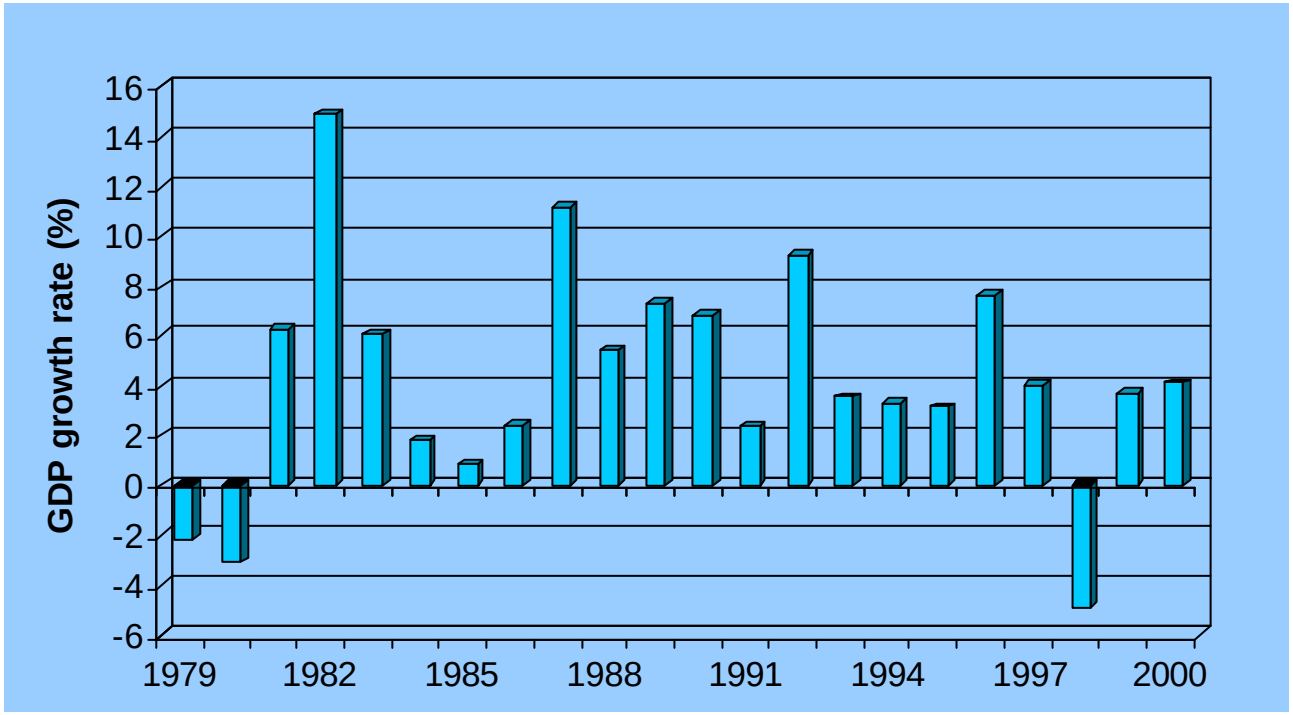
Area 1: The overall growth in the economy indicated through the growth rates in GDP (gross national product)

Area 2: The composition, size and growth rate of the main economic sectors indicated through the sectoral share of the total GDP

Indicator area 1: Overall GDP growth

Sabah has experienced a remarkable economic growth during the last decades. Even though the rate of economic development in Sabah has remained slightly below that of the rest of Malaysia, the rate of growth can still be considered high compared with other countries in the region and indeed globally.

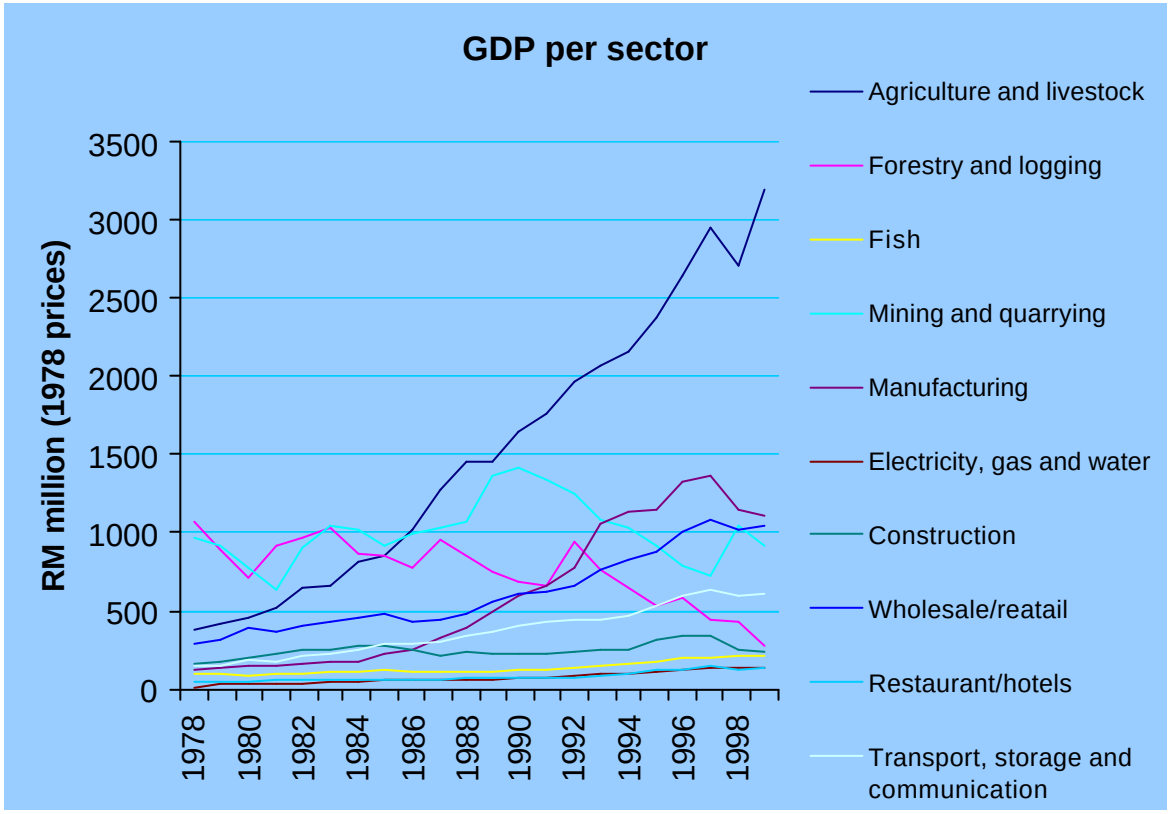
The GDP (in fixed 1978 prices) more than doubled in the two decades from 1978 to 1999. In the last part of the 1970s the growth rate was negative at around minus 3 %. The first part of the 1980s then saw high growth rates at 6-14 %, which declined to 1-2 % in the mid-1980s. The growth rates from the end of the 1980s to the end of the 1990s was in general very high, 6-11 % at the best and 3-4 at the lowest. The only exception was 1998, which saw a negative 5 % growth rate (Source: Statistics Department Sabah)



Indicator area 2: Sector composition and growth rates

In Peninsular Malaysia economic growth has been attributed to the transition from a natural resource based and agriculturally dependent economy to a competitive manufacturing economy. This development path has yet to take place in Sabah, which still remains largely dependent on natural resources and agriculture as the primary source of income. Sabah is now at a critical juncture, with a continued reliance upon natural resources and agriculture, and a still relatively low GDP contribution from manufacturing, tourism and other new sectors that in the future will have to take over as income earners for the state.

GDP for agriculture/livestock has grown markedly during the last decades, and is today by far the most important economic sector. Forestry has seen a rapid decline from being the most important sector in the 1970s to only being at sixth place in the 1990s. Manufacturing and wholesale/retail has experienced an increase in the last decades, while the relative economic importance of construction, electricity, fish, restaurants/hotels, transport/storage/ communication and mining/quarrying has remained almost stable (Source: Statistics Department Sabah)



PART II

Environmental management and protection

– an overview of trends in selected environmental areas


FOREST

FOREST

Land classified as forest land covers a total of about 4.7 million ha and comprises several categories:

State Parks, comprising 0.25 million ha, are forest areas granted total protection

Permanent Forest Reserve comprising 3.6 million ha is land permanently reserved by Government for commercial and non-commercial forest services for the continued and overall benefit of the State. Areas designated for logging within the Permanent Forest Reserve are the Commercial (Class II) Forest Reserves, which shall be managed for sustainable wood production. The Class II Forest Reserve is divided into 27 forest management units, some of which have been allocated to the private sector through long-term license agreements

State land forests, comprising 0.5 million ha, most of which will eventually be converted to another type of land use, mainly agriculture, are forests outside of the commercial reserves, that may be harvested under a valid timber-cutting license. State lands are usually situated in coastal areas and along major rivers

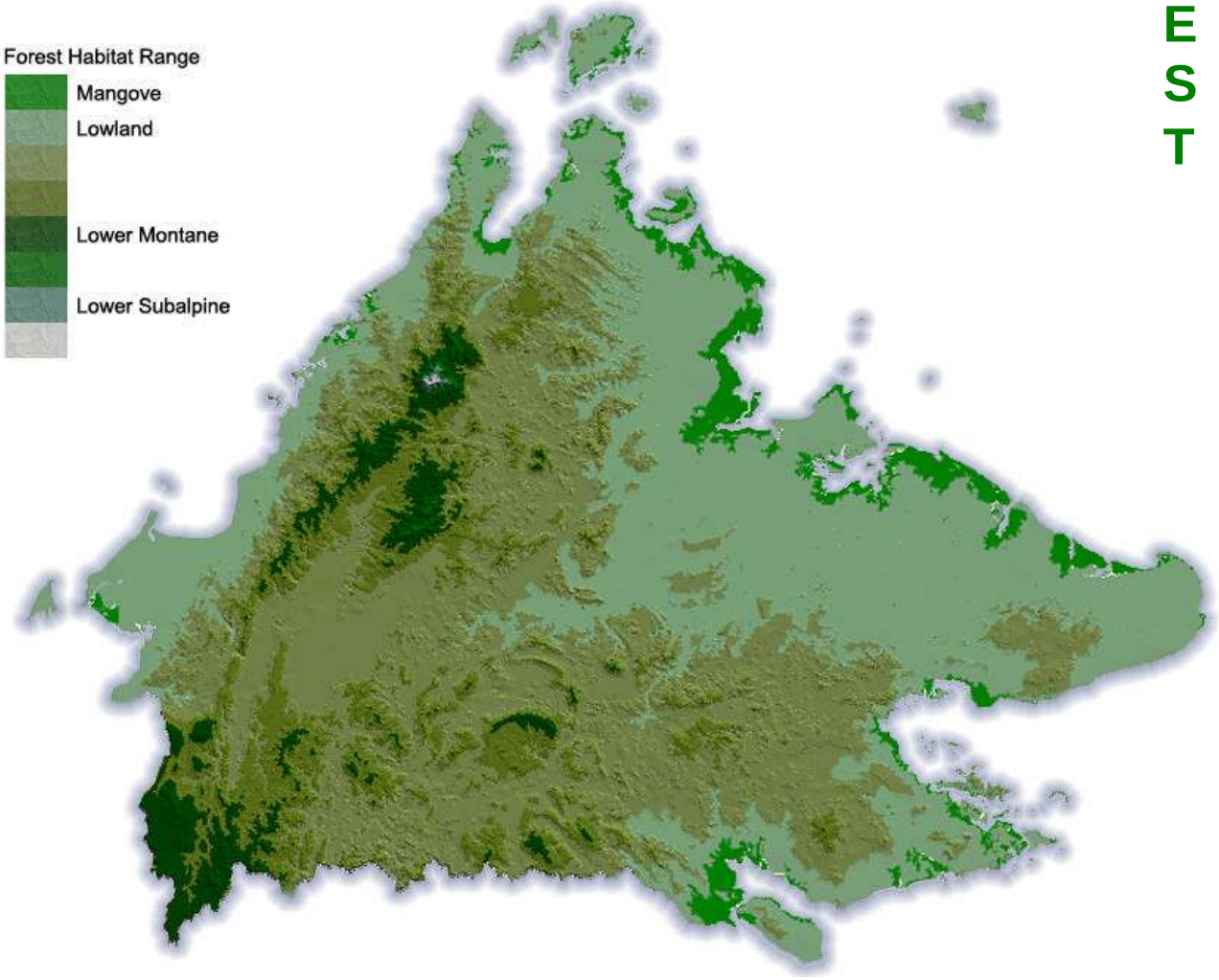
Industrial tree plantations, covering 0.35 million ha, are primarily being undertaken be four large plantation companies, the largest being SFI on the southwest coast of Sabah (Source: Sabah Forestry Department 1997, 2002)

Land status - distribution of forested land	Area (million ha)	
State parks		0.25
Permanent Forest Reserve		3.60
(Commercial (Class II) Forest Reserve)	(2.74)	
State land forest		0.50
Industrial Tree Plantation (ITP)Total		0.35
Sabah Forest Industries (SFI) at Sipitang Forest Reserve	(0.17)	
KTS Plantation Sdn Bhd Segaliud – Lukan Forest Reserve	(0.06)	
SAFODA	(0.06)	
SSSB	(0.06)	
Total		4.70

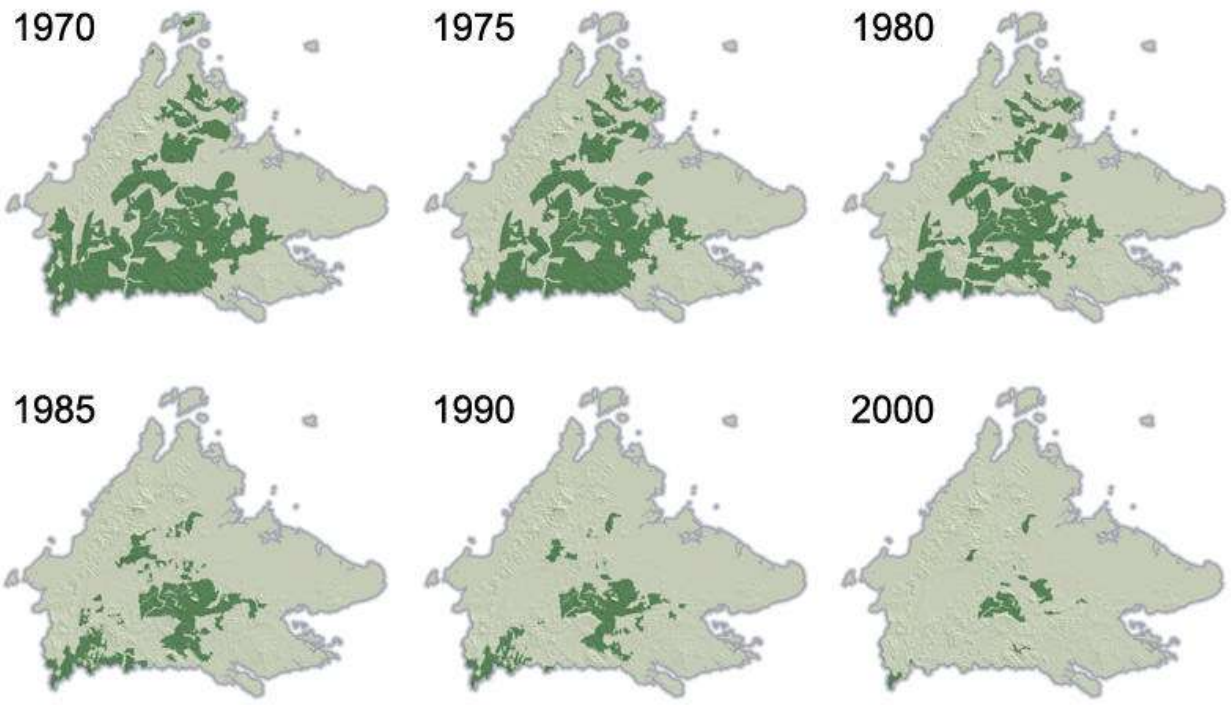
Sabah was at one time entirely covered by forests of which today about 60 per cent remains.

Based on altitude four main types of forest cover exists in Sabah, the main one being the lowland evergreen rain forest rich in dipterocarps, which is the natural vegetation throughout the interior in the lowlands (marked light greenish). With increasing altitude the lowland rain forest is replaced with hill forests found throughout the hilly parts of the interior (darker greenish), while at the highest altitude montane forest are found on mountain ranges like Crocker Range and the areas around Mt. Trus Madi and Long Pasia (dark green). Mangroves, the last main forest type, are found at the lowest altitude - particularly on the east coast of Sabah (light green)

Apart from these main forest types, other specialised forest types can be found in Sabah, including: Swamp forest at a few low-lying peat-rich coastal areas; heath forest or kerangas on inland patches of sandstone; specialised forests on some limestone outcrops e.g. Gomantong and nearby Lahad Datu; and floristically distinctive forests on the ultrabasic rocks outcrops in the northeast and southeast (Source: Environment Protection Department, 2002)



The timber industry in Sabah has been the main source of revenue for the socio-economic development in the Sate, and remains significant even though at a much reduced level. However, this development has not taken place without environmental consequences, of which the key environmental impacts are river pollution due to increased soil erosion, which in turn leads to adverse impacts on human settlements due to deteriorating water quality, and adverse impact on flora and fauna.



The progressive harvesting of the Commercial (Class II) Forest Reserve in Sabah – 1970 to 2000. Dark green areas represent the remaining undisturbed (un-logged) forest outside of the protected area system. Data for 1970 represents, more or less, the entire Permanent Forest Reserve (Source: Environment Protection Department, 2002, adapted from Sabah Forestry Department, 2002)

Forest indicators

Forests remain the major land user in Sabah. The area covered with forest, and especially the type of forest cover, however, has changed in the last decades and will probably continue to change. This change in forest cover has been intimately linked with income generation from forest resources, why together, type of forest cover and income generation give some indication of the quality of the remaining forests. If in the future forest cover remains the same but revenue falls, this will probably indicate that the remaining forests are in poor condition. As the supply of timber from natural forests diminishes, there will be an increased reliance upon timber from plantation forests; therefore a third indicator for industrial tree plantations is included.

This leads to the following indicator areas for forests:

Area 2: Income generation by forestry indicated through percentage contribution to state revenue

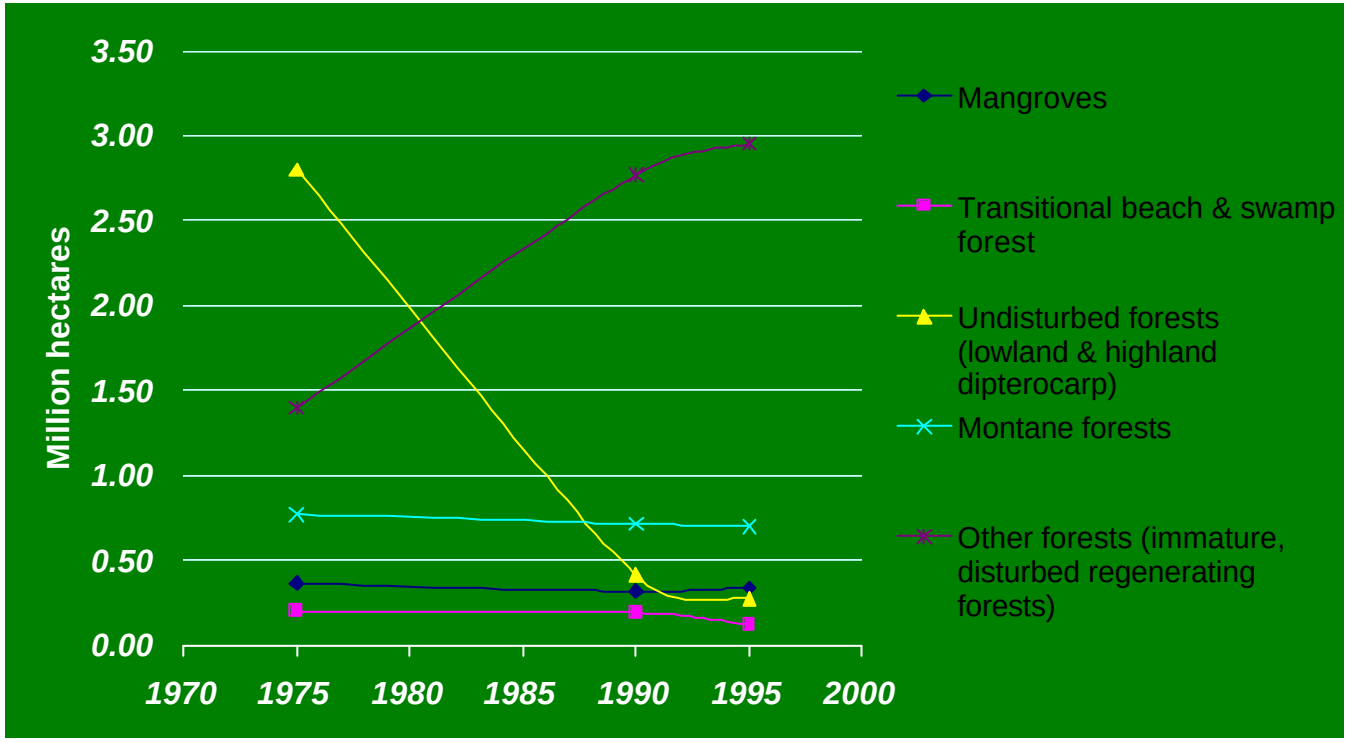
Area 1: Forest types and the status of each type indicated in hectares per type

Area 3: Area planted with industrial tree plantations and derived revenue indicated in hectares and million ringgit

Indicator area 1: Forest cover by type

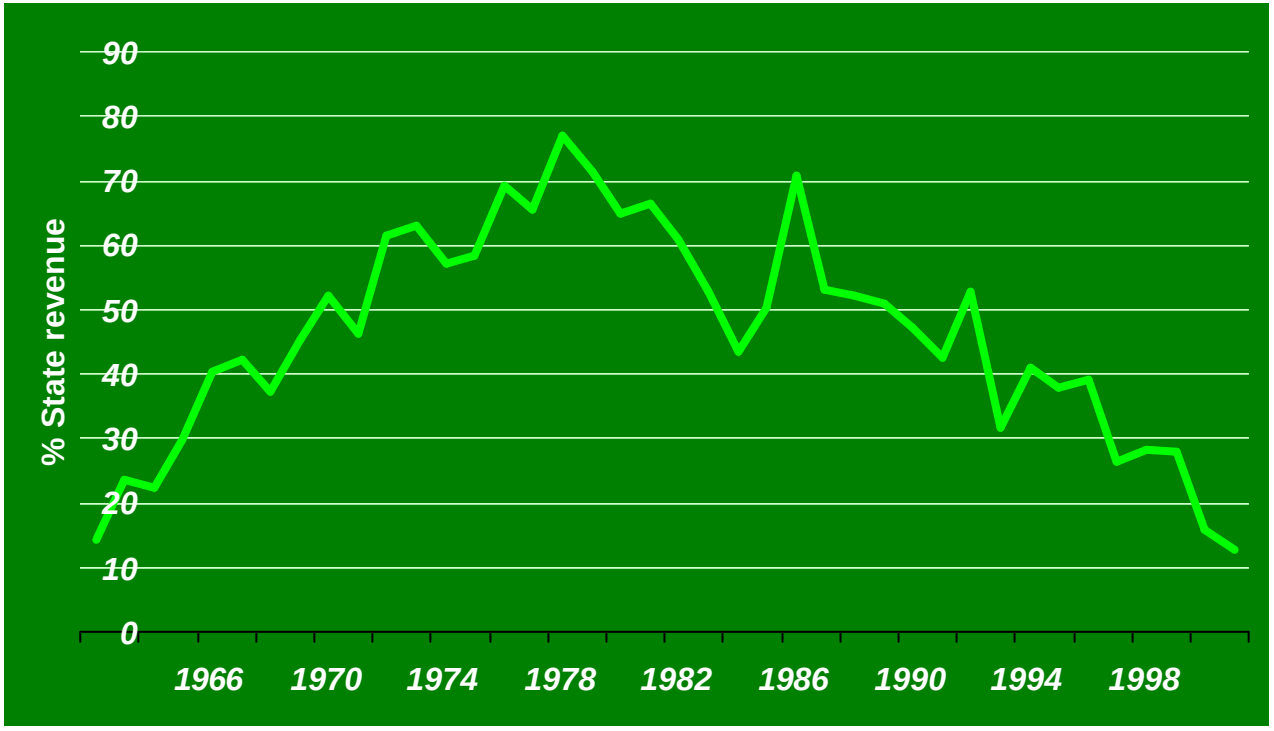
Lowland dipterocarp is found below 300 metres altitude, where the most important commercial timber species are found. Upper dipterocarp forests rise to 1200 metres and become the target for logging activities once lowland forests have been depleted. Where the natural forests have either been logged or cleared during shifting cultivation, secondary forests evolve. In terms of structure, productivity and composition, the secondary differs from the primary forest. Most valuable species of the initial forest have been felled, leaving seedlings to mature into the new forest. Pioneer secondary species, such as Macaranga and Mallotus, get established. Over a long time, secondary forests may develop into areas as mature as the original, although with a new composition.

