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Environmental Indicator Report, Sabah, Malaysia

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Appreciation

The Department appreciates the support from DANIDA (Danish Agency for International Development Assistance) in the preparation of this report

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

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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 indicator 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.

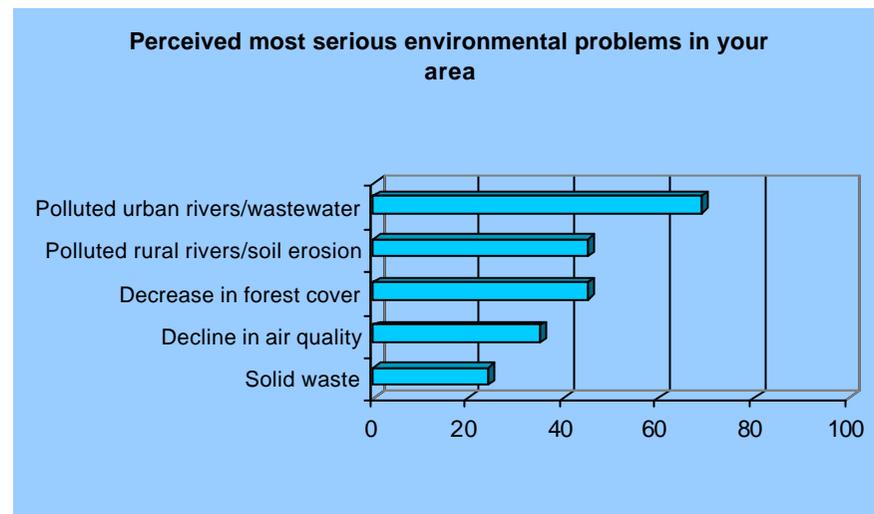
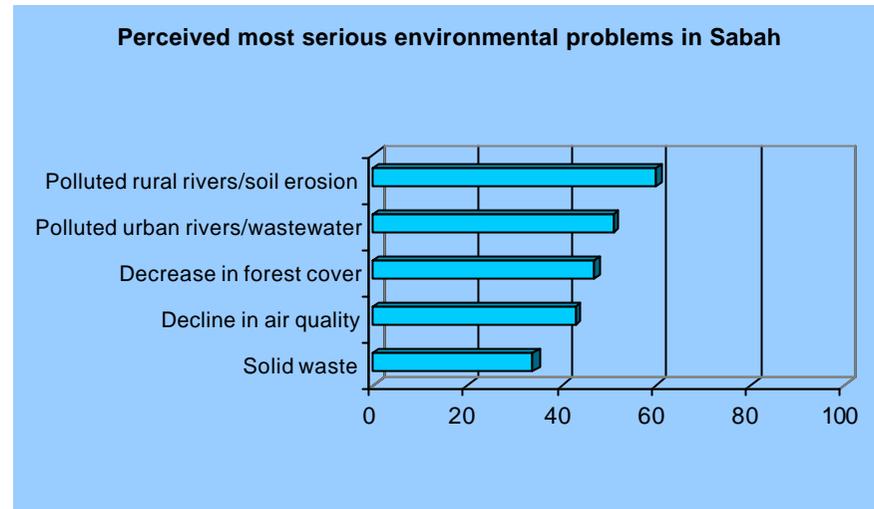
To a large extent the selection of indicators for each topic was influenced by availability of data. A broader range of indicators would provide a more complete sample of environmental trends. Our aim has been to cover the main aspects of environmental concerns in Sabah today, with the data available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

An aerial photograph showing a vast, dense plantation of palm trees, likely oil palms, stretching across a landscape. The trees are arranged in a regular, grid-like pattern, creating a textured, green surface. The lighting is bright, highlighting the individual fronds and the overall density of the crop. On the right side of the image, the word "LAND" is written vertically in a bold, teal-colored font. In the top-left corner, there is a small white rectangular box.