The most notable trend is the dramatic reduction of undisturbed forest and corresponding increase in the amount of disturbed and regenerating forests. Other forest types show a more gradual decline in area, except for mangroves, which recorded a slight increase in the second half of the period. (Source: Sabah Forest Department, 1994, 2002. Note: Some discrepancy between total forest areas reported here and figures reported elsewhere in this report attributed to the fact that the data above was derived from air photograph interpretation rather than classified reserve and titled areas)



Indicator area 2: State revenue from forest activities

Current trends indicate that Sabahs forests will continue to decline as the world demand for quality timber shows no sign of slowing down. Stable revenue from forest activities normally indicates sustainable forest management of the natural resource.



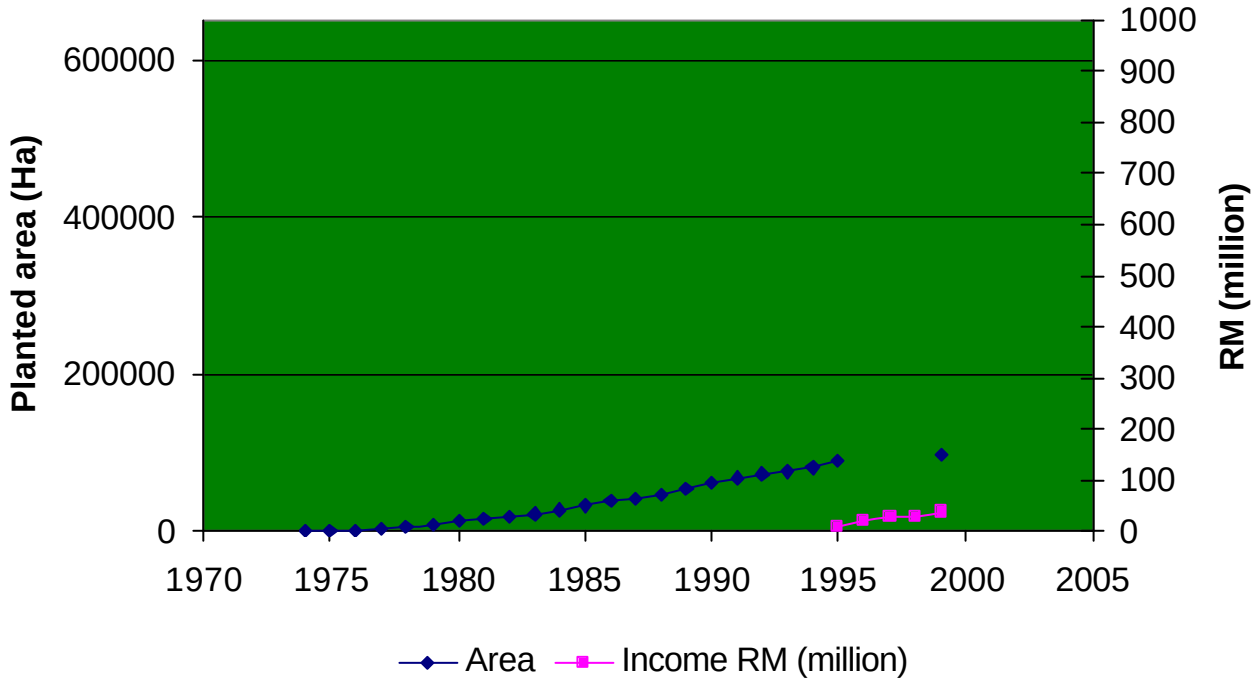
At one time Sabah derived nearly 80 per cent of state revenue from forest activities, and although forest activities remain important contributors to state revenue, it is clear that the boom years are over. Today only slightly more than ten % of the State revenue is derived from forest resources (Source: State Ministry of Finance; Annual Bulletin of Statistics, various years)

Indicator area 3: Land area under industrial tree plantation and derived revenue

As the supply of timber from natural forests diminish, an increased reliance upon timber from plantation forests occurs. Industrial tree plantations invariably occur at a cost to natural forests, and therefore can be seen as a threat to the natural environment, however, if planted and managed as part of an integrated forest management plan, plantations can benefit the environment in that some pressure is taken off existing natural forests and re-afforested areas are provided with much needed protection for bare soil and eroding areas.

About 416,000 hectares of commercial forest reserve and 220,000 hectares of non-forest reserve have currently been earmarked for forest plantation development.

The total area planted with Industrial Tree Plantations has shown a steady increase from very few ha in 1975 to almost 100,000 ha in year 2000. State revenue from forest plantations has increased since 1995 to about RM50 million in 2000 (Source: Sabah Forestry Department, 2001)



ANIMAL & PLANT

The terrestrial environment in Sabah is characterised by a complete range of forest habitats, ranging from extensive tracts of mangrove and other coastal swamp forests, though lowland rainforest, to the sub-alpine dwarf forest of Mount Kinabalu. It is this diverse array of habitats that provide a home for the tremendous biodiversity found in the state; the existence and survival of which are closely linked to the continued existence of this forest cover. Malaysia is identified as one of the world's twelve mega-diversity areas with extremely rich biological resources. In Malaysia there are over 15,000 known species of flowering plants, 286 species of mammals, 150,000 species of invertebrates, over 1,000 species of butterflies and 12,000 moth species, and much of this biological richness can be found in Sabah. 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 plays an important role in our lives.

The richness and uniqueness of animals and plants is the single most important attraction that draws tourists to Sabah. The tourism sector today is a targeted growth area, a particular focus of which is largely nature based

Today, the greatest threat to the animals and plants of Sabah is habitat loss and fragmentation of the remaining habitat. As forested lands are cleared to make way for plantations and other forms of land development, the continuous forests that once characterised our landscape are becoming more and more fragmented; and the remaining fragments, smaller and smaller. Such fragmentation significantly impacts animal and plant populations.

Reports of elephants intruding into and destroying areas of oil palm plantations can be attributed to the fact that some of today's plantations now occupy the previous elephant range. Larger mammals require larger territories to sustain their food supply and continue to survive in the wild. It is also believed that through forest fragmentation, active breeding populations are less likely to come into contact with each other resulting in reduced reproduction opportunities of the species

Animal and plant indicators

To protect and maintain the current high levels of biodiversity, adequate portions of the remaining natural habitat need to be set aside from the normal land use system and provided with protection. Accordingly, our first indicators are the size, type and number of protected areas.

Whether or not these protected areas are adequate, or whether or not they are being managed sufficiently to protect the remaining biodiversity can only be determined by examining population numbers for some selected indicator species. In order to do this three species have been chosen as indicators. Trends in population number of these species will give some indication as to the effectiveness of the protected area system.

Area 1: The total area granted protection in ha

Area 2: The number and size in hectares of protected areas

Area 3: The total number of Orang-utans

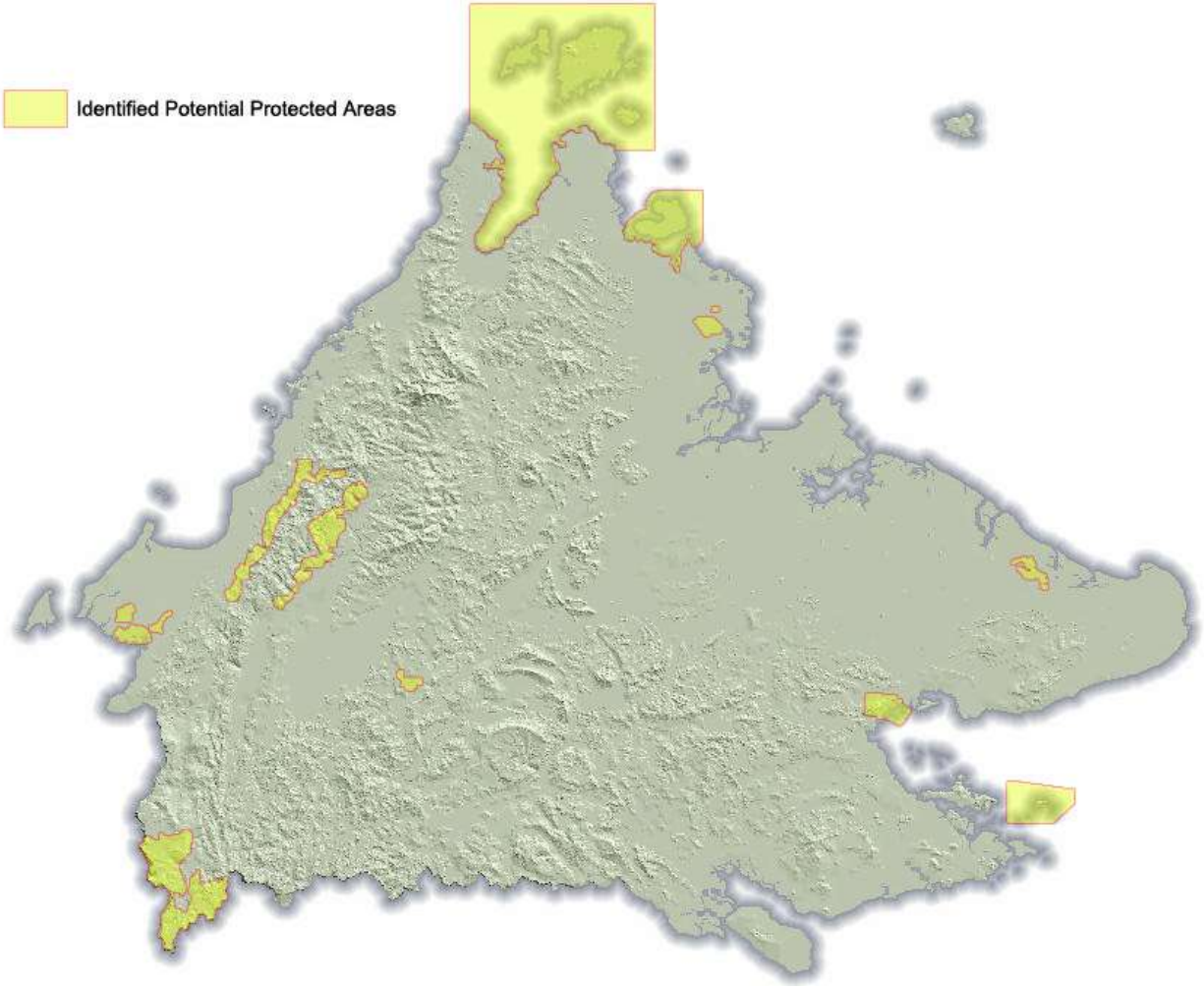
Area 4: The total number of Sumatran rhinoceros (Photo by Kit Sun Tan, courtesy of Asian Rhino Action Plan & SOS Rhino Malaysia)

Area 5: The total number of Asian elephants (Photo by Raymond Alfred, WWF Malaysi

The protected area system in Sabah currently provides good protection for a broad range of habitat types – and the number and area of land receiving protection is increasing. If it is possible to maintain protection for these existing areas then the goal to allocate and maintain more than 10 per cent of land area for nature conservation is eminently winnable. However, it is a concern that few of these areas receive complete protection and in the future could be subject to increased pressure as the demand for land, timber and other resources grows.

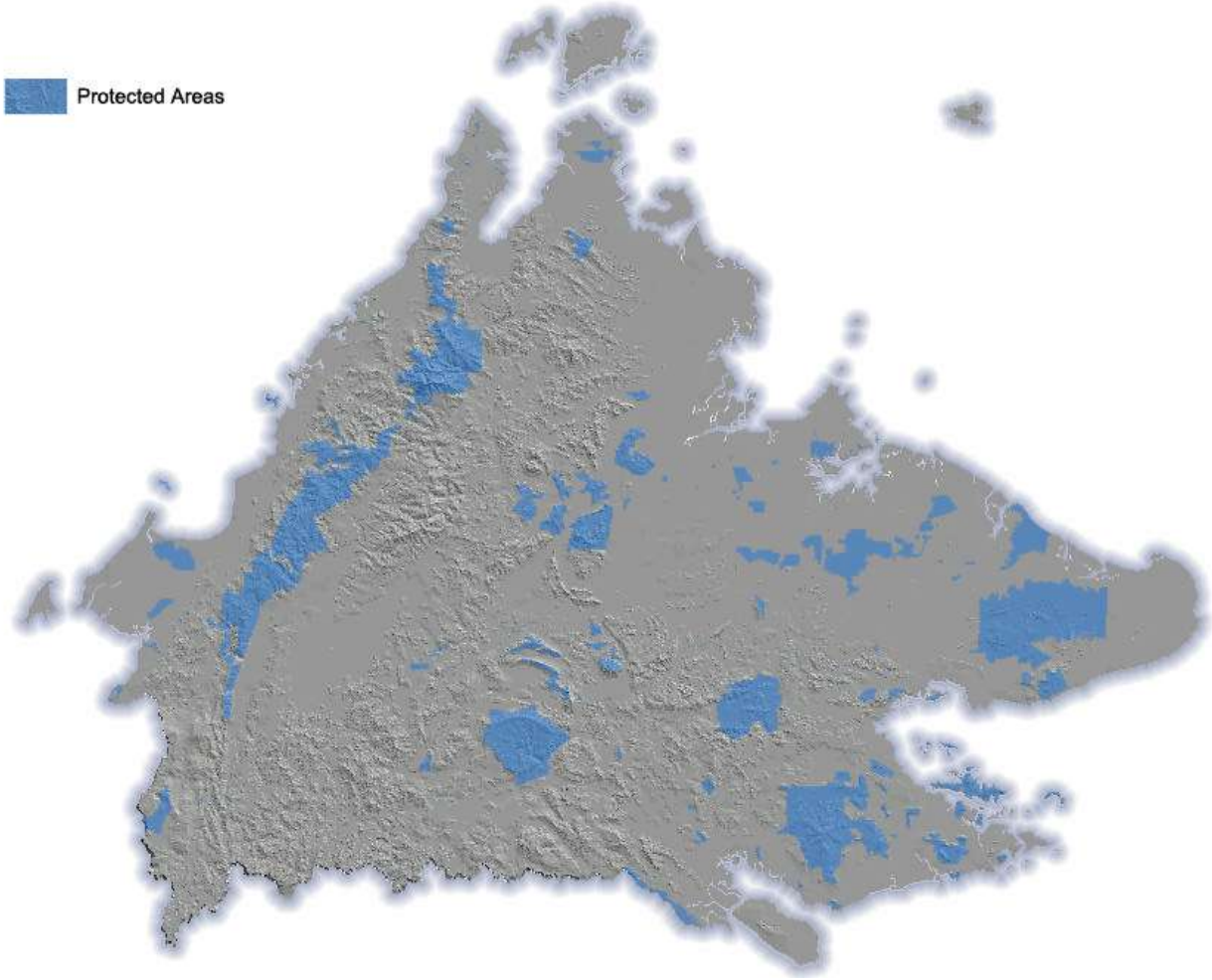
A number of additional conservation areas have been proposed to complement the existing protected areas and may warrant inclusion in the protected area system in the near future. These include: Ulu Padas, Crocker Range foothills, Klias, Nabawan, Sugut and Segama – all di 'Identified potential protected areas' – and the proposed Semporna Island Park, Darvel Bay/Bukit Silan and Pulau Banggi (all marked yellow on the map)

In addition to these the following are being considered: (i) Mangroves as there is currently a lack of adequate protection for mangroves, (ii) Mount Trus Madi, the second highest mountain in Borneo, which still scope for becoming a new State Park covering the upper and some lower reaches and (iii) Imbak Valley which warrants inclusion for a number reasons, not least of which is its spectacular physical beauty



Indicator area 1: The total area granted protection

The key element of biodiversity conservation in Sabah is to identify and maintain a system of protected areas, which adequately covers the full range of habitats. It has been suggested by the international conservation community that if every nation reserved about 10 per cent of national land area for inclusion into a protected area system, this would be sufficient to ensure the survival of a broad range of biodiversity.



Today in Sabah, a total of 1,191,783 million hectares on land had protected area status, equating to about 16.1 per cent of the total land area. In addition to this, 51,697 hectares of marine areas were allocated protected status (Source: Environment Protection Department, 2002)

Indicator area 2: Number, size and type of protected areas

Sabah has a long history of setting aside important natural areas for conservation of its unique and rich assemblage of flora and fauna. Today a variety of categories of protected areas comprise the core component of nature conservation.

Under the Parks Enactment, 1984, ***six parks with a total size of 264,840 ha*** *have been gazetted:*

- three Terrestrial Parks; Mt. Kinabalu 75,370, Crocker Range 139,919 and Tawau Hills 27,927 ha

- three Marine Parks; Turtle Island 1,740 (of which 15 ha is forested), Tunku Abdul Rahman 4,020 (forested 1,289) and Pulau Tiga 15,864 ha (forested 607)

Under the Wildlife Conservation Enactment, 1997, ***six areas with a total size of 70,097 ha*** *have been granted protected status as wildlife, marine or bird santuary:*

- Lankayan Billean Tegapil Marine Conservation Area 30,000, Lower Kinabatangan 27,800, Kota Belud 12,200, Mantanani Kecil 61, Kota Kinabalu 24 and Sipadan 12 ha (Source: Sabah Forestry Department, Sabah Wildlife Department, Sabah Parks, all 2002)

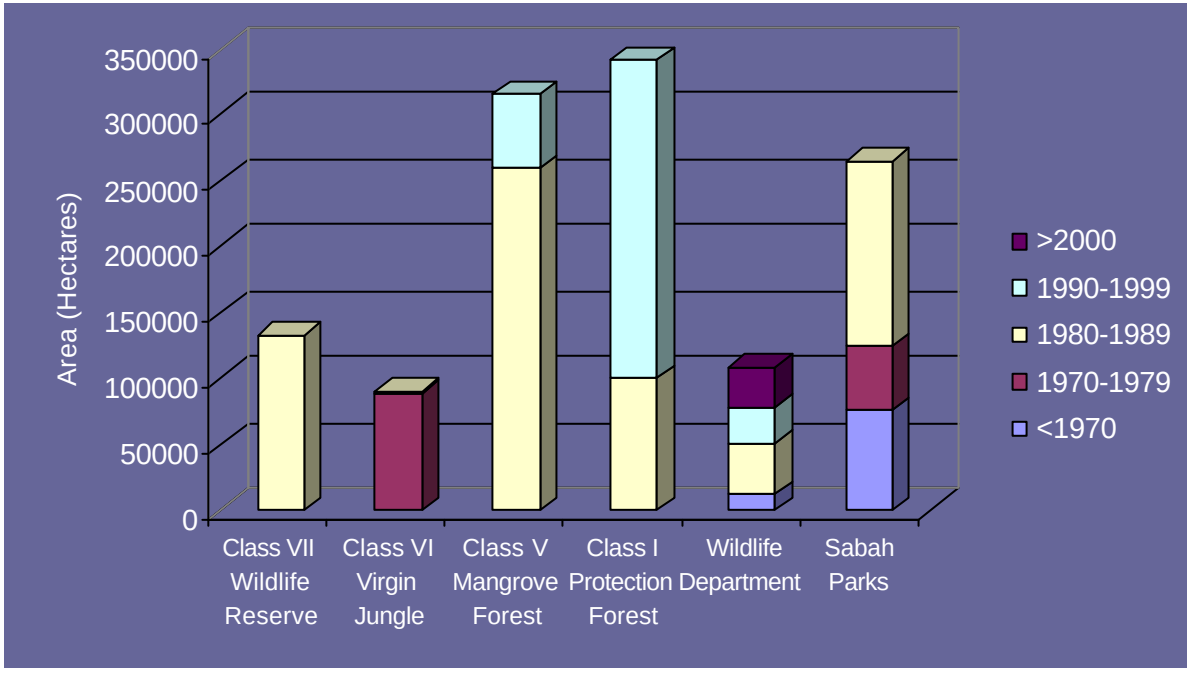
Under the Forest Enactment, 1968, ***four of the seven classes of forest reserves may be regarded as protected areas. Under these a total of 906,632 ha*** *have been granted protection:*

- 342,216 ha as Class I Protection forests, comprising 43 different areas, including Maliau Basin (58,900), Danum Valley (43,800), Ulu Kalumpang (51,118), Tawai (22,697), Bidu-bidu (16,094), Binsuluk (12,106), Mt. Pock (11,585), Timbun Mata (11,497) and Silabukan (10,601) – mostly offered protection in the 1990s

- 341,377 ha as Class V Mangrove forests comprising 17 areas, including Kuala Bongaya & Labuk (56,507), Trusan Kinabatangan (40,471), Tawau (38,990), Sg. Sugut, Paitan Pulau Jambongan (38,564), Elopura (24,674), Kuala Segama & Maruap (23,993), Semporna (23,400) - the main part offered protection in the 1980s

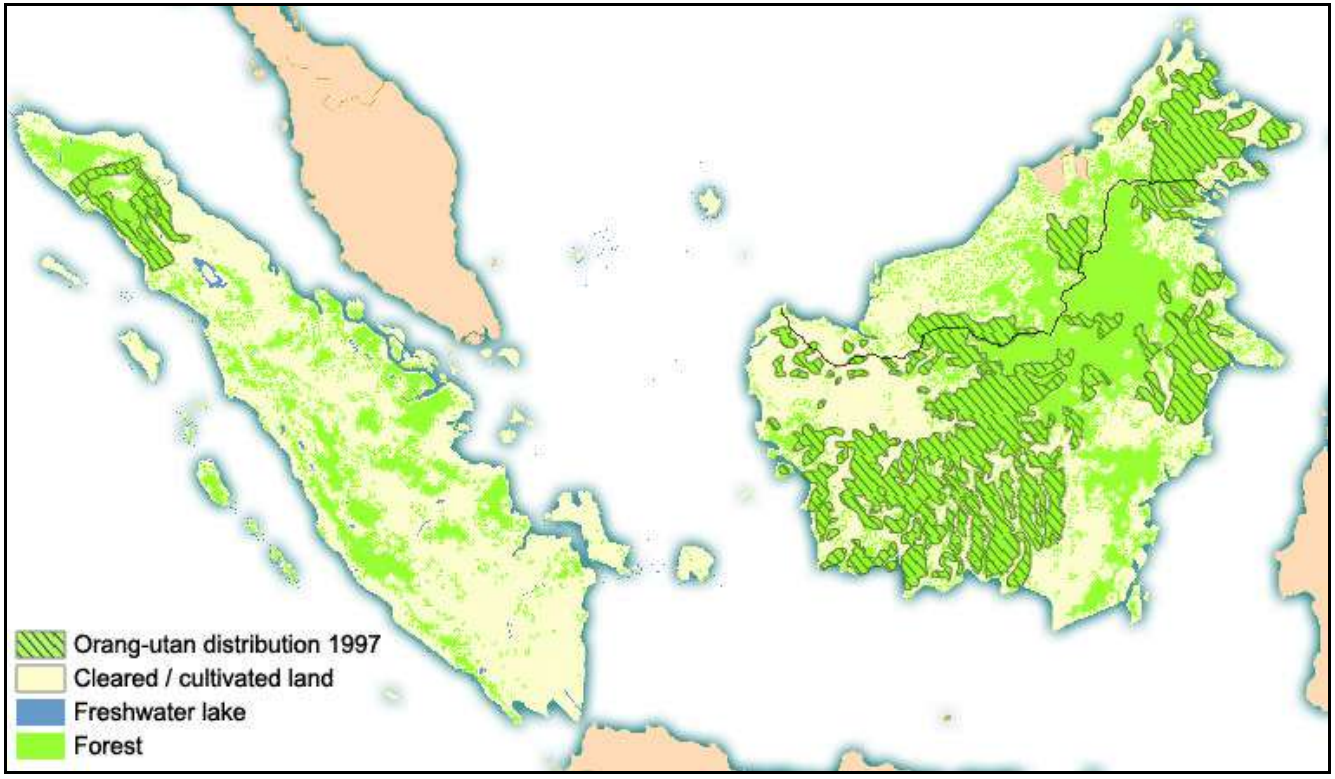
- 90,386 hectares as Class VI, Virgin Jungle Reserves, all established before 1980s and comprising 50 areas intended to provide undisturbed forest for research purposes and the preservation of gene pools, including Sg. Imbak (18,113), Maligan (9,240) and Lungmanis (6,735)

- 132,653 ha as Class VII, Wildlife Reserves, comprising two areas; the large Tabin wildlife reserve (111,971) and Kalumba (20,682), both established in the 1980s



World distribution of Orang-utan (Pongo pygmaeus). Serious forest fires in Indonesia during 1997-98 occurred in parts of south, southwest and central Kalimantan, known to be important for orang-utans and it is estimated that 25-60 per cent of their known habitat was destroyed by fire. Although there is considerable uncertainty about the impact of these fires on population numbers, available information suggests that population numbers continue to decline, with the probable loss of up to 50 per cent of the population since the early 1990s.

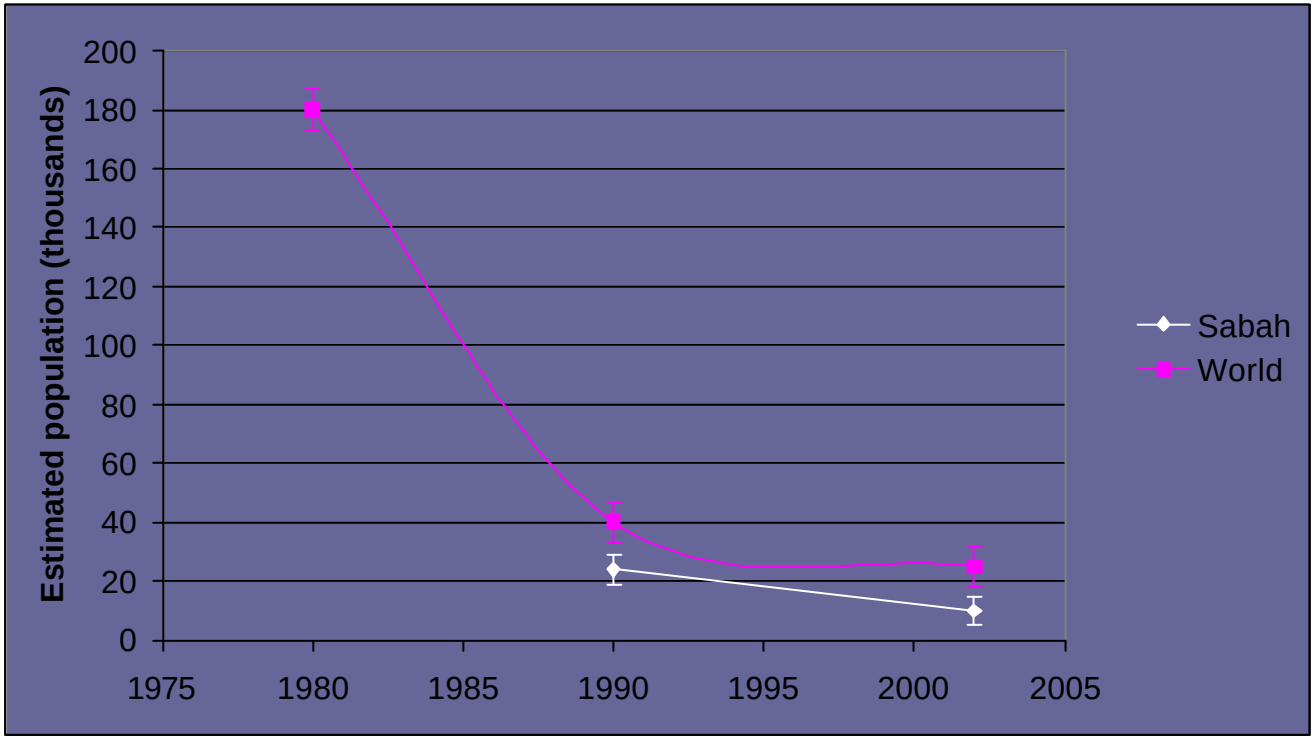
Given that population numbers in Indonesia are falling so dramatically, for example. in Sumatra by an estimated 1000 animals per year, this now means that Sabah remains a key locality for ensuring the survival of the species. Surveys within the Kinabatangan Wildlife Sanctuary suggest that the population is currently stable. However, as witnessed during previous ENSO related drought and fire years, extensive tracts of forest can quickly be consumed by fire and the small fragmented patches of the Sanctuary remain extremely vulnerable (Source: Adapted from World Conservation Monitoring Centre, 2002)



Indicator area 3: Orang-utan (*Pongo pygmaeus*)

Orang-utans are the only great ape outside Africa, occurring in dwindling forest habitat on the islands of Borneo and Sumatra. Extensive loss of suitable forest habitat, due to logging and forest clearance activities, particularly conversion to large-scale cash crop agriculture, is by far the greatest threat. Forest fires, associated in part with the logging and forest clearance activities, have also damaged or destroyed large areas of forest known to be important to orang-utans. The Species Survival Commission of IUCN categorised the Bornean Orang-utan as Endangered overall, i.e. facing a very high risk of extinction in the wild in the near future.

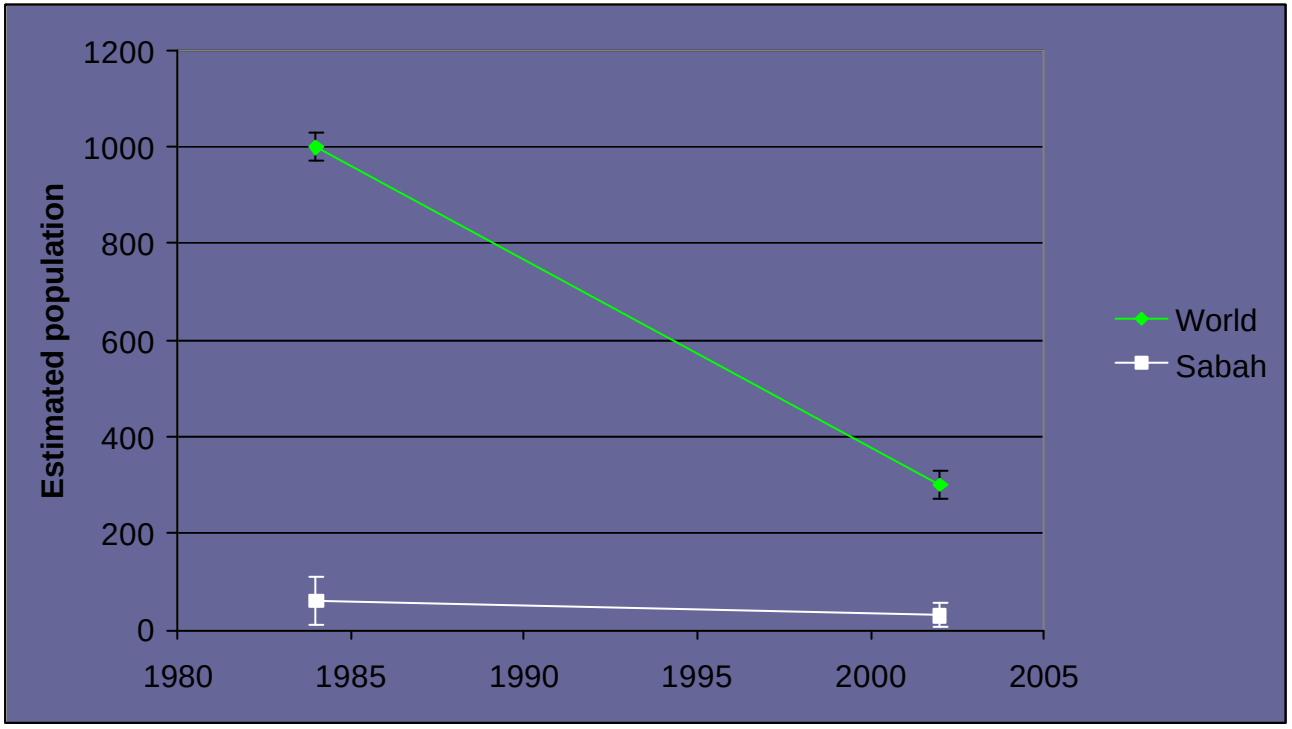
As with other forest animals, it is difficult to accurately assess orang-utan population size and monitor trends. In the 1980s the total population in Indonesia and Malaysia was estimated at 180,000. In 1990, the IUCN/SSC Primate Specialist Group estimated approximately 30,000 to 50,000 orang-utans to be remaining in the wild, but cautioned that these figures may be over-estimates. It is now thought that only about 25,000 animals remain in the wild with an estimated population in Sabah of between 5–10,000 animals (Source: World Conservation Monitoring Centre, 2002)



Indicator 4: Sumatran rhinoceros (*Dicerorhinus sumatrensis*)

The Sumatran rhino is the smallest of the five rhinoceros species living today, standing 0.9-1.5 m tall. The Sumatran rhino is also the oldest living species of rhino, and is a descendant of the wooly rhinoceros. It is thought that they have remained unchanged for the last 2 million years. Sumatrans are covered in long course, reddish-brown hair, with tufts on their ears. Sumatran rhinos are solitary, with males the most nomadic wandering along streams and game trails. It feeds before dawn and sunset, moves mostly by night and spends much of the day in mud wallows or rainwater ponds usually created by the animal themselves. Their native habitat is dense tropical forest and mountain moss forest.

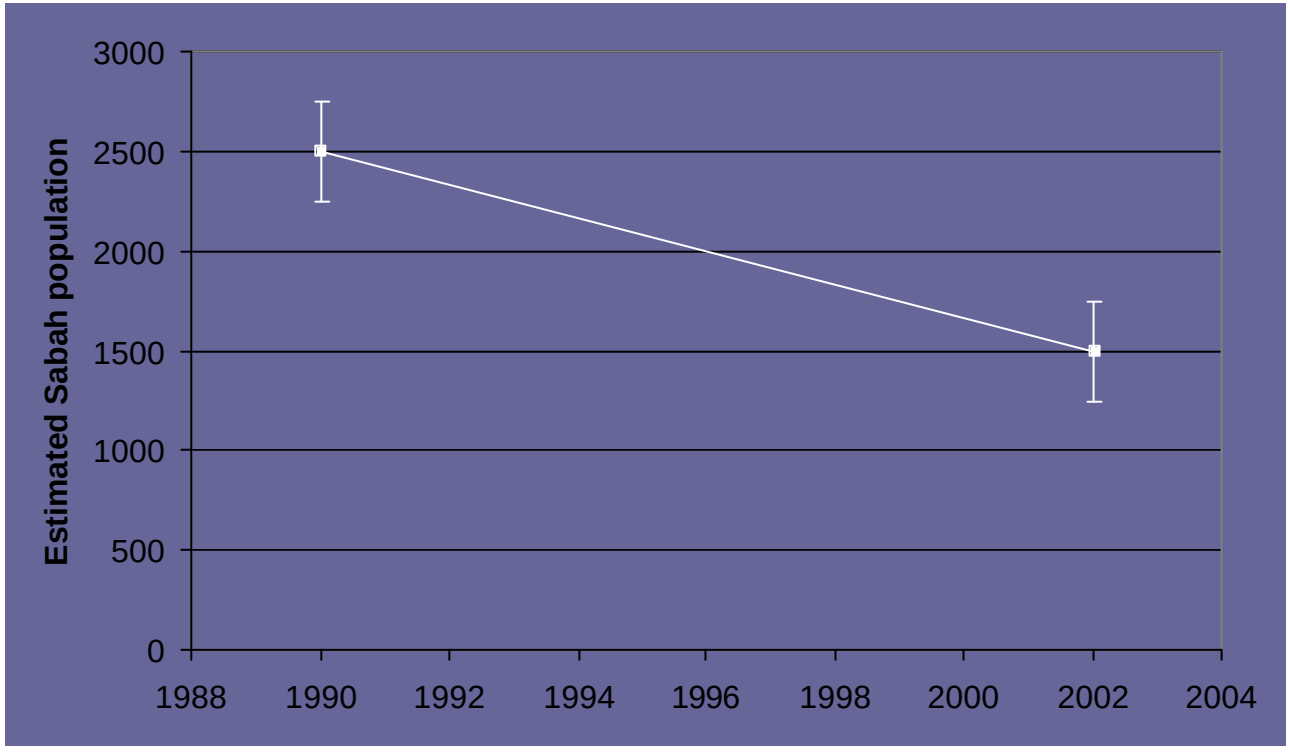
There are about 300 Sumatran rhinos remaining today in small fragmented populations in Sumatra, Peninsular Malaysia and Borneo. Constantly threatened by poaching and habitat loss, the Sumatran rhino population decreased from an estimated 1,000 animals in 1984 to the 300 animals today. It has been estimated that in 2002, at the most, 30 rhinoceros remain in the forests of Sabah. Tabin Wildlife Reserve, located 50 km northeast of Lahad Datu measuring 40km by 30km, is thought to have the largest viable population of the critically endangered species in Sabah (Source: Asian Rhino Action Plan & SOS Rhino Malaysia)



Indicator area 5: Asian elephant (*Elephas maximus*)

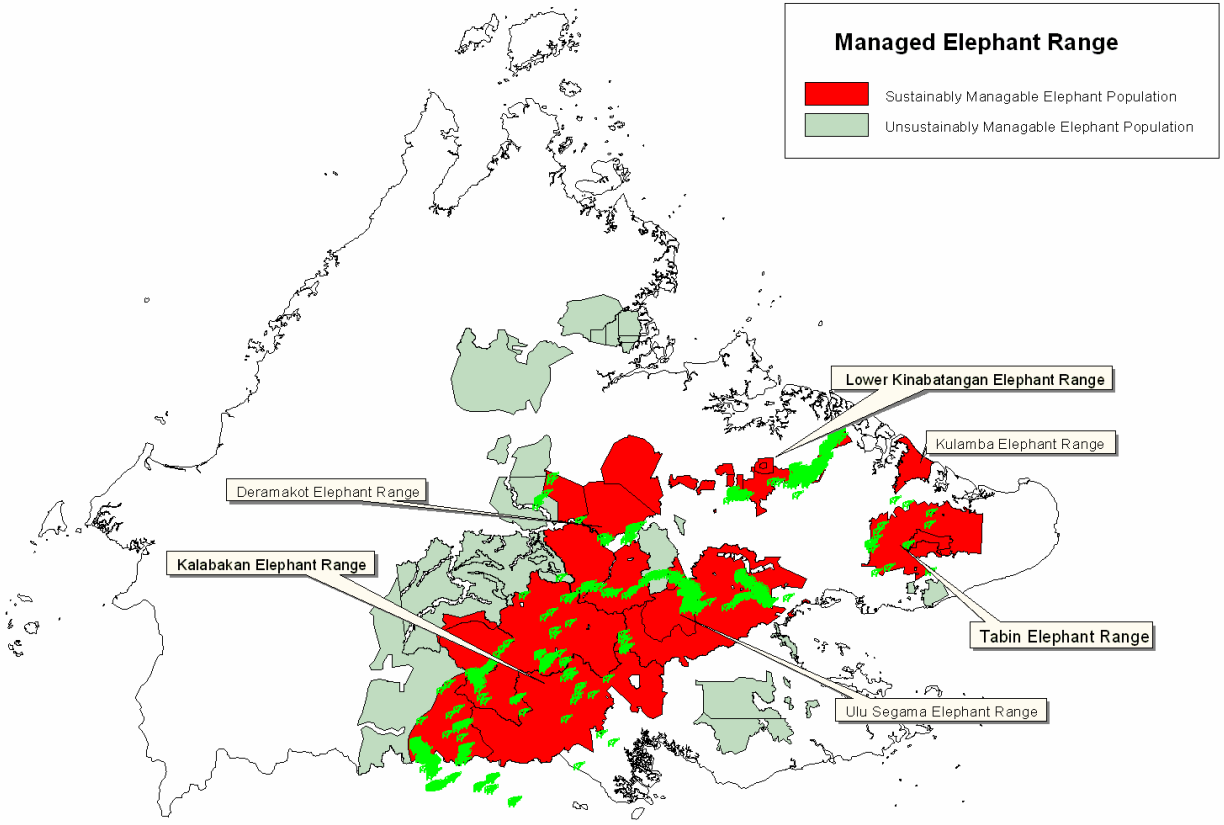
The Asian elephant is the largest terrestrial mammal in Asia. Asian elephants are primarily forest animals preferring a shady environment. They are found through a wide variety of forest types; with distribution limited by the need for daily access to water, and a preference for feeding on grass. Large areas of closed-canopy forest tend to be avoided. More than two thirds of the day can be spent feeding on grasses, but large amounts of bark, roots, leaves and small stems are also eaten. Cultivated crops such as bananas, rice and sugar cane are favoured foods. Elephants live in herds based on breeding groups of between 3 and 40 females and young. Herds form part of larger related groupings called clans.

The global population of Asian elephants at the start of the 20th century has been estimated to about 100.000. In 1990 the World Conservation Monitoring Centre estimated the population to have declined to about 34.000-54.000. The population of Asian elephants in Sabah in 2002 has been estimated to between 1.100 and 1.600 (Source: World Conservation Monitoring Centre 2002, Sabah Wildlife Department, WWFM)



Elephants occur in Borneo only in the extreme northeast and in Sabah probably more than half of the elephants live outside protected areas. Tabin Wildlife Reserve and the surrounding large area of commercial forest reserves containing elephants, was gazetted in 1984. Since then other patches of important riparian forest, comprising the Kinabatangan Wildlife Sanctuary, have been gazetted. Although these reserves provide important protection for some elephant populations in Sabah, it is likely that the conflict between elephants and agriculture will continue.

Range and distribution of elephants in Borneo (Source: Andau and Payne, 1990)



Distribution and sightings of elephants. The green symbols represent sighting in Sabah circa 2001-2002 (Source: WWFM AREAS Project, 2002)


MANGROVE

MANGROVE

Traditionally mangrove swamps provide two main resources, habitat for fishing, and wood for firewood or construction.