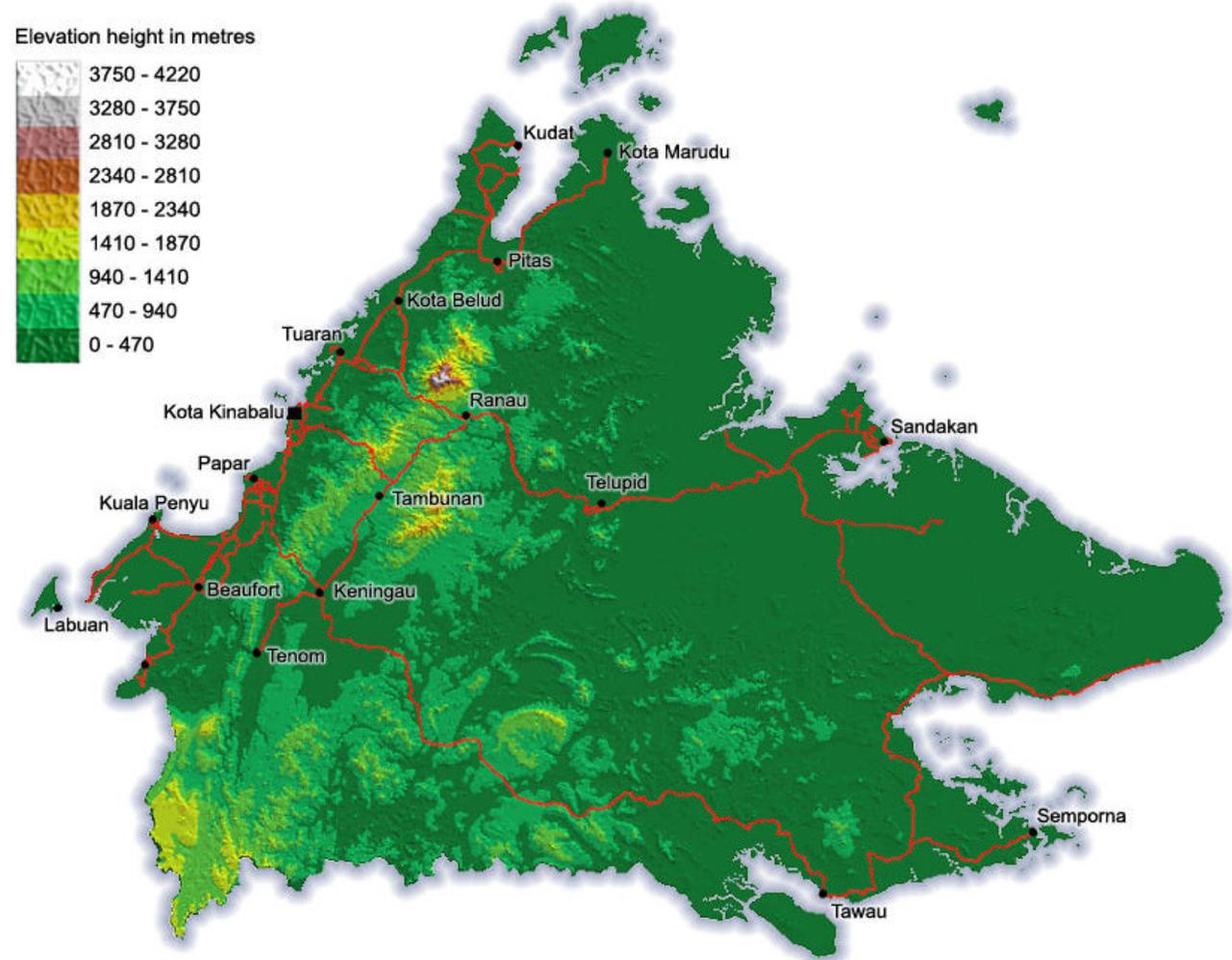
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LAND

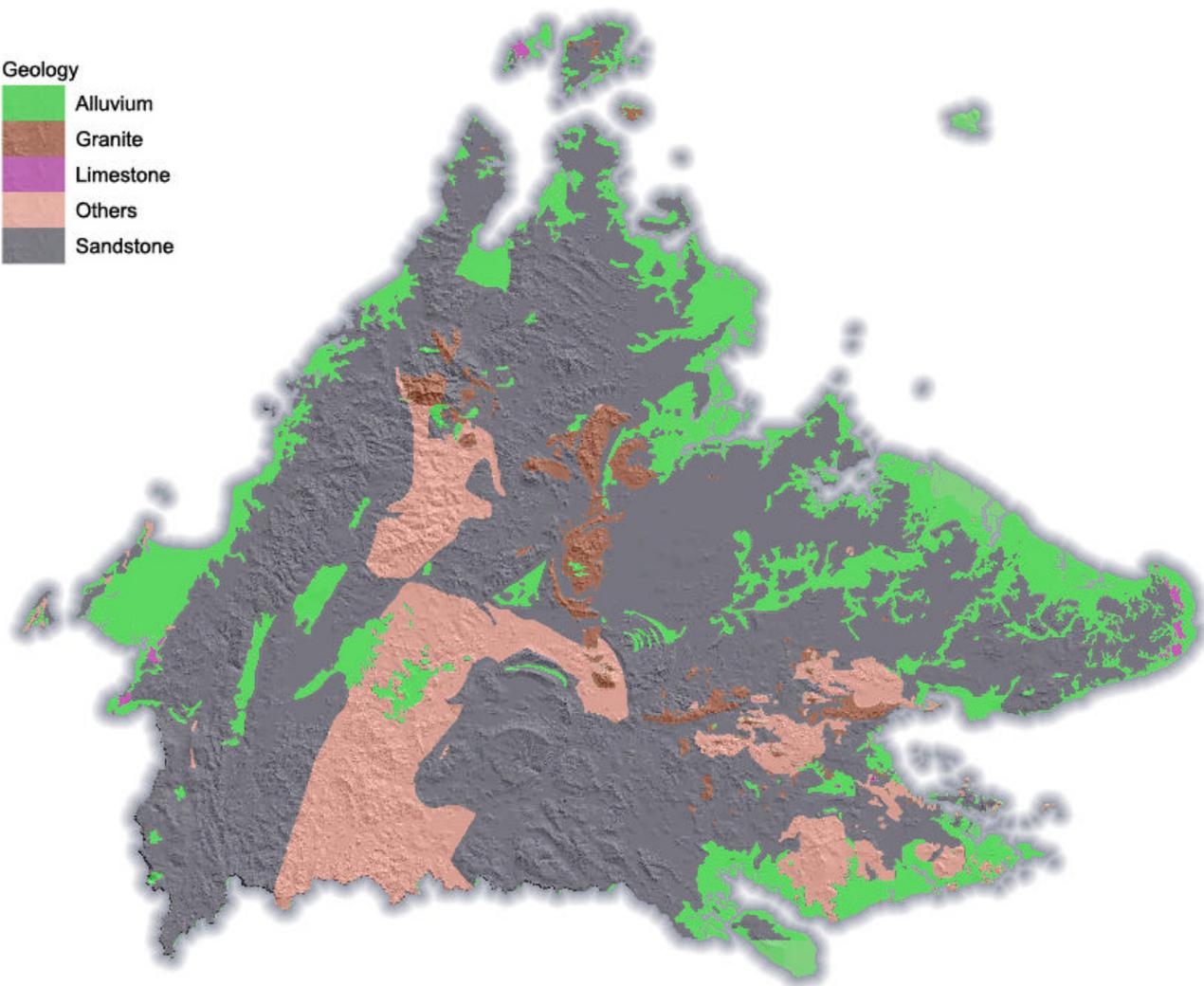
Nature, environment and land use development patterns in Sabah are closely linked to its geographical attributes. Within a land area of about 73,7 million hectares Sabah exhibits a remarkable range of physical landscapes and an accompanying assemblage of rich ecological diversity. The deltas and lowlands 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