Road side sale of mangrove cuttings for firewood. Although in the past, the harvesting and utilisation of wood by local communities had little impact, the increased number of peoples involved in the activity today is beginning to significantly impact remaining forests. Rapidly decreasing yields of wood from dry land forests in Sabah, might also lead to an increased pressure to utilise mangrove forests for forest produce in the future

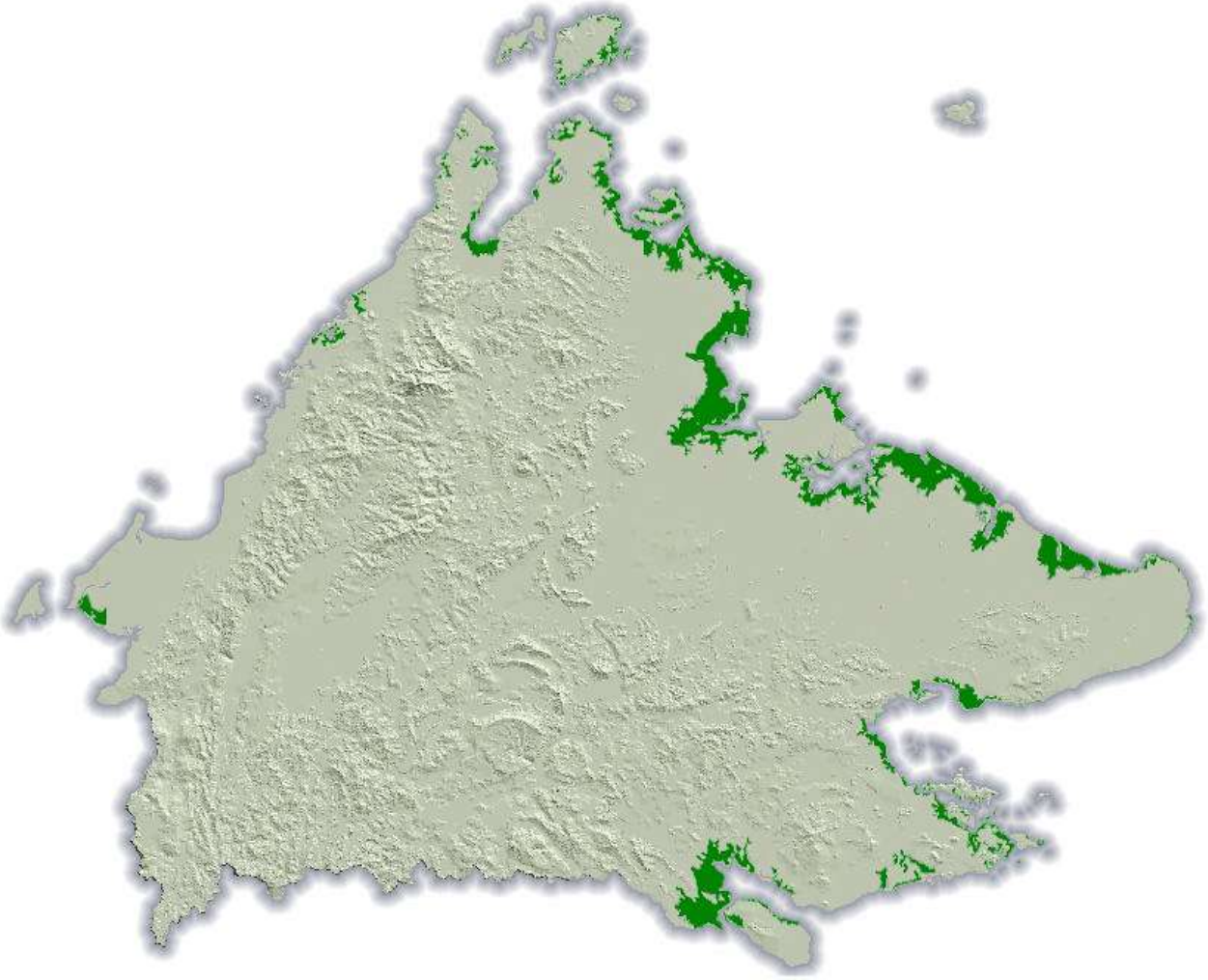
The main threat today to mangrove areas, however, is alienation of land for various development purposes, including land reclamation and aquaculture activities

MANGROVE

Mangrove swamps are coastal forests, which occur in the upper half of the inter-tidal zone on sheltered, flat muddy, tropical shores. Mangrove areas are ecological important for several reasons. The forests form the feeding and nursery grounds for prawns, fish and other invertebrate species, while at the same time protecting coastal areas from erosion by providing a buffer zone against tidal currents, floods and storms.

The substrate in the mangrove forest is usually a firm to soft mud. Muddy substrates release a pungent hydrogen sulphide smell that indicates the oxygen-free nature of the waterlogged soil in the mangrove forest. Such conditions provide ideal breeding grounds for mosquitoes.

Mangroves have historically been considered wastelands and thus reclaimed for development for urban, industrial and agricultural purposes. Outside the protected mangrove reserves, tracts of non-reserved mangroves have in Sabah been converted to other land uses in the last decades.



Mangroves are well represented along the alluvial banks and shores of Sabah, particularly along the east coast (Source: Environment Protection Department, 2002)

Mangrove indicators

For mangroves to remain ecologically intact requires not only protection of the mangrove area, but also that stretches of habitat inland of the mangrove reserves, for example nipah swamp, remain undisturbed, maintaining the connection and exchange with the freshwater environment.

Sabah still maintains significant tracts of mangrove habitat, but it can be expected that the utilisation of these areas will increase in the coming decades, especially for construction and aquaculture.

We have chosen to use the following indicator areas for protection, transition and change of our mangroves:

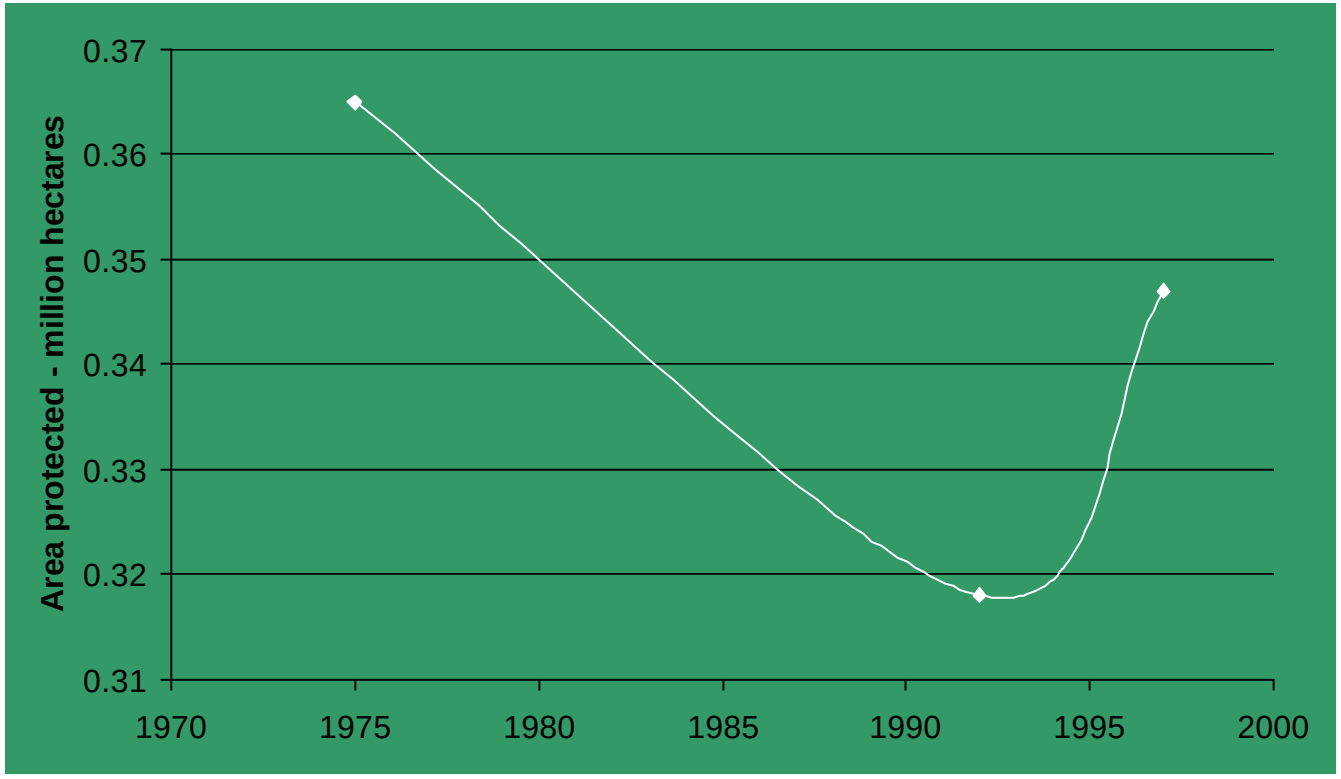
Area 1: Protected mangrove areas indicated through the total area offered protected status

Area 2: Loss of mangrove forest outside of protected areas indicated through case studies of the development of mangrove areas at Menggatal, Mengabong and Papar

Area 3: The development of the prawn farm industry indicated through the development trends regarding production in tonnes and pond area in ha

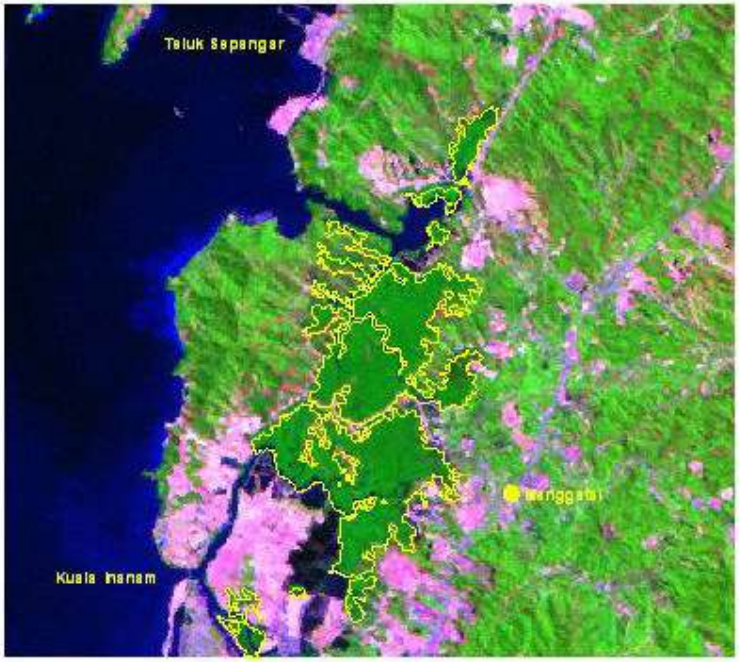
Indicator area 1: Mangrove area

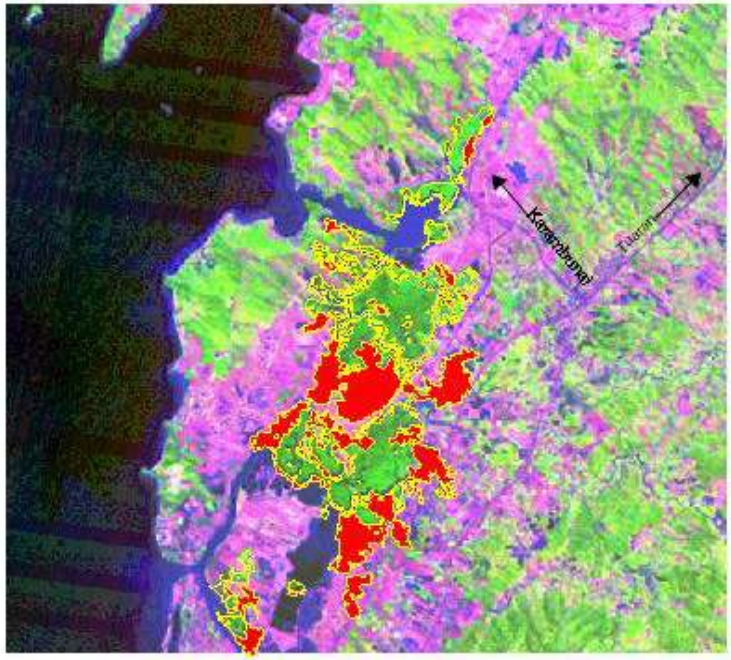
Mangroves are one of the major wetland types in Malaysia. Over half the total mangrove forests are located in eastern Sabah, which is a global centre for mangrove diversity with over 60 tree species recorded. This is an extremely rich collection when compared to tropical Africa and the Americas where only 7-12 species grow.



The amount of protected area mangrove has more or less remained constant over the last 30 years. The total mangrove areas provided protection under the Forestry Enactment, 1968, in 2002 amounted to over 340,000 hectares. This can be compared to about 160,000 hectares in Sarawak and 110,000 hectares in Peninsular Malaysia (Source: Forestry Department, Sabah, 2002)

Indicator area 2A: Mangroves in Menggatal



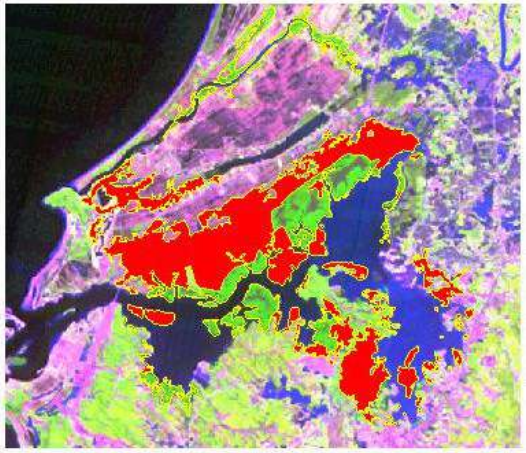


The mangroves in Sepandar Bay area, immediately north of Kota Kinabalu, experienced a 44 % decrease from 1991 to 2000. In 1991 mangroves covered 7.3 sq km (the upper images), while the figure in 2000 was 4.1 sq km (lower image).

The green areas on both images represent vegetation, whereas the pale and red colours indicate bare land, for example land that has been cleared for construction. Of note is the loss of a large area of mangrove forest (dark green colour in the centre of the image) to the west of the township of Menggatal (Source: Environment Protection Department, 2002; Landdsat satellite image 1991, SPOT satellite image, 2000)

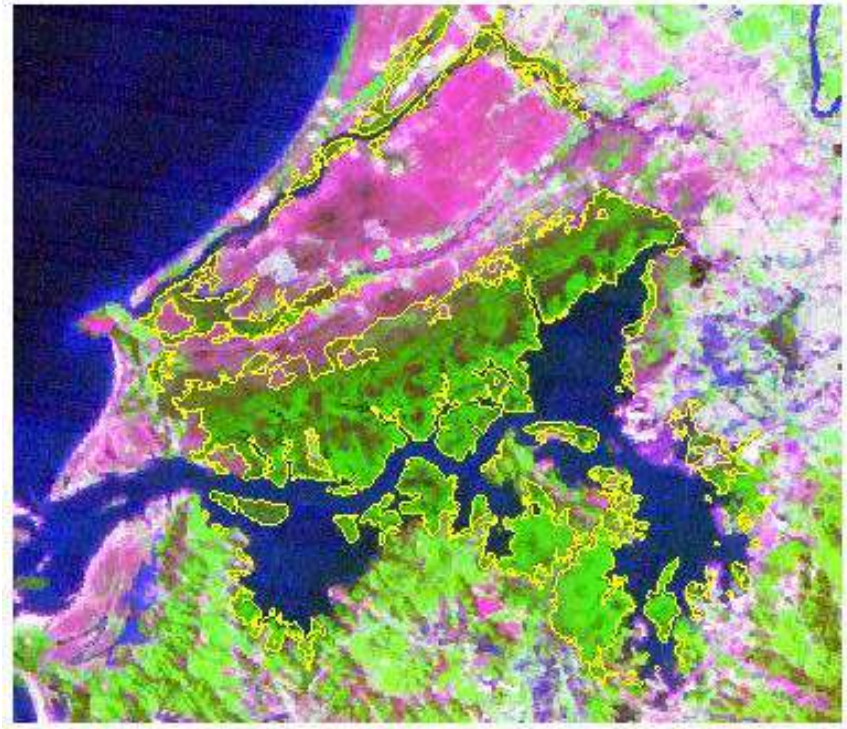
Indicator area 2B: Mangroves in Mengabong

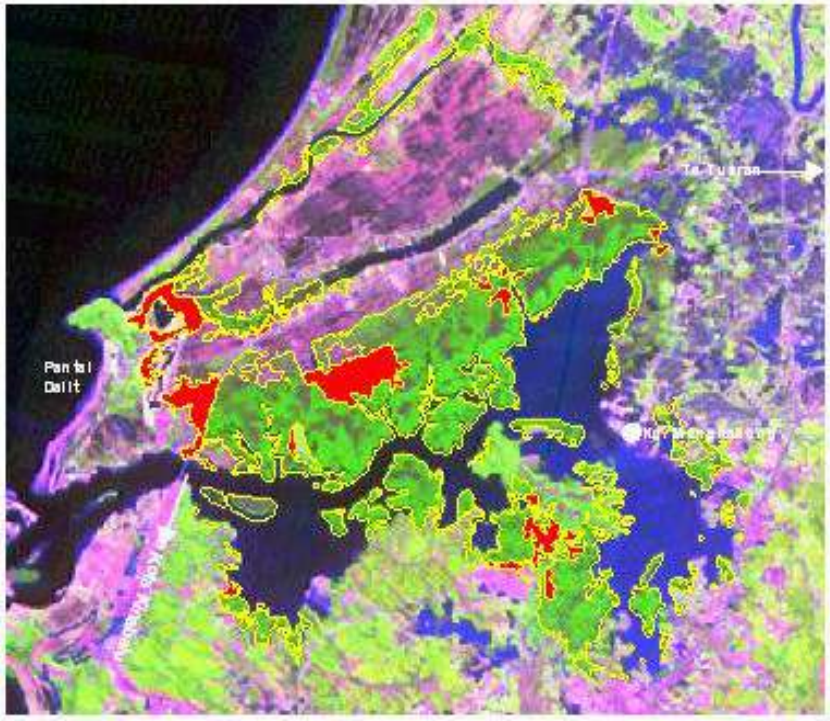
The Mengkabong mangroves, Tuaran District, experienced a 15% decrease from 1991 to 2000. In 1991 the mangroves covered 12.6 sq km (upper right image), while the figure in 2000 was 10.7 sq km (lower right image)



Future developments plans on already alienated land within the mangroves show that eventually little original mangrove forest will remain. By 2020 it can be predicted that the mangroves will cover only 3.8 sq km; a 70% decrease (above)

Green areas on the images represent vegetation, whereas the pale and red colours indicate bare land. Most of the mangroves lost, have been lost due to the spread of rural development such as housing and aquaculture projects. (Source: Environment Protection Department, 2002; Landsat image, 1991; SPOT image, 2000)





Indicator area 2C: Mangroves in Papar

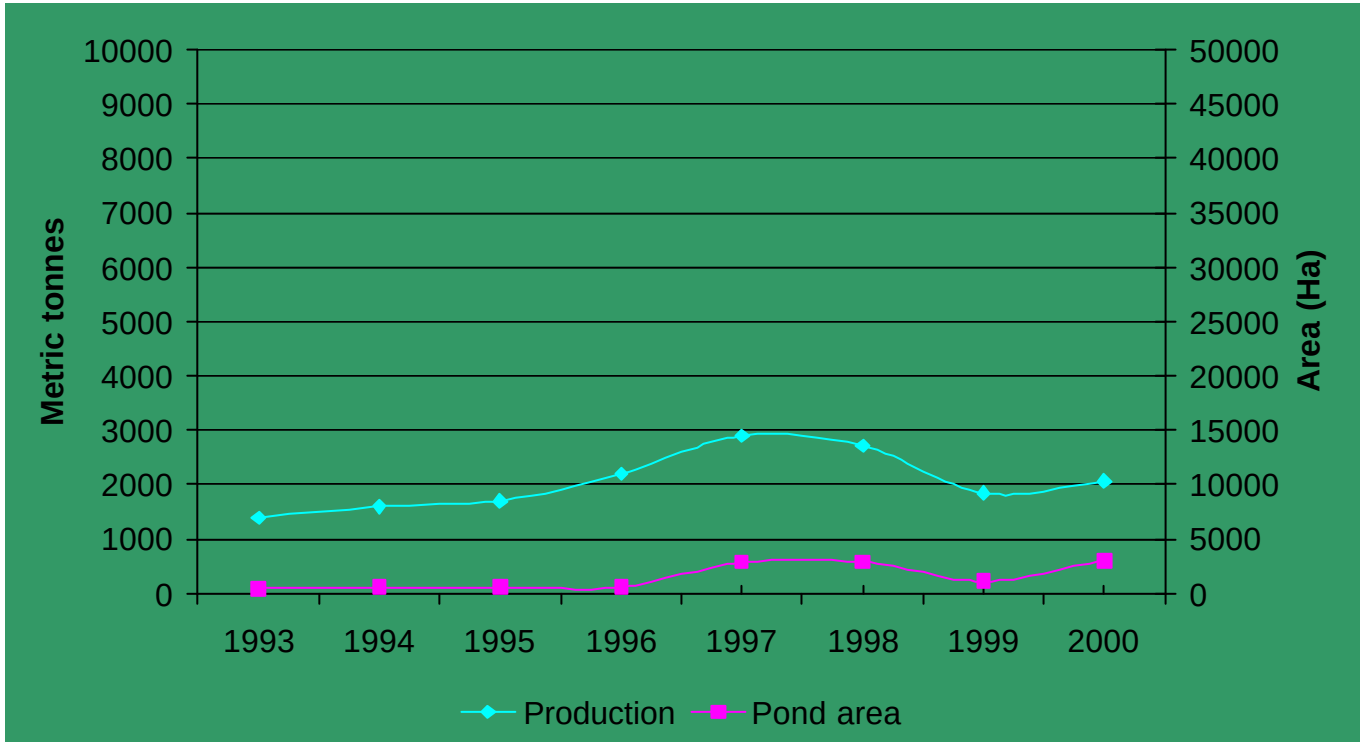
The mangroves and wetlands of Papar experienced a 16.9% decrease from 1991 to 2000. In 1991 mangroves and wetlands covered 5.9 sq km (upper right image), while the figure in 2000 was 4.9 sq km (lower image)

The green areas on both images represent vegetation, whereas the pale and red colours indicate bare land. Of note is that the loss of mangroves and wetlands around the town of Papar to date has been relatively small indicating a still relatively low development pressure (Source: Environment Protection Department, 2002; Landdsat satellite image 1991, SPOT satellite image, 2000)

Indicator 3: Land based prawn aquaculture

The intensive culture of tiger prawn *(Penaeus monodon)* constitutes the main part of export-oriented pond aquaculture product from Sabah. Aquaculture still remains a minor industry and the potential for further development remains high.

The intensive culture of tiger prawn at Covie Bay, Tawau



The trend in production of brackish prawns shows a slight increase in farm production and pond area from 1993 to 2000. Still a total pond area in 2000 of less than 4000 ha and a production around 10,000 mt must be regarded quite low, especially compared to surrounding countries (Source: Department of Fisheries, 2002)


RIVER

RIVER

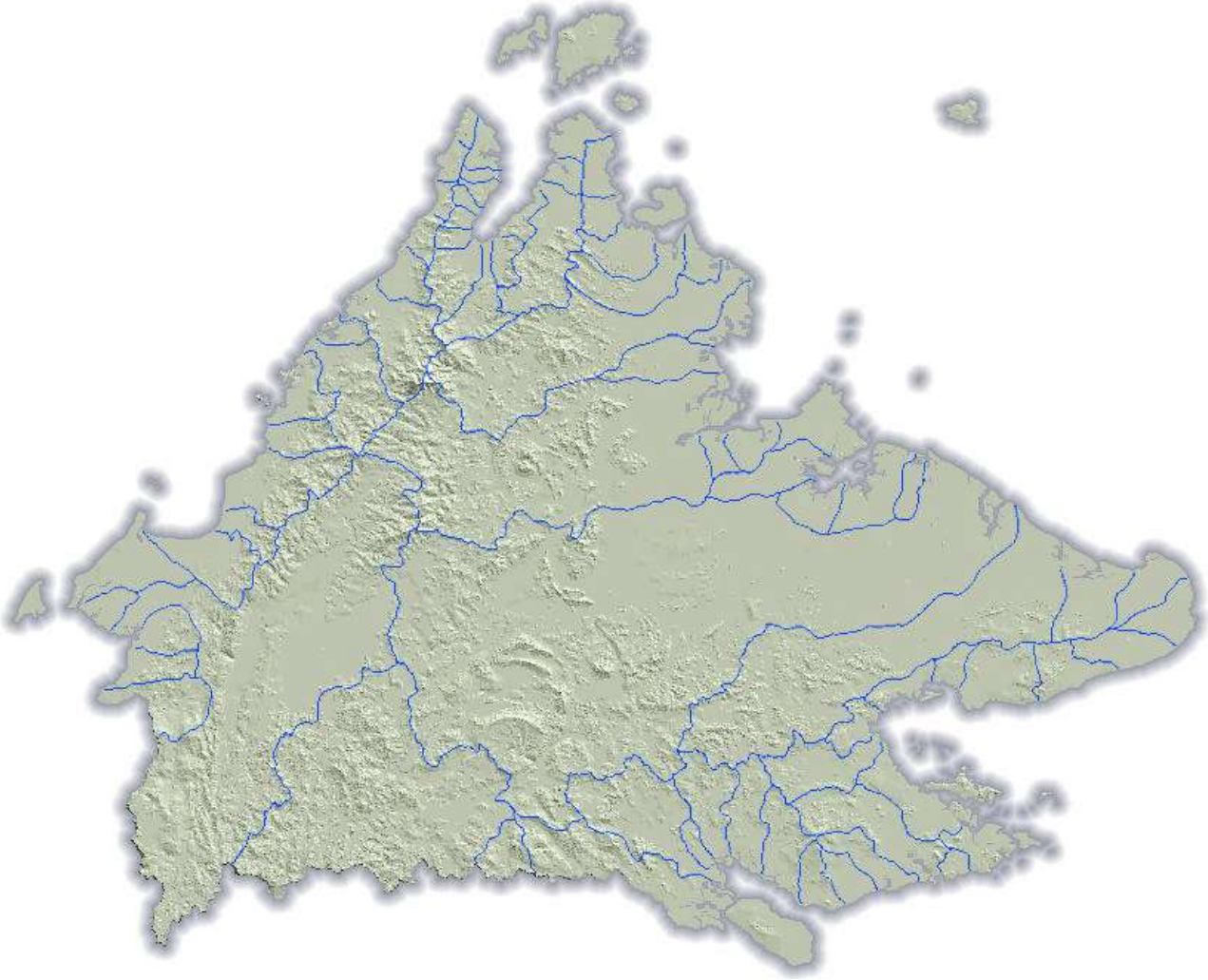
The condition of river water in Sabah is of special importance as surface water i.e. streams and rivers are the primary source of freshwater in the State. A clean and constant supply of water is not only essential for human activities, but plants and animals living in and near rivers are also dependent upon a regular supply of good quality water.

In many parts of Sabah, yellow waters characterise rivers polluted by sediment

Recent year have seen an increase in river pollution by both point and non-point sources. Industries, mining and urban areas are major point sources of pollution, while forestry and agricultural run-off containing fertiliser, pesticide and eroded soil are the major non-point sources of pollution. Deforested hill areas, steep agricultural land, roads and other construction activities are the primary contributors of silt from eroded soil.

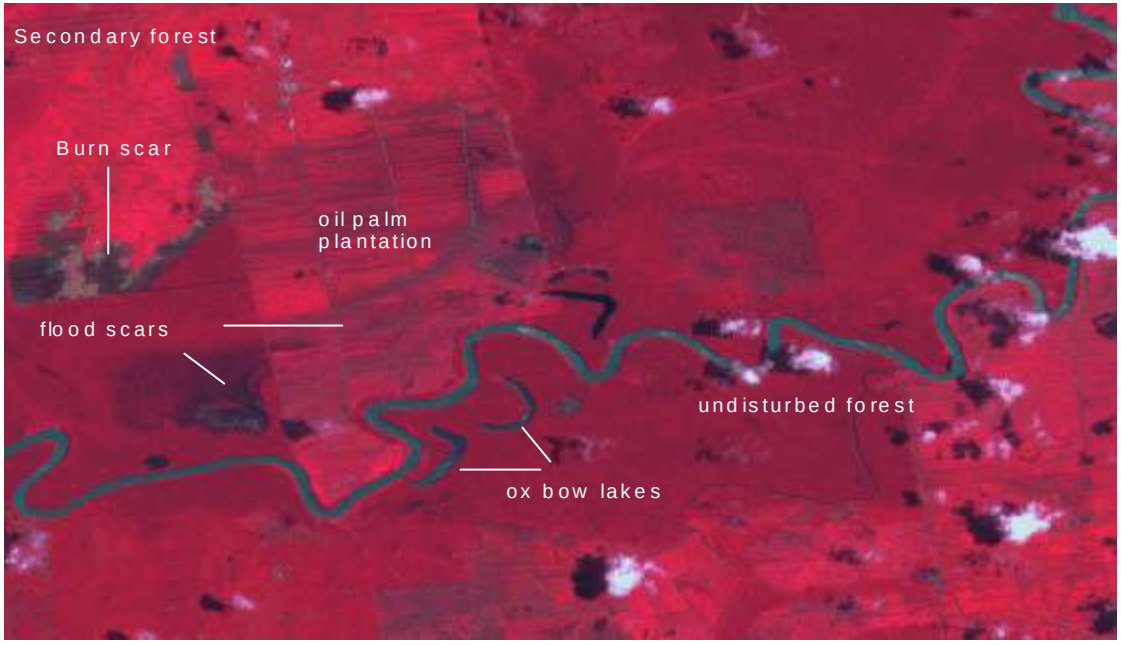
RIVER

Water is a vital resource, which makes possible the survival of all living things and the availability of water sets limits for economic and social development. Rivers, streams, lakes, man-made reservoirs, underground aquifers and wetlands constitute the freshwater resource, which is essential for agriculture, industry, human settlements and energy production.



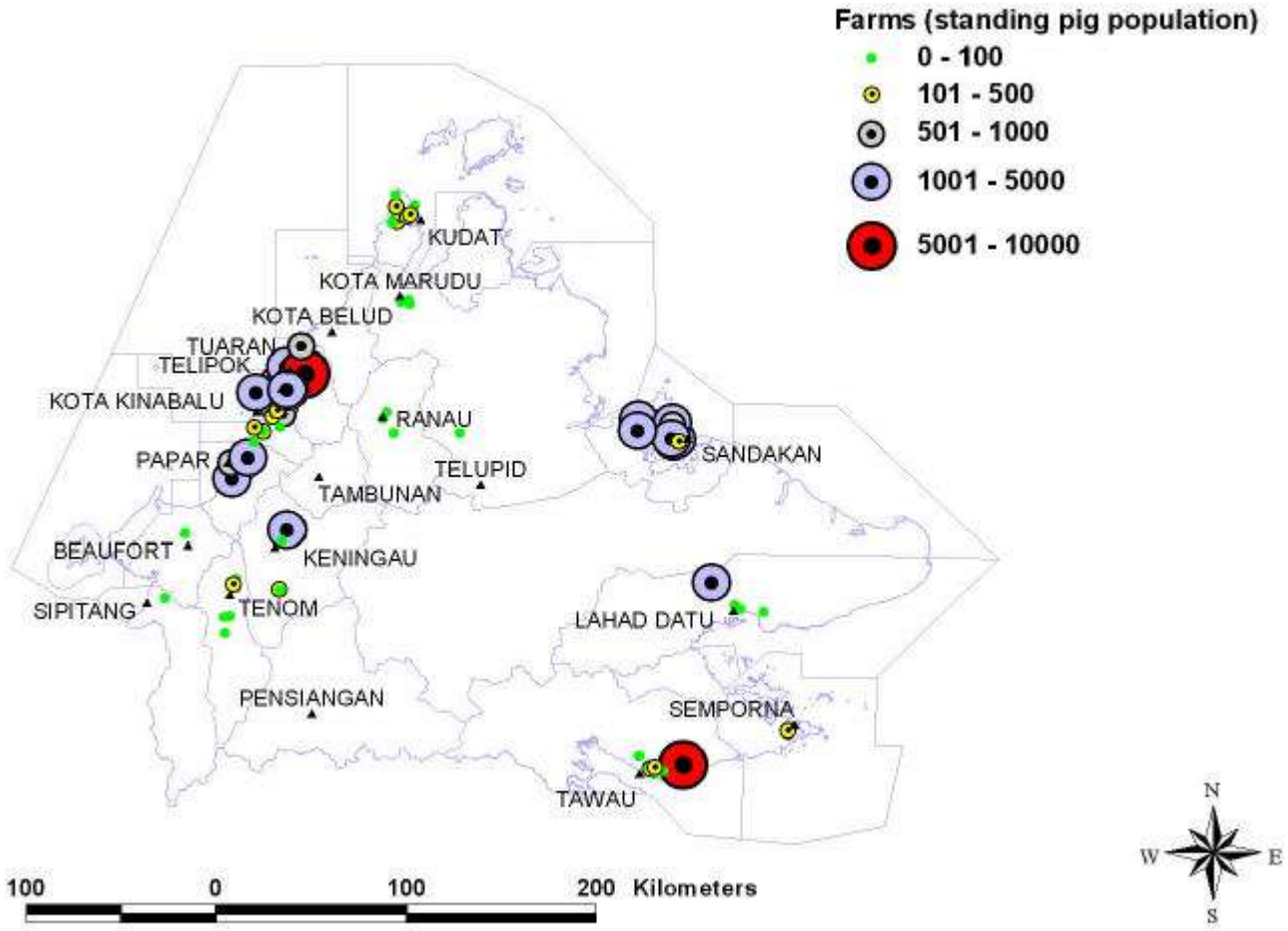
In Sabah there are altogether about 79 river catchment areas. The Kinabatangan river basin draining to the east coast is the largest covering an area of about 1,669,000 hectare. The Padas river basin on the west coast covers an area of about 890,000 hectare. Directly to the north of the Kinabatangan is the Labuk catchment, draining an area of about 580,000 hectare. Most of the other basins are comparatively small (Source: Environmental Conservation Department; adapted from Department of Drainage and Irrigation, 2002)

The presence or absence of riverbank vegetation is important for the health of a river system. River bank vegetation serves multiple functions. Plant root systems stabilise and protect riverbanks from erosion, particularly during floods, while also acting as a natural buffer for some water borne pollutants, filtering runoff from neighbouring lands. Riverbank vegetation is also an important habitat for many plants and animals. With the increased demand for land there is pressure to develop as much land as possible, often resulting in development right up to the water's edge.



A satellite image of part of the Kinabatangan river flood plain. In this image vegetation is represented by red colours. Light and bright red colours represent young vegetation such as recently planted crops or young ground vegetation such as grasses or creepers; darker red colours represent forested land. In some areas, plantation development has extended to the river bank. As can be seen from the image, the river is a very dynamic system. Recent but now abandoned river pathways are evident by the presence of ox bow lakes. The route the river takes during periods of flood can be seen, running from left to right, on the north bank of the river, where old flood scars are evident (Source: WWFM–Partners for Wetlands)

River bank vegetation plays a multiple environmental protection role as well as providing a rich environment for fauna and flora. Increased land use pressure often results in the destruction of river bank vegetation, with subsequent negative impacts on water quality and habitats



The distribution of pig farms throughout Sabah is strongly controlled by domestic market forces with the majority of farms being located in and around Kota Kinabalu, Tawau, and Sandakan i.e. the coastal areas nearby urban centres. Two farms house over 5,000 animals, one in the district of Tuaran and one nearby Tawau. Smaller towns have smaller farms located nearby. Farms that do not adequately treat wastes, pollute rivers through the release of high volumes of organic waste matter (Source Environment Protection Department, 2001)

River indicators

River water quality and the pollution of rivers can be a difficult and complex environmental issue to measure and understand. Water quality may be judged by many parameters. In this report we have chosen to present parameters linked to the main pollution issues. The first is suspended sediment, which provides an indication of the amount of soil eroded and transported into river systems. The second is biological oxygen demand (BOD), which, although not revealing the concentration of a specific substance, does provide an indication of the level of organic wastes in rivers, and in this context, human and animal wastes in particular.

This leads to the following indicator areas for rivers:

Area 1: Number of rivers polluted by soil pollution as classified by Department of Environment

Area 2: Location of rivers polluted by soil pollution as classified by Department of Environment

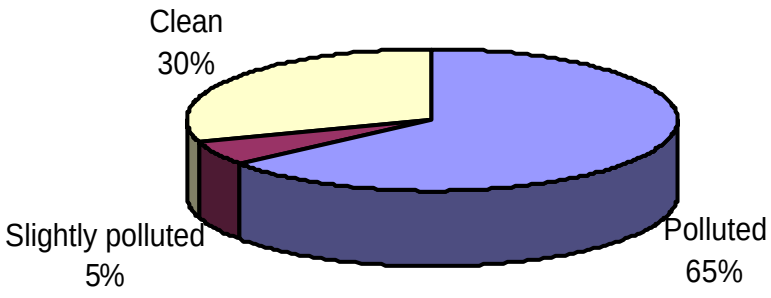
Area 3: Number of rivers polluted by organic pollution as classified by Department of Environment

Area 4: Number of rivers polluted by organic pollution as classified by Department of Environment

Indicator area 1:Soil pollution

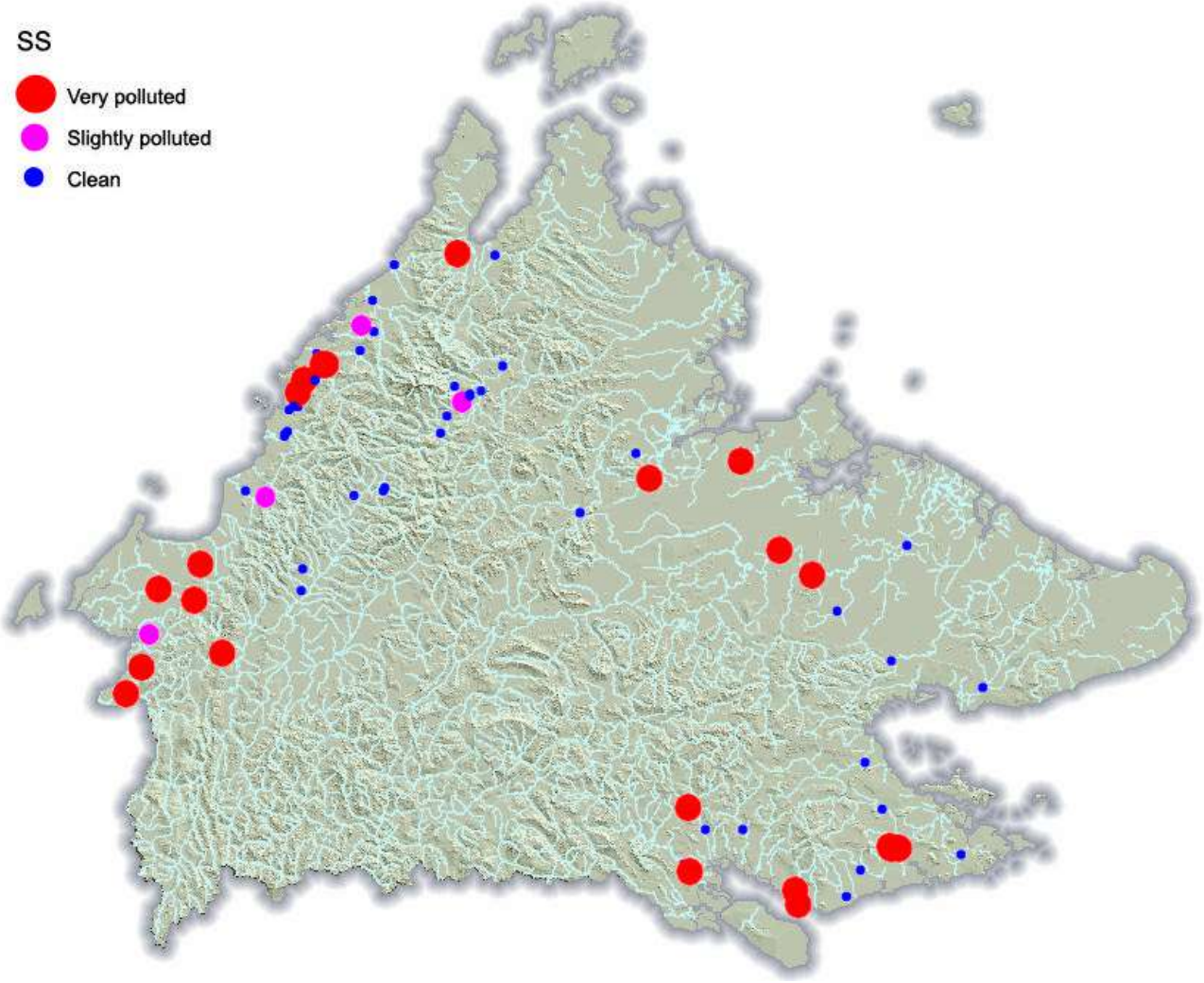
Rivers that are yellow to dark brown in colour normally indicate high levels of suspended sediments, giving the water a muddy cloudy appearance. Soil erosion is the most common source of high levels of suspended solids in water. Land uses which cause soil erosion include, forest clearance and logging activities, mining, farming, construction and unpaved roads. A major environmental concern today in Sabah is the agriculture sector, where as a result of massive land clearance projects, huge amounts of soil are being eroded and washed into river systems each year.

In the year 2000, which will be used as baseline, 47 out of 73 river monitoring stations, or 65 per cent, fell into the polluted category, four were classified as slightly polluted (5%), and 22 clean or free from pollution (30%) (Source: Department of the Environment 2000)



Indicator area 2: Distribution of soil pollution

Suspended sediment is normally an indicator of land disturbance, for example, soil erosion associated with logging activities or with land conversion to agriculture or urban development.



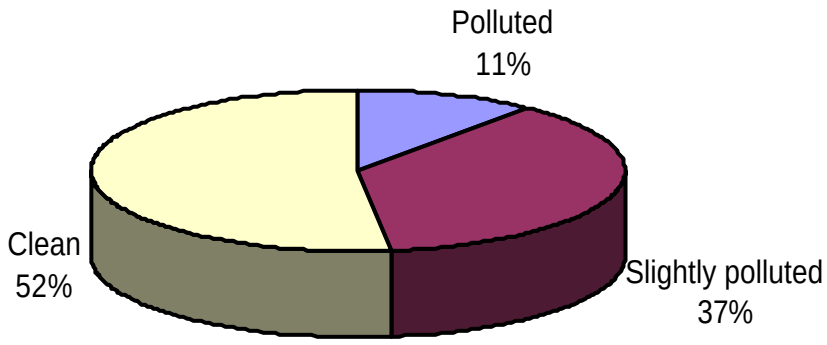
The distribution of soil polluted rivers in Sabah is widespread, but mainly concentrated to areas downstream of active logging concessions or around the main urban area of Kota Kinabalu. Soil polluted rivers include the Padas at Beaufort and the Kinabatangan river. As would be expected, areas with more stable land use patterns and activities are the least polluted, for example the Pegelan River in the Tambunan – Keningau valley (Source: Department of Environment, 2000)

Indicator area 3: Organic pollution

Urban and rural rivers face organic pollution from different pollution sources. Rural rivers are likely to be receiving high volumes of organic pollution in the form of animal wastes or effluent discharge from palm oil mills, while urban rivers mainly receives high volumes of organic pollution from human wastes.

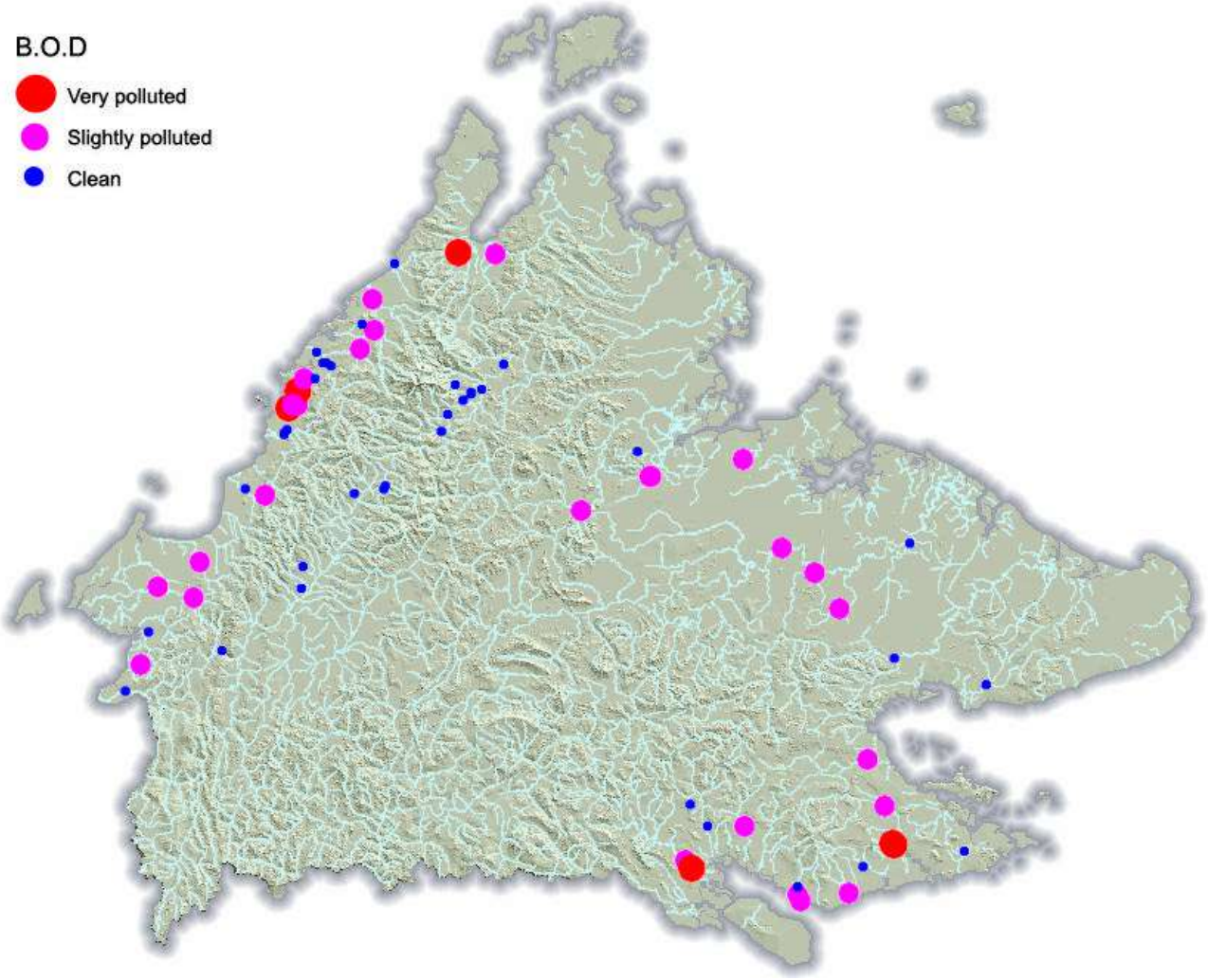
Biological Oxygen Demand (BOD) is a measure of the quantity of dissolved oxygen used by bacteria as they break down organic wastes. In slow moving and polluted waters, much of the available dissolved oxygen is consumed by bacteria, robbing other aquatic organisms of the dissolved oxygen needed to live. Rivers that are green-blue or black in colour, with a musky or sulphur odour (rotten eggs) indicate the growth of algae, which is usually caused by high levels of nutrient pollution. Nutrient pollution can come from organic wastes or untreated sewage.

In 2000, which will be used as baseline year, eight out of 73 river monitoring stations, or 11%, fell into the polluted category, 27 was classified slightly polluted (37%) and 38 clean or free of organic pollution (52%) (Source: Department of the Environment 2000)

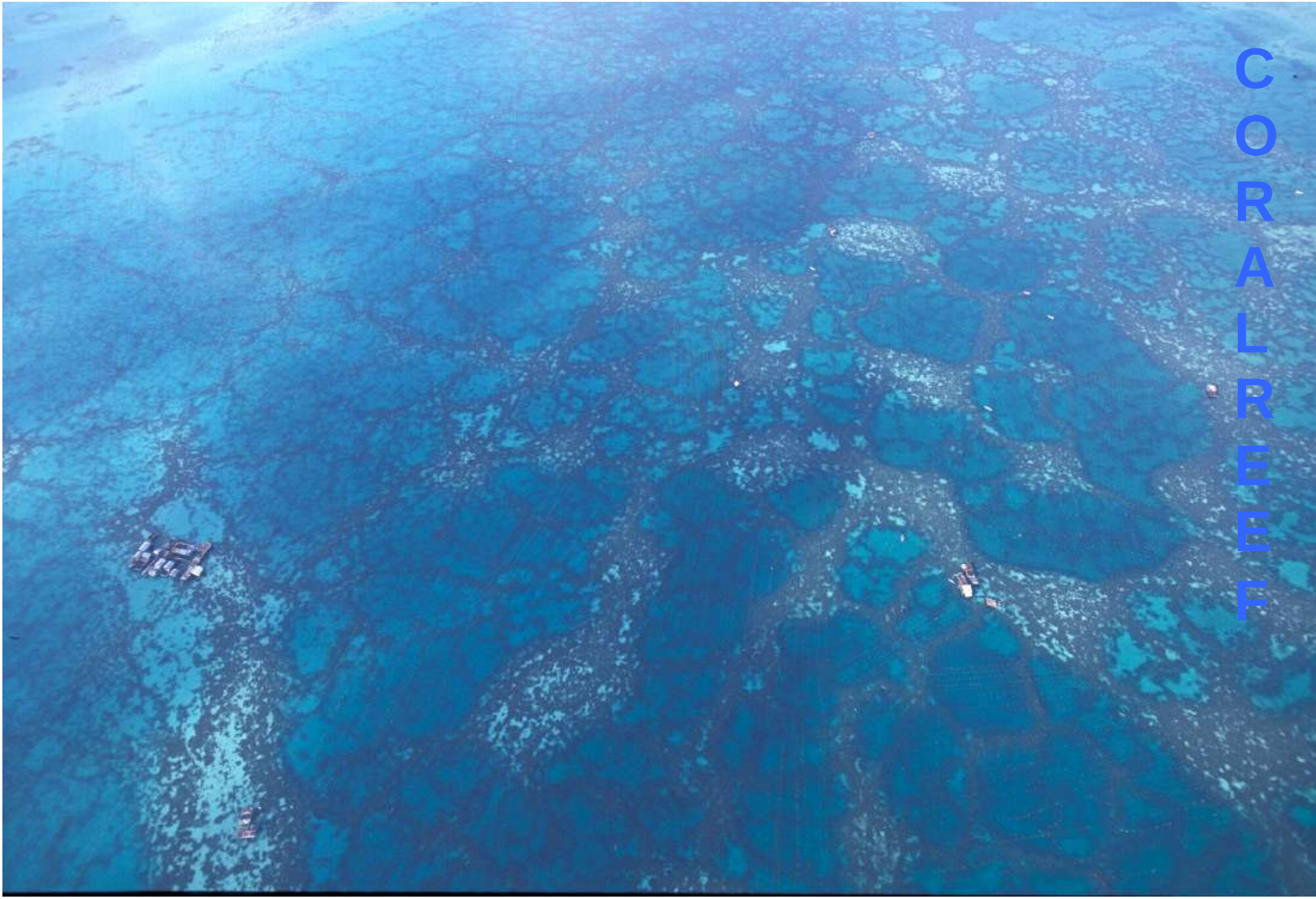


Indicator area 4: Distribution of organic pollution

Biological oxygen demand is an indicator of organic pollution, for example, pollution associated with agricultural activities such as livestock farming and the mismanagement of effluent from oil palm mills.



Slightly organic polluted rivers are occurring across the State, following the distribution of settlements, livestock farms and palm oil mills. The most polluted rivers are found in and around Kota Kinabalu and Tawau, and rural rivers that receive effluent from oil palm mills. The areas with the least organic pollution are located either in the interior along the Tambunan – Keningau valley or in remote areas on the east coast (Source: Department of Environment, 2000)

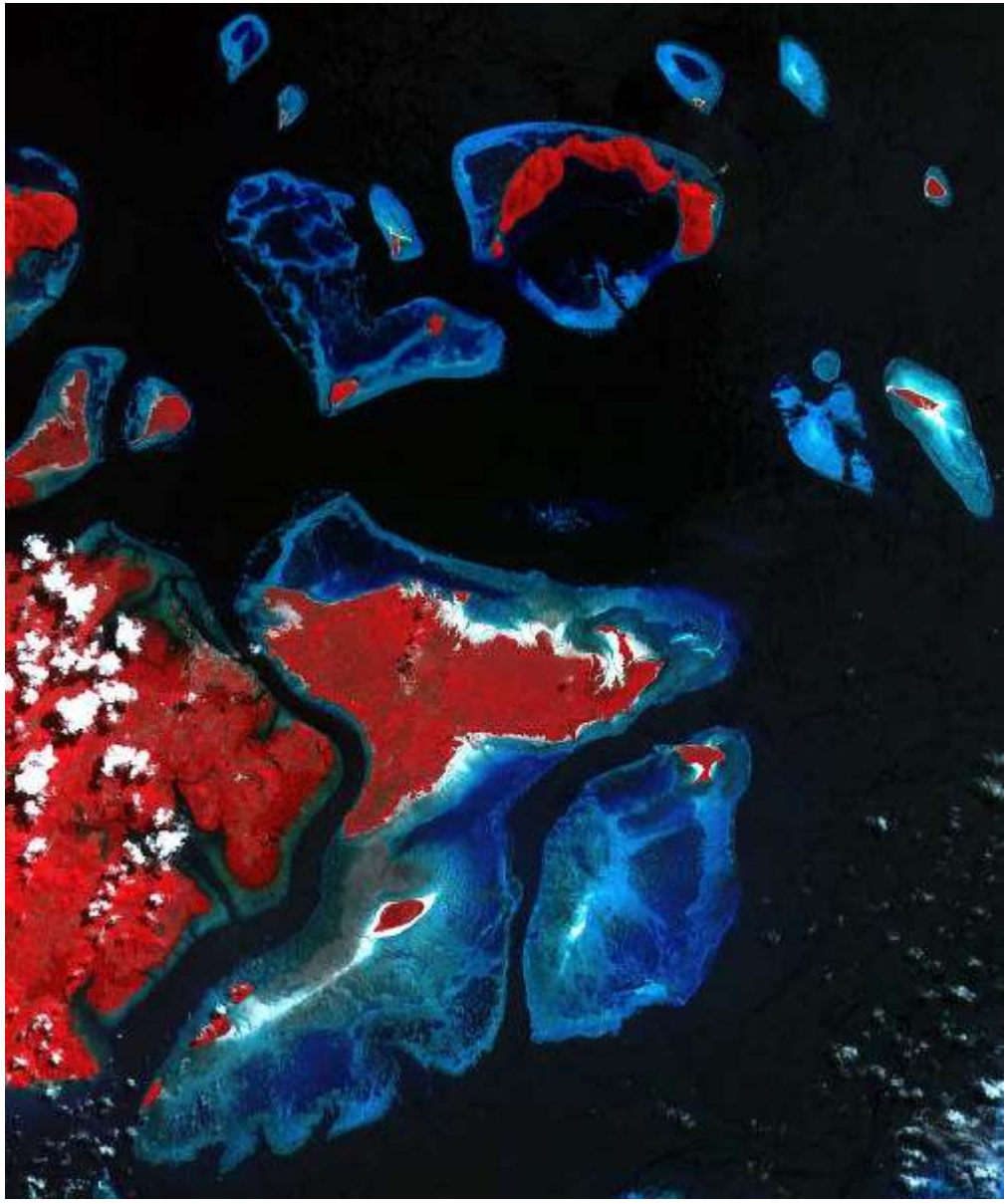

CORAL REEF

CORAL REEF

Corals are tiny animals, called polyps, which are related to and look like sea anemones. Each coral secretes a stony cup of limestone around itself as a skeleton. As the coral colonies build up on top of each other, they gradually form a coral reef. Individual coral colonies may be up to 1,000 years old, while coral reefs may be many thousands of years old. The greatest diversity of reef plants and animals in the world is in South-east Asia, where a single reef may have over 3,000 different kinds of plants and animals. Sabah is at the epicentre of this diversity.

Coral reefs and adjacent waters are important for both subsistence and commercial fishing. Reef fish comprise an important component of total commercial fish landings. Reefs serves as a source of seafood, provides materials for medicines, generates income from tourism, buffers coastal cities and settlements from storm damage and is mined for use as limestone in buildings and road construction, particularly on the west coast, for example Labuan and south of Kota Kinabalu.

Fringing reefs off the east coast of Sabah. The grey coloured town of Semporna can just be made out on the mainland coast, immediately to the east of the white clouds (Source: SPOT image; acquired and processed by the Centre for Remote Imaging, Sensing and Processing, National University of Singapore, 2000)

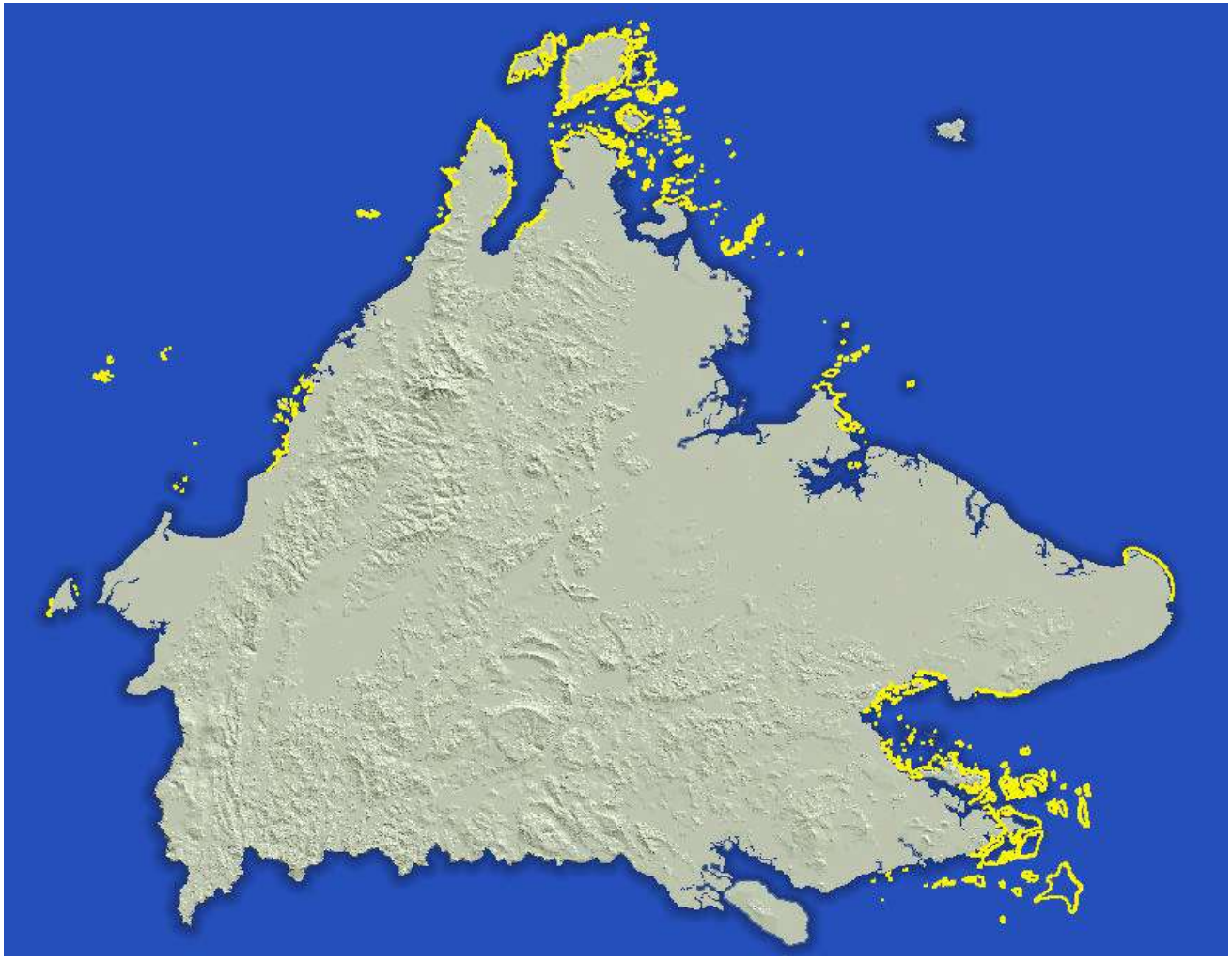


Sabah is situated on the Sunda Shelf in relatively shallow water. Surface water temperatures are around 27-28 Celcius and average annual salinity is generallt between 23.5 and 34 parts per thousand.

Fringing reefs occur around the 40 or so islands lying in shallow waters off the west coast, but there is restricted reef development along the mainland coastline. The Kudat area has about 109 km of reef, the Kota Belud District has about 64 km, Kota Kinabalu has about 54 km and the Labuan area about 37 km. Reefs extend to a maximum depth of about 17m.

In the north-east of Sabah there is little reef development except fringing some of the offshore Isalnds, e.g. within the Turtle Islands Park.

Off the south-east coast there are extensive fringing and parch reefs and a small barrier reef associated with offshore islands. On this coast the water is clearer and reefs reach 25m or more in depth. Those in the Semporna area and around the oceanic island Pulau Sipadan, which lies off the edge of the continental shelf, has corals to depths of over 40m. The only coral atoll in Malaysia, Pulau Layang-Layang, occurs off the west coast of Sabah (Source: Environment Protection Department, adapted from Cabanban, 2001)



CORAL REEF

A combination of natural and human impacts threatens the existence of our reefs. Ongoing research shows dramatic trends regarding loss of coral reef life in Sabah. Natural impacts are event such as extreme storms, coral bleaching due to raised water temperatures in association with ENSO events or invasion by Crown of Thorns starfish. Tropical storms are infrequent in Sabah (normally on a 50-year cycle), but tropical storm Greg in 1996, caused serious damage on the reefs of Tunku Abdul Rahman Park, reducing coral cover on exposed reefs to coral rubble. The natural effects, however, rarely cause permanent damage, and reefs do recover over time. Destructive fishing practices and coastal sediment pollution are today by far the greatest threats to the coral reefs. The reefs of the South East Asia region are the most threatened of any region. More than eighty per cent are at risk, primarily from coastal development and fishing related pressures.

Land reclamation nearby Kota Kinabalu, where the reef fringing the land provides a convenient platform to construct a retaining bund for land reclamation. Nearby reefs will also be impacted due to increased suspended sediment in the waters as a result of the construction activities

A persistent pressure on the coastal coral reefs of Sabah is land-based pollution. The main pollutants are sediment and nutrients. The transport of nutrients into the marine ecosystem, is an important process that occurs naturally, but has become more rapid and widespread in recent years as a result of land development and urbanisation. At present, in most of Sabah's urban areas, raw sewage is discharged directly into the sea. The extent of toxic polluting industries is still limited, but will most probably increase in the near future.

A satellite image of the Klias Peninsula, Sabah. Waters from the Padas River, heavily laden with sediment, can be seen discharging into the sea (pink colours). Most of this suspended sediment has been carried many kilometres from the upper portions of the catchment, were logging activities are prevalent (Source: Environment Protection Department, 2001)

Indicator area 1: Marine protected areas

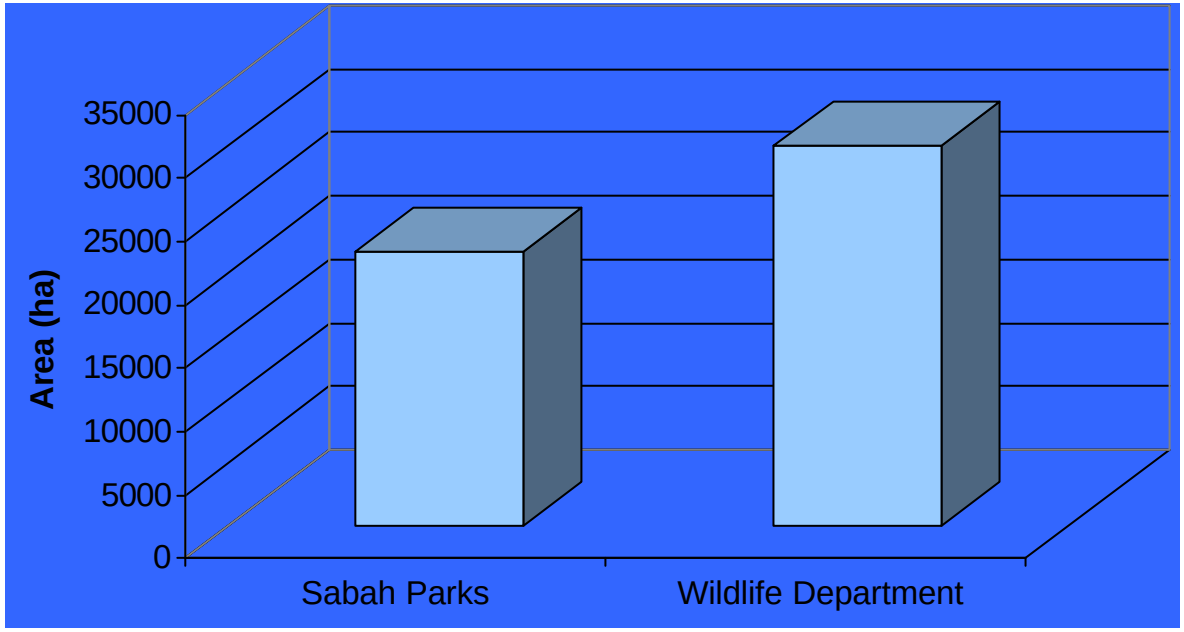
Marine protected areas, if well managed, are one of the best solutions to halt current trends in destruction and loss of coral reef habitat. These areas will also assist in the long term recovery of commercial fisheries as it may take up to ten years for some fish populations to reach levels and sizes which provide returns for fisherman.

A total of 51,697 ha have been granted marine protected status by 2002:

- Under the Wildlife Conservation Enactment, 1997, three areas (total 30.073 ha): Lankayan Billean Tegapil Marine Conservation Area 30.000 (established in 2002), Mantanani Kecil 61 and Sipadan 12 ha (both established before 1970)

- Under Parks Enactment, 1984, three marine parks with a total size of 21,624 ha: Turtle Island 1.740, Tunku Abdul Rahman 4.020 and Pulau Tiga 15.864 ha, all gazetted in the 1970s (Source: Forestry & Wildlife Department, 2002)

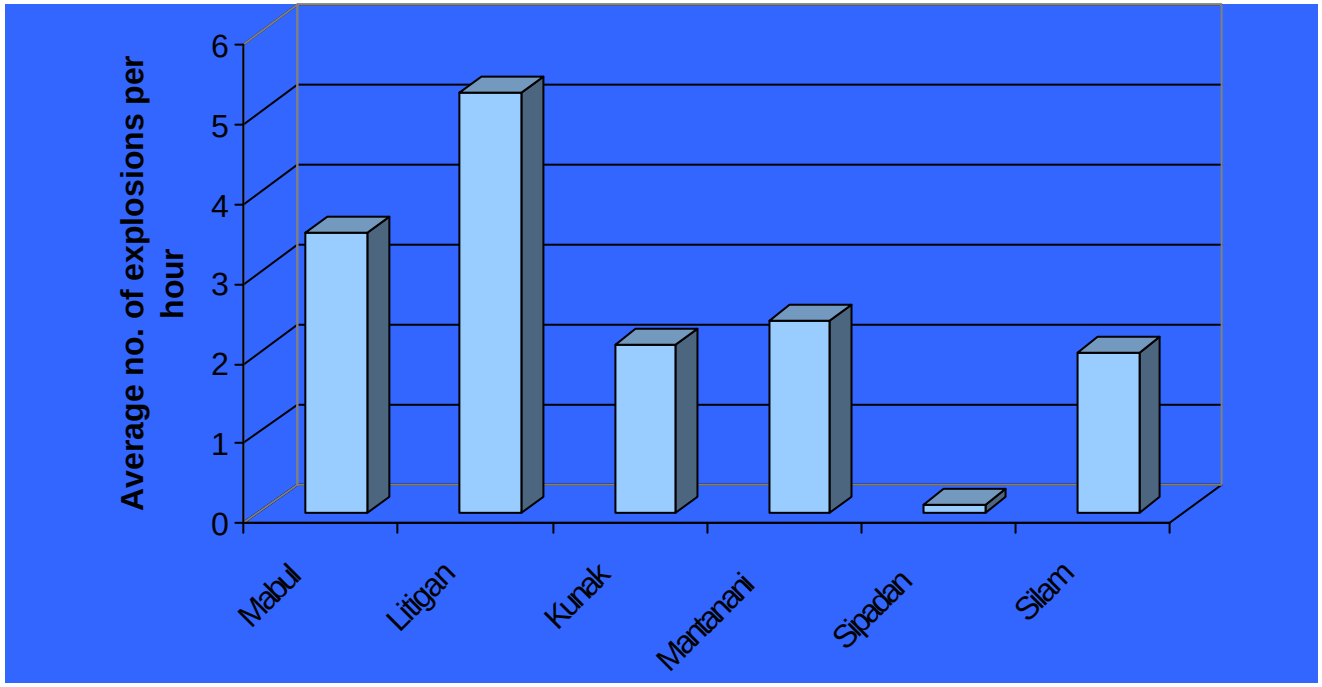
Two other areas have been identified: Paula Banggi and surrounds, north of Kudat, and the proposed Semporna Islands Marine Park, which if gazetted, will be Sabahs largest Marine Park, providing protection for 325,000 ha of what is recognised as one of the prime marine conservation sites in Southeast Asia



Indicator area 2: Fish bombing

Destructive fishing practices and over-fishing poses the most severe threats to the coral reefs. Fish **bombing** is practised along nearly the entire coast of Sabah. Fishermen use improvised explosives made of fertiliser and fuse-caps inserted into bottles. The bombs are placed in shallow water above coral reefs and scoop up the fish that float to the surface, leaving a car-sized patch of flattened coral rubble behind. The use of **cyanide** to poison fish is on the increase and just as destructive. Cyanide is released directly onto coral reefs where the fish are hiding in crevices. The cyanide immediately stuns the fish. Cyanide fisherman then break off segments of live coral to pull the fish from its hiding place to be placed in a holding tank aboard the fishing vessel. The cyanide remains on the coral reef killing vast sections, along with other fish, crustaceans and marine invertebrates. Blast and cyanide fishing has caused the destruction of vast tracts of coral reefs, accounting for the loss of more than 80 per cent of the original cover in many areas. This loss has resulted in the virtual eradication of commercially valuable species along many parts of the Sabah coastline.

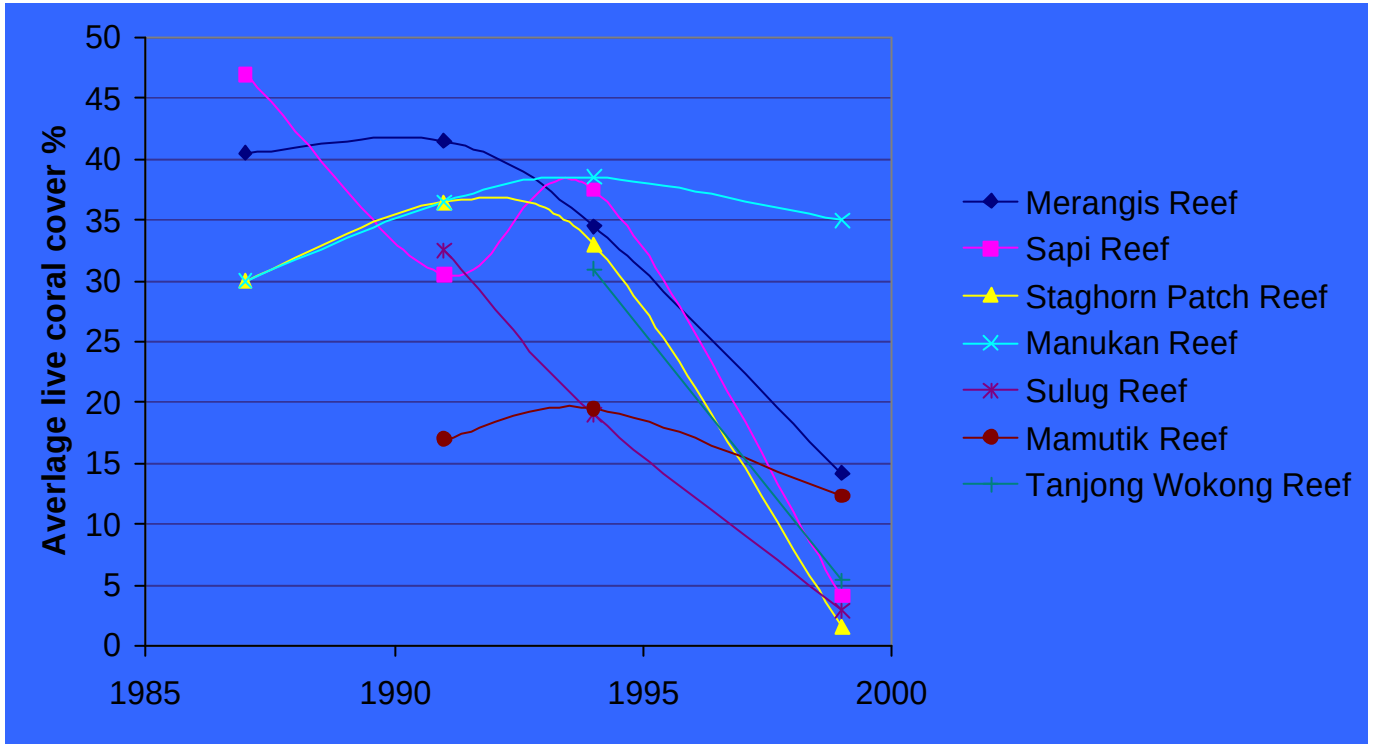
Five bombs exploded on average per hour at Litigan coral reefs, more than 3 bombs at Mabul, around 2 at Kunak, Mantanani and Silam and at 0.1 bomb at Sipidan coral reefs (Source: Survey results, Pilcher and Oakley, 1997)



Indicator area 3: Coral reef quality

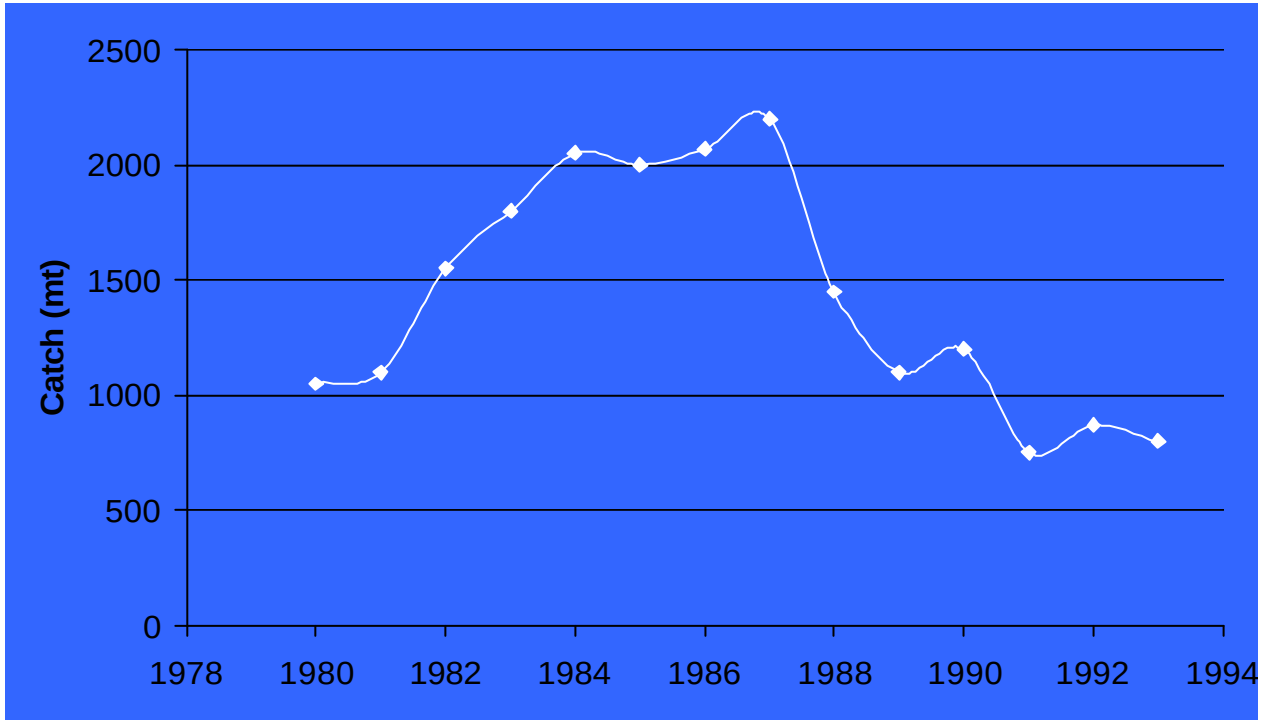
The coral cover in Tunku Abdul Rahman Marine Park off Kota Kinabalu changed dramatically from 1987 to 1999 indicating that even in marine protected areas reef decline is evident.

In the late 1980s 30-35% of the coral cover was still intact, but this fell drastic in the 1990s to between 2 and 15%. The decline is in part due to natural events but may largely be attributed to the impact of human activities. Tropical storm Greg hit the Park in 1996, causing a loss of live coral cover on most reefs. Other natural impacts include outbreaks of crown-of-thorns starfish on some reefs, particularly Merangis reef during 1991 and 1994, which impacted the survival of some branching corals. However, clearing of mangroves and land reclamation nearby Kota Kinabalu has resulted in the decline of water quality with an increase in sediment and nutrient loading of water draining into coastal waters. The poor water quality threatens the remaining reefs and is probably responsible for the relatively slow recovery of the reefs since Storm Greg. Litter, especially plastic bags, is a persistent problem and is frequently found smothering corals. Despite protection by Sabah Parks, fish bombing still occurs in the Park. Many reefs outside of the park have been completely destroyed (Source: Mitchell, 1999; Pilcher & Cabanban, 2001)



Indicator area 4: Coral fish production

Landings of coral fish have declined since the late 1980s and it is believed that the drastic decline is due to the impacts of fish-bombing on the coral reef. The decline in the fisheries is an indicator of the state of the coral reef fish populations. To maintain healthy seas, fishing activities need to be managed in such a way that fish populations are maintained, both in quantity and diversity.



The landings of coral reef fishes in Sabah did see a sharp increase in 1980-88, then to fall markedly in the beginning of the 1990s. At the height of the coral fish landings in 1987, about 2200 MT fish were recorded landed. In the mid 1990s the figure had fallen to around 700 MT (Source: Cabanban and Biusing, 2000)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Fish have long been the major source of protein consumed by the people of Sabah and the fisheries industry has played an important role in the economic development of the State. The marine fishing industry in Sabah has grown rapidly in the last twenty years or so, with the arrival of larger trawlers, and has fulfilled local fish demand and also provided a surplus for export. Besides providing an affordable and readily accessible source of protein, it also provides various socio-economic opportunities including employment.

The fisheries industry in Sabah has three distinct sub-sectors, the inland, aquaculture and marine capture fisheries. The most predominant sub-sector in terms of employment and export is the marine capture fisheries. Just as important, however, are the more traditional or artisinal fisheries, which although smaller, with poorer returns, allow easy access for many to support the protein needs of a family.

In 1998, there were 20,000 fulltime fishermen in Sabah. From 1996 to the year 2000, fisheries contributed a steady three to four per cent of the GDP






The average annual fish consumption in Malaysia is currently over 45 kg and projection for per capita consumption in the year 2010 is at 55 kg.

With increasing population numbers and increased export earnings being derived from the fisheries sector, marine fisheries in particular, there is obviously a risk that the resource may be overfished. As early as 1995 there were already signs that some fish resources were being overexploited e.g. shrimps. The more specialised demand for the live fish trade, for local consumption in restaurants or export, is furthermore placing an increased demand upon the coral fish resource.

Malaysian marine waters are estimated to have the highest catch potential of near-shore fisheries in the world, second only to those in Peru

Indicator for seas

It is difficult to measure the overall health of the seas due to the depth and dynamic nature of the waters, which makes data collection difficult at best. Given these limitations, two indicators have been selected. First, the annual marine catch, which provides information on our fishing activities in relation to the amount of fish available.

Second, near-shore pollution measurements, which provides some indication of the liquid wastes we are discharging into the sea. The Department of the Environment maintain a coastal water quality monitoring network, with 31 stations established at estuarine and coastal monitoring stations providing useful indicator of overall nearshore marine pollution. We have selected four parameters for land based activities: Total suspended solids (TSS) to represent land development activities, Escherichia coli (e-coli) for sewage pollution; and two heavy metals, lead and cadmium, for industrial pollution.

This leads to the selection of the following three indicator areas for our seas:

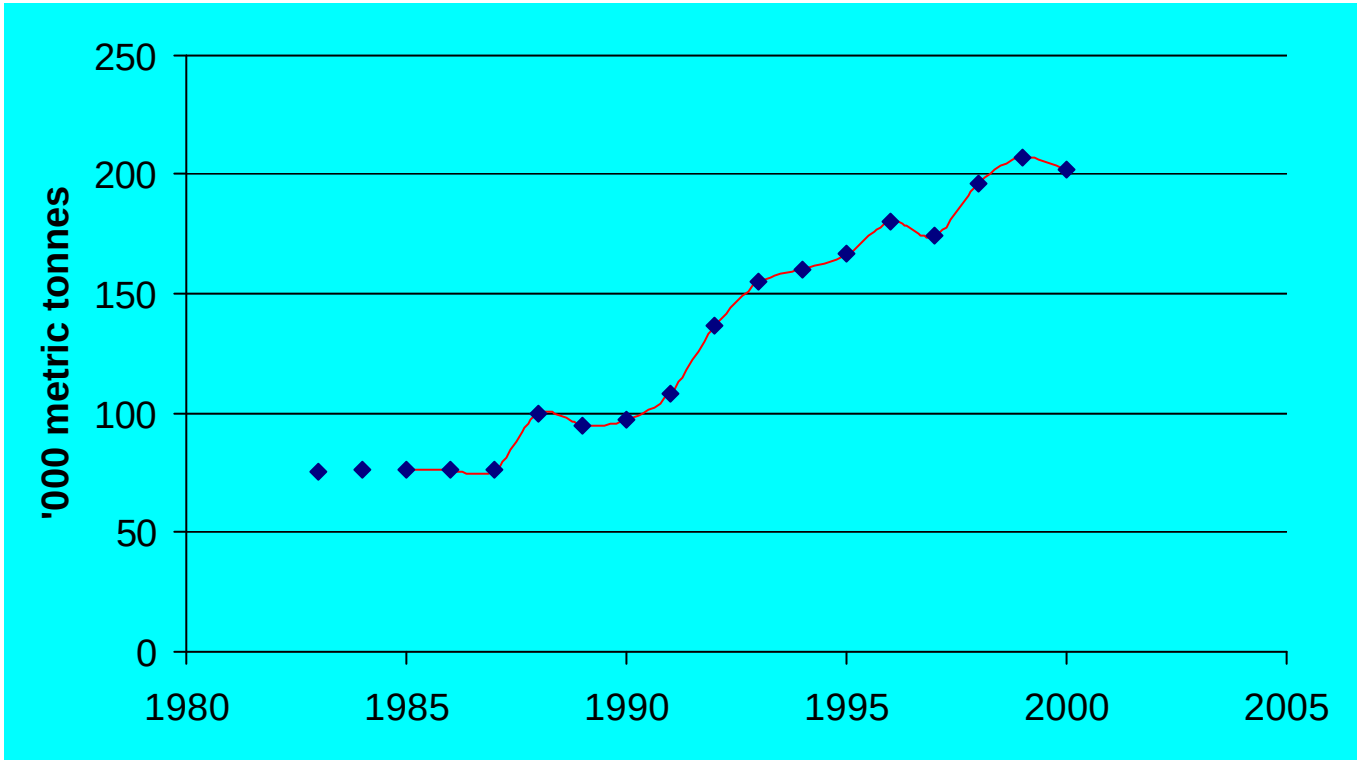
Area 1: Marine landings in metric tonnes

Area 2: Sediment and sewerage pollution in the near-shore areas indicated through levels of total suspended sediments and e-coli

Area 3: Industrial pollution in the near-shore areas indicated through levels of lead and cadmium

Indicator area 1: Sustainable marine population

The potential yield of the marine fisheries resource of Sabah has been estimated to be in the region of 350,000 metric tonnes, which is well above the present level of landings. Still, the trend from current data is that catches are on the increase and therefore may face over-exploitation within the coming decade or so.

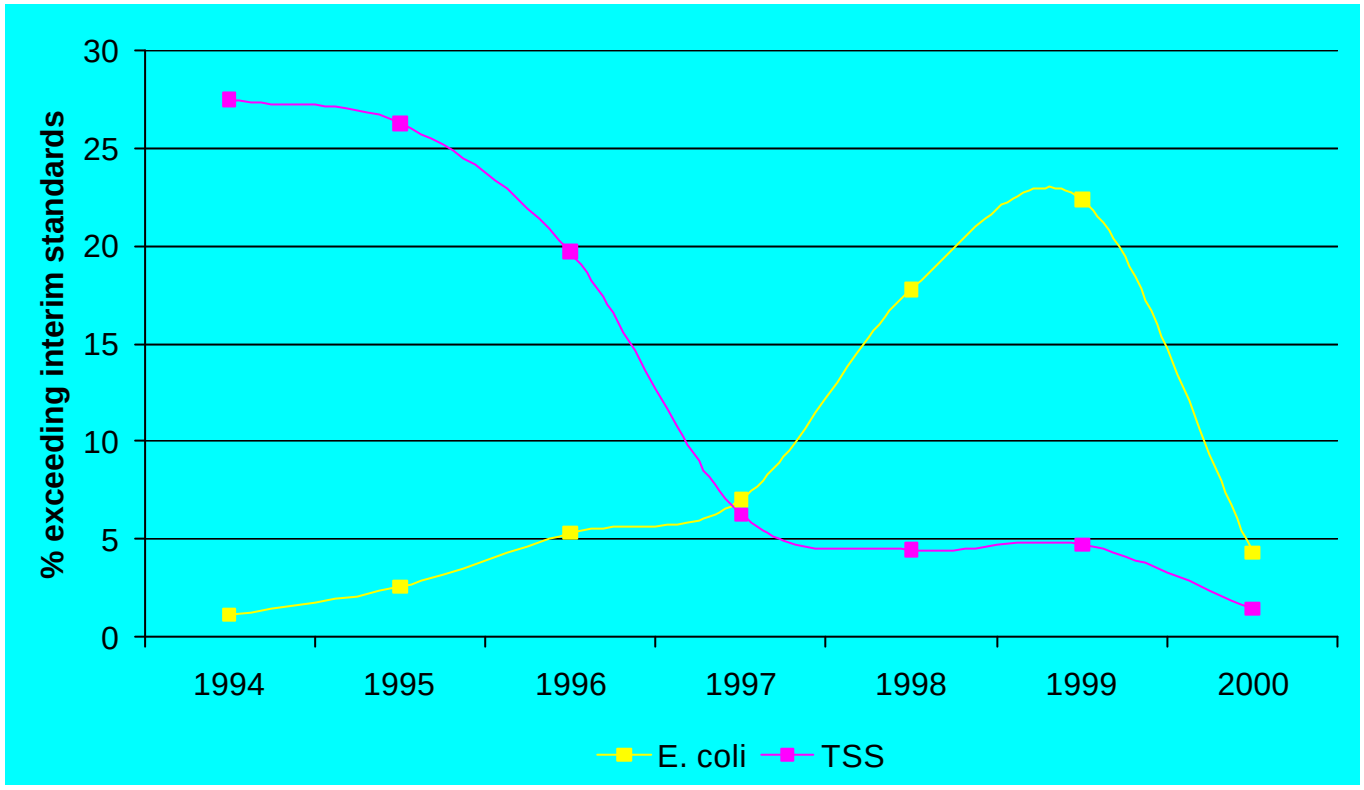


The reported marina landings increased from around 75,000 MT in the early 1980s to around 200,000 MT in the year 2000 (Source: Department of Fisheries, Sabah, 1995 and 2000)

Indicator area 2: Sediment and sewerage pollution of marine waters

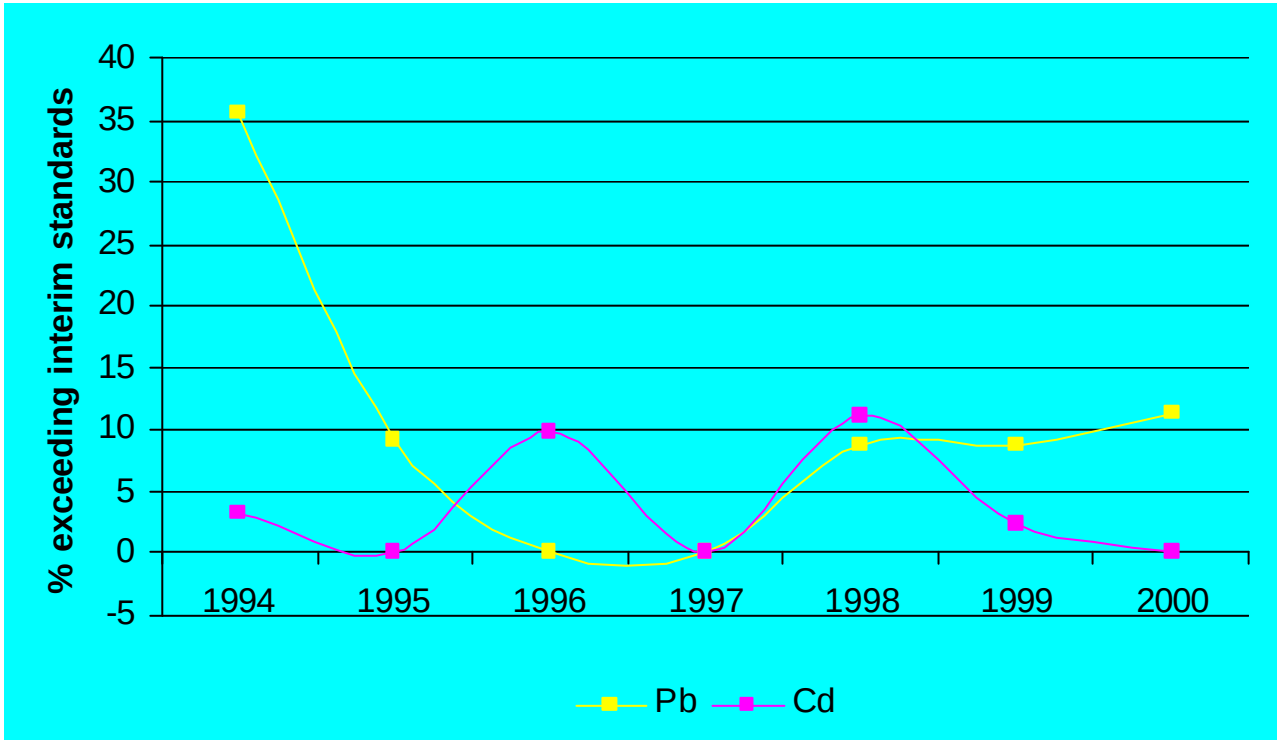
The number of marine monitoring stations reporting to exceed the marine water quality interim standards for levels of suspended sediments fell from 28 in 1994 to 2 in 2000 (out of 31 stations). Although suspended sediment remains prevalent in many coastal waters though out the state, there is a general and noticeable reduction in the trend. This probably reflects the reduced level of logging activity, although the relationship between sediment availability, supply and transport is complex. Sediment may remain available for transport many years after the land based activity has stopped

The number of marine monitoring station reporting to the marine water quality interim standards for levels of e-coli increased from 1 in 1994 to 22 in 1999 (out of 31 stations). This increased presence of Escherichia coli in coastal waters has principally been attributed to the discharge of untreated or partially treated domestic sewage and animal waste. The steep decline in 2000 remains unexplained (Source: Department of the Environment, 2001)


% exceeding interim standards
30
25
20
15
10
5
0
1994
1995
1996
1997
1998
1999
2000
E. coli
TSS

Indicator area 3: Industrial pollution of marine waters

The presence of lead and cadmium in marine water provides an indication of the impact of industrial activity. Cadmium is a soft metal which is readily soluble in mineral acids and is toxic to humans. Fish and invertebrates are sensitive to even low levels of cadmium. Although lead does occur in nature, municipal and industrial waste discharges and runoff from streets and other surfaces serve as an additional source of lead.



The heavy metal indicators currently show no clear trends. As Sabah becomes more and more industrialised, this situation may change The figure shows the number of monitoring stations, out of a total of 31 stations, that exceeded the interim standards for marine water quality for lead (Pb) and Cadmium (Cd), Sabah, 1994-2000. (Source: Department of the Environment, 2001)


URBAN AREA

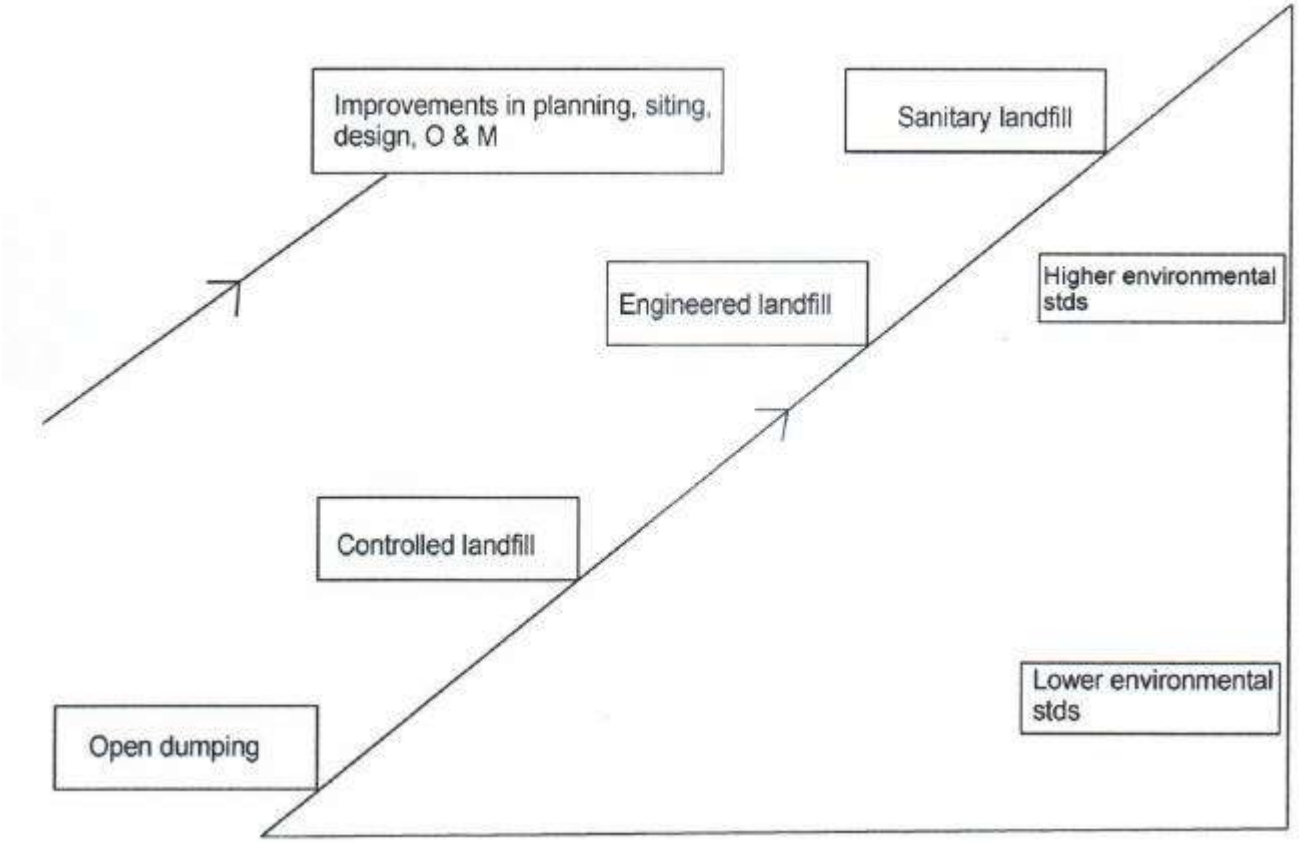
The urban environment is characterised by high concentrations of the population and a high intensity of human activity. Once established, urban areas usually extend beyond the suitable land, which originally attracted the settlers or determined its location, and low and high-lying land as well as agricultural land is converted to make way for housing and other urban infrastructure. This result in expansion onto less desirable lands, for example up slopes and across flood-prone areas and these urban areas thereafter have to cope with floods, subsidence and problems related to landslides.

In Sabah, considerable alteration and deterioration of the landscape in and around urban areas has taken place through hill cutting, land reclamation, road construction, quarrying, land clearance, and industrial and housing developments.

The safe and healthy storage, collection, transportation, processing, recycling and disposal of garbage constitute a main function of municipal urban services and take up a substantial share of manpower and financial resources. In Sabah, the prevailing practice involves direct haulage of solid waste from collection point to disposal site, normally open dumpsites, without any immediate treatment.

Open dumping sites, however, are unsightly and unsanitary as they encourage debris to blow into the air, they attract birds and disease carrying rodents and liquids from the garbage may contaminate streams and groundwater.

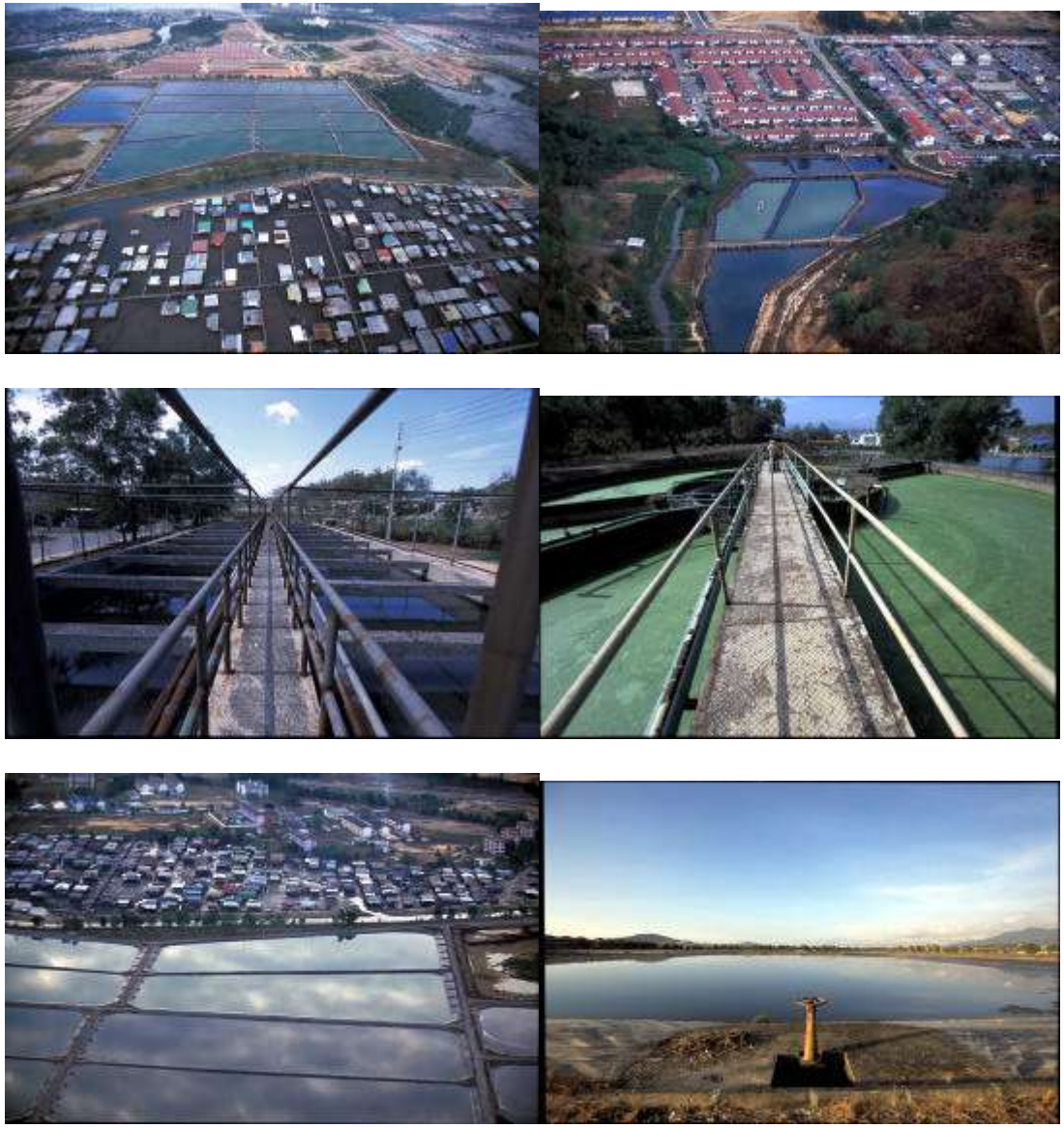
Upgrading of open dumping sites to controlled and sanitary landfills is a must for the near future. In controlled and sanitary landfills sound sanitary principles ensure effective environmental protection. Soil is used daily to cover deposited waste to control pests, odour, fire and littering. The landfill is sited to control environmental impact. Leaches are safely collected and treated to avoid contamination of drinking water



Homes, commercial premises and industrial complexes in Sabahs urban centres generate garbage and sewerage every day. As living standards continue to improve, expectations as to how the growing piles of waste should be disposed of rise. Sabahans more than ever expect a disposal practice which not only preserves public health and the environment, but also provides a higher degree of comfort in their daily life and provides for a beautiful and aesthetic urban landscape.

Urban sewerage is the biggest single source of pollution in urban rivers. It is mainly domestic in origin, arising from personal sanitation, washing, laundry and food preparation. In Sabahs hot climate, the dissolved oxygen that breaks down the organic matters can quickly become exhausted, rendering the sewerage stale or septic and thus unhealthy. Sewerage can also carry organisms which thrive and may lead to infections, such as cholera, typhoid and infectious hepatitis. Sewerage should therefore be adequately treated before being discharged into waterways.

The wet Sabah climate favours a sewerage system that is separate from storm water drains. Voluminous storm water flow is kept apart in the surface water drainage system, thus reducing sewerage flows, and therefore sewer sizes and treatment costs.



Urban indicators

The installation and maintenance of wastewater infrastructure in both an enormous logistical and financial undertaking, however, an efficient sewerage system is vital for a fast growing developing state. A reliable system will not only ensure that our increasing population is kept away from unnecessary health risks, but also that our water resources are protected. As an indicator of the environmental stress that may be placed on our environment due to wastewater we have chosen to look at the coverage and operational status of treatment facilities in four main urban areas in Sabah.

Second, proper disposal of garbage constitute a main function of urban services, why the standard and location of disposal sites in Sabah have been chosen as another area for indicating the quality of urban area management.

This leads to the selection of the following four indicator areas for our urban areas:

Area 1: Coverage of wastewater treatment facilities in four main urban areas in relation to total number of population covered by designed and operational wastewater treatment facilities

Area 2: Operational status of wastewater treatment facilities in four main urban areas in relation to total number of treatment facilities in operation

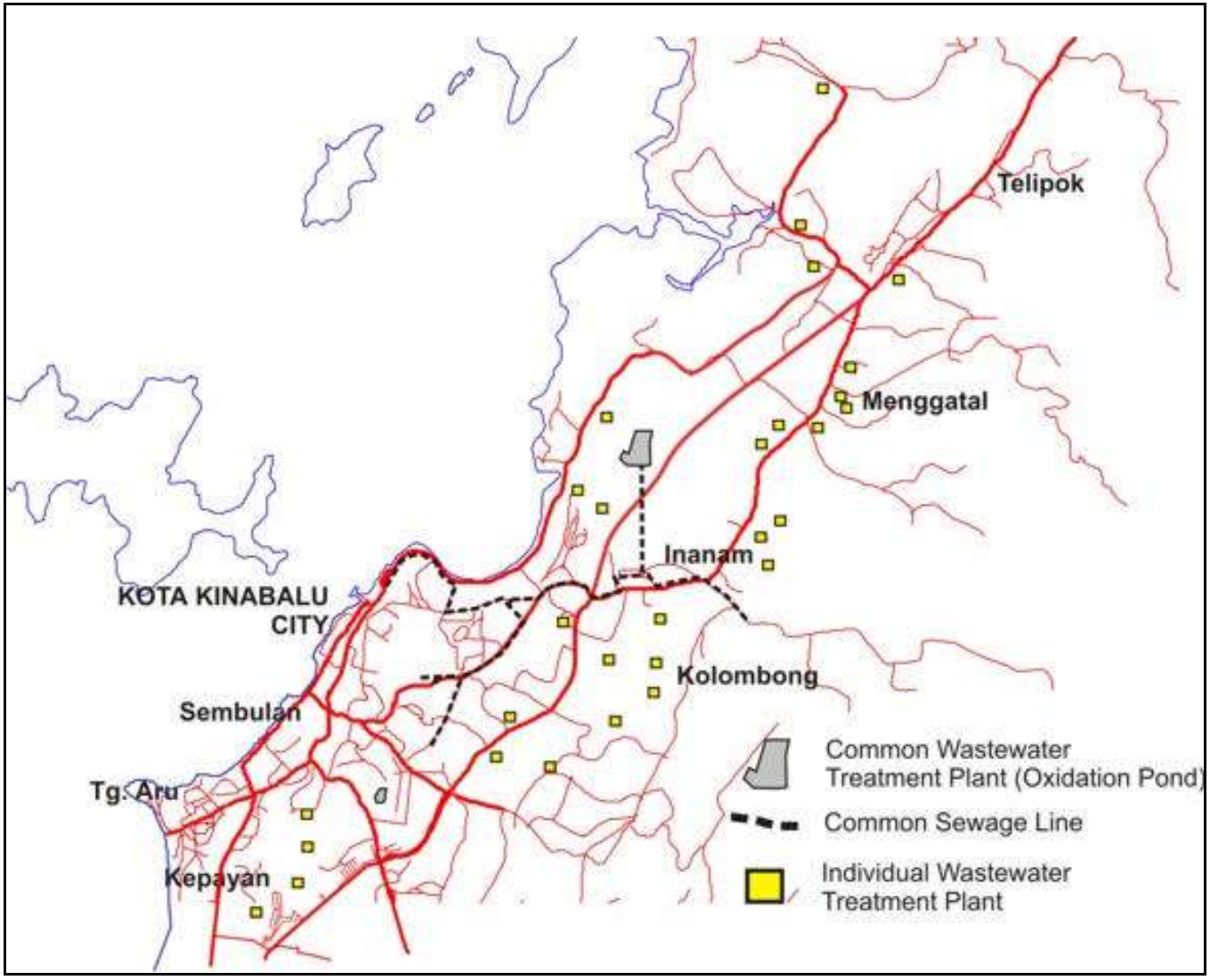
Area 3: Types of disposal sites in Sabah according the classification of environmental management

Area 4: Location of disposal sites in Sabah according to classification of environmental suitability

Sabahs urban population generally have access to piped water and flush toilets, which flush either into drains leading to directly watercourses or flush into treatment systems like household septic tanks, housing estate treatment systems or centralised wastewater treatment plants. Household septic tanks are small, rectangular chambers usually located just below ground level, where sewerage is retained for 1-3 days. Although the solids settle to the bottom aof the tank, which requires desludging every few years, the effluent is still dangerous and is disposed of in permeable soil soakways.

In centralised estate or municipal plants sewage is collected via sewer pipes and pumps stations, to its place of treatment and disposal. A common wastewater treatment system is preferred to the individual wastewater treatment systems as they can cater for a the large population numbers associated with towns and cities, and at the same time relieve the local authorities from the responsibilities of maintaining dozens of individual different treatment plants and technologies.

The present centralised (common) and housing estate (individual) wastewater system in Kota Kinabalu. These systems still only cater for a relatively small portion of the urban areas, and are often in lack of maintenance (Source: DBKK, Sabah 2002)



Indicator area 1: Coverage of wastewater treatment facilities in four urban areas

The provision of wastewater treatment facilities is a crucial component of urban infrastructure, I order to treat wastewater that would otherwise harm human health or pollute the water, land and air environment. The only practical outlets for the disposal of treated wastewater are streams, rivers, and oceans. To protect these water resources, wastewater needs to be treated appropriately, normally via a wastewater treatment plant. When wastewater is discharged without sufficient or proper treatment the wastes consume oxygen which is normally found dissolved in river water. Constant dumping of poorly or untreated wastewater, for example, will mean that the river will lack sufficient oxygen to allow aquatic life and plants to survive. Such a dead river emits an unpleasant odour, is unsightly, poses a health risk and does not support any plant or animal life.

A total of 95 wastewater treatment plants under the management of local authorities and JKR have been constructed to cover the four urban areas or Kota Kinabalu, Penampang, Tawau and Keningau. These plants are designed to serve 31% of the population in these districts. However, as 2/3, or 66 or the 95, of these plants are out of operation, only 16 % of the total population in these districts are in fact covered by municipal wastewater treatment facilities.

District	No. of treatment plants		Total design capacity (p.e.)	Approx. design capacity of plants in operation (p.e.)	Population
	Centralised	Housing estates			
KK	2	32	171,252	79,312	354,153
Tawau	1	22	50,000	50,000	304,888
Keningau	1	0	9000	0	145,762
Penampang	0	37	33,183	15,830	130,809
Total	4	91	263,435	145,142	935,612

Indicator area 2: Operational status of wastewater treatment facilities in Kota Kinabalu, Penampang, Tawau and Keningau

Municipal wastewater discharges, especially of untreated sewage, constitute the main and worst source of pollution of inland urban waters in Sabah. Sewage poses a threat not only to human health, but also increases the nutrient load in the receiving waters. The level of coliforms bacteria in selected rivers, estuaries and coasts of Sabah clearly indicate a high degree of sewage contamination along the coast and nearby towns in Sabah. Many urban areas in Sabah suffer from the spread of marginal settlements. These marginal settlements are characterised by the absence or lack of basic infrastructure and environmental services such as water supply, solid waste collection and sewerage and drainage, which all contribute to pollution of the urban rivers.

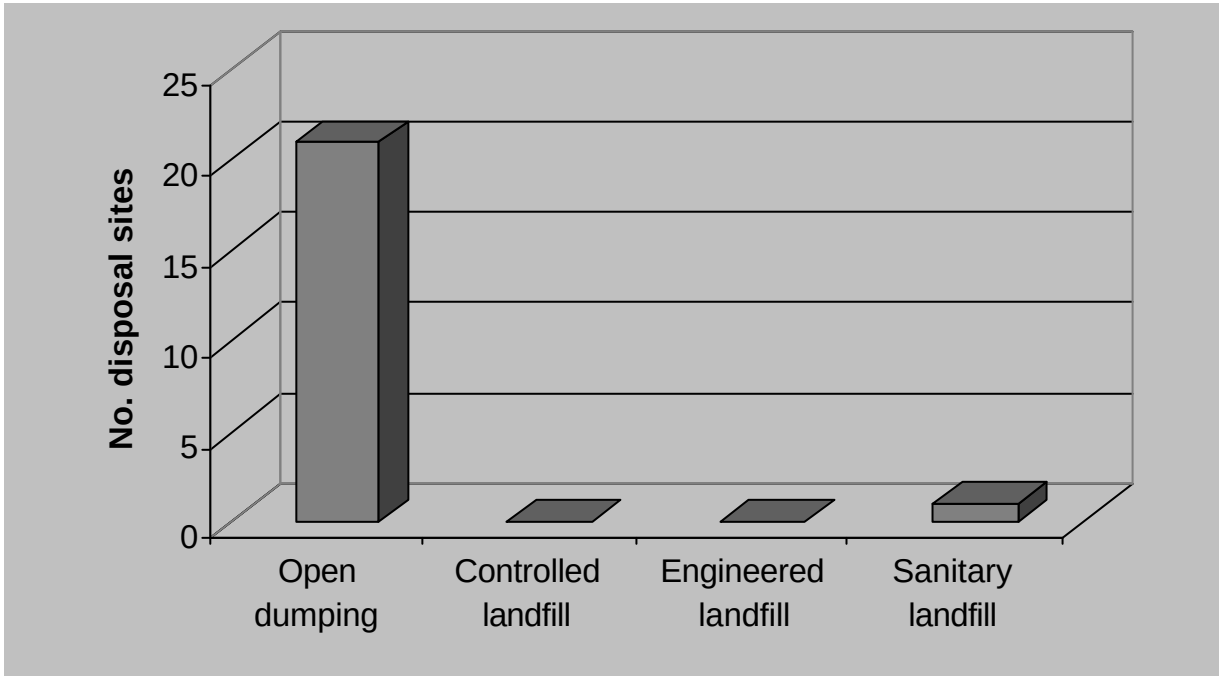
In 2001, the operational status of the 95 wastewater treatment plants under municipal management in the four districts of Kota Kinabalu, Penampang, Tawau and Keningau were as follows: 67 %, or two out of three, were out of operation, 21 % were in operation, but working inefficiently, and 12 % were in operation. Of the centralised plants were 50 % in operation, while only 8 % of the housing estate plants were in operation (Source: Environment Protection Department, 2002)

	Centralised plants			Housing estate plant			Total		
	In operation	In-effective	Out of operation	In operation	In-effective	Out of operation	In operation	In-effective	Out of operation
Kota Kinabalu	2	-	-	3	5	24	5	5	24
Penempang	-	-	-	3	-	34	3	-	34
Tawau	-	1	-	1	14	7	1	15	7
Keningau	-	-	1	-	-	-	-	-	1
Total	2	1	1	7	19	65	9	20	66

Indicator area 3: Types of solid waste disposal sites

The task of collecting, treating and disposing of solid waste is demanding, and even more so in hot climates where organic waste rapidly decomposes, causing odours and providing breeding grounds for rats, flies and other vectors of disease transmission. In hot humid conditions it is essential that garbage is collected and disposed of quickly. With increased affluence and higher standards of living, consumption patterns change and the types and volumes of waste change accordingly as well as the quantities. In Sabah, it is the local authorites, which is responsible for providing a solid waste collection and disposal service.

Of the 22 disposal sites in Sabah, 21 sites are open dumping sites, where waste is dumped directly in valleys, swamps, pits, or side slopes. One site, Kayu Madang, is a Level IV Sanitary Landfill. 15 of the disposal sites are poorly designed, 4 sites fair and 3 well designed. 20 of the sites are non-engineered with for example no bottom liner, leachate collection or treatment system (Source: Environment Protection Department, 2002)



Indicator area 4: Location of solid waste disposal sites

The task of allocating appropriate sites for disposal of solid waste is demanding, and some local authorities are facing increasing difficulties in getting suitable land for disposal sites due to public objections and the high cost of land acquisition.

14 of the 22 disposal sites in Sabah are not suitable for disposal (64 %), mainly because they are situated in swamps (5 sites), valleys & side slopes (8 sites) or on raised terraces (2 sites) or because they are unsuitably located due to proximity to development in the surrounding area. Seven sites are considered fairly suitable located, namely the sites at Beluran, Kinabatangan, Kota Belud, Kunak, Nabawan, Sandakan and Sipitang, while only one site, Kayu Madang (Kota Kinabalu), is considered suitably located (Environment Protection Department, 2002)