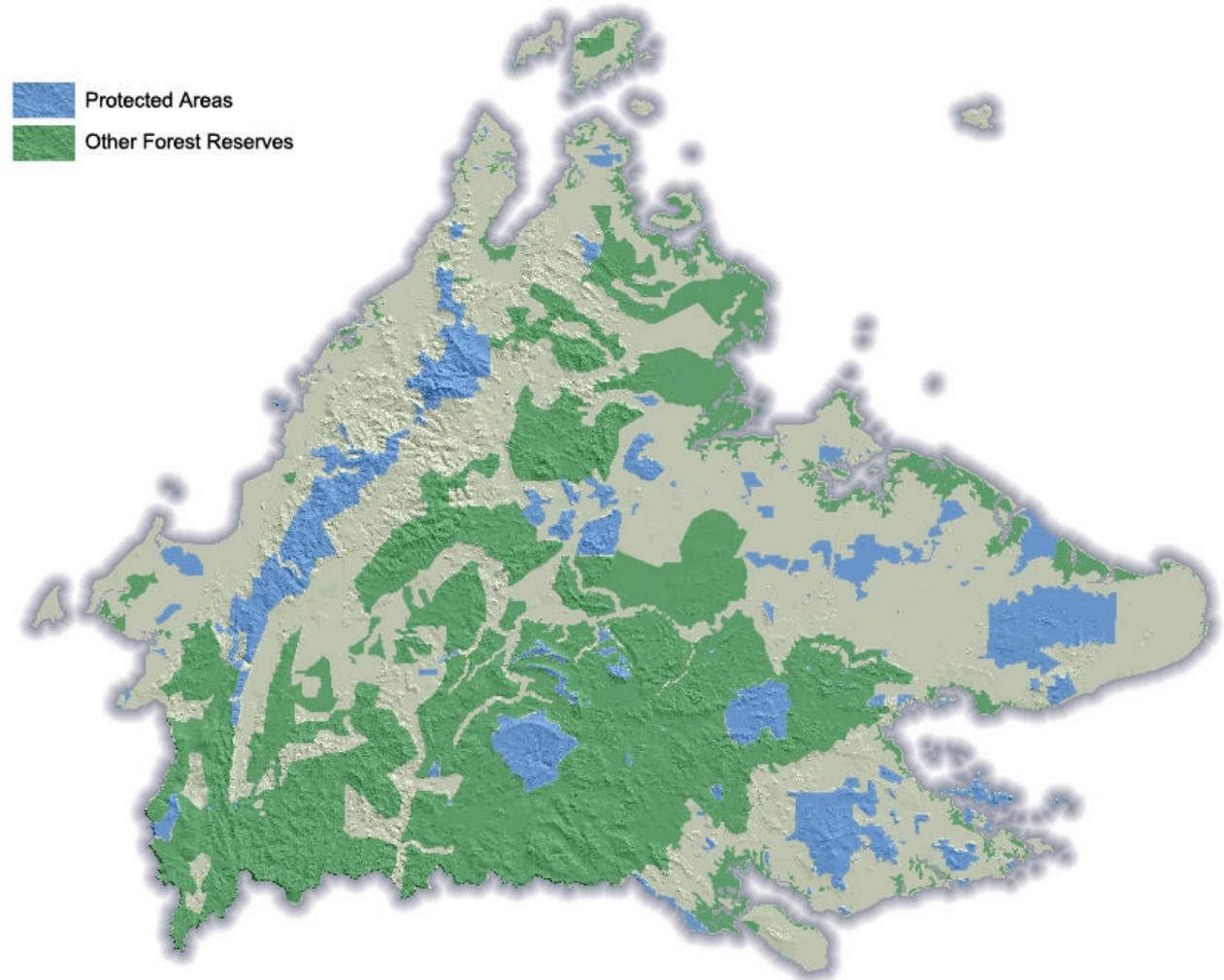
LAND

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.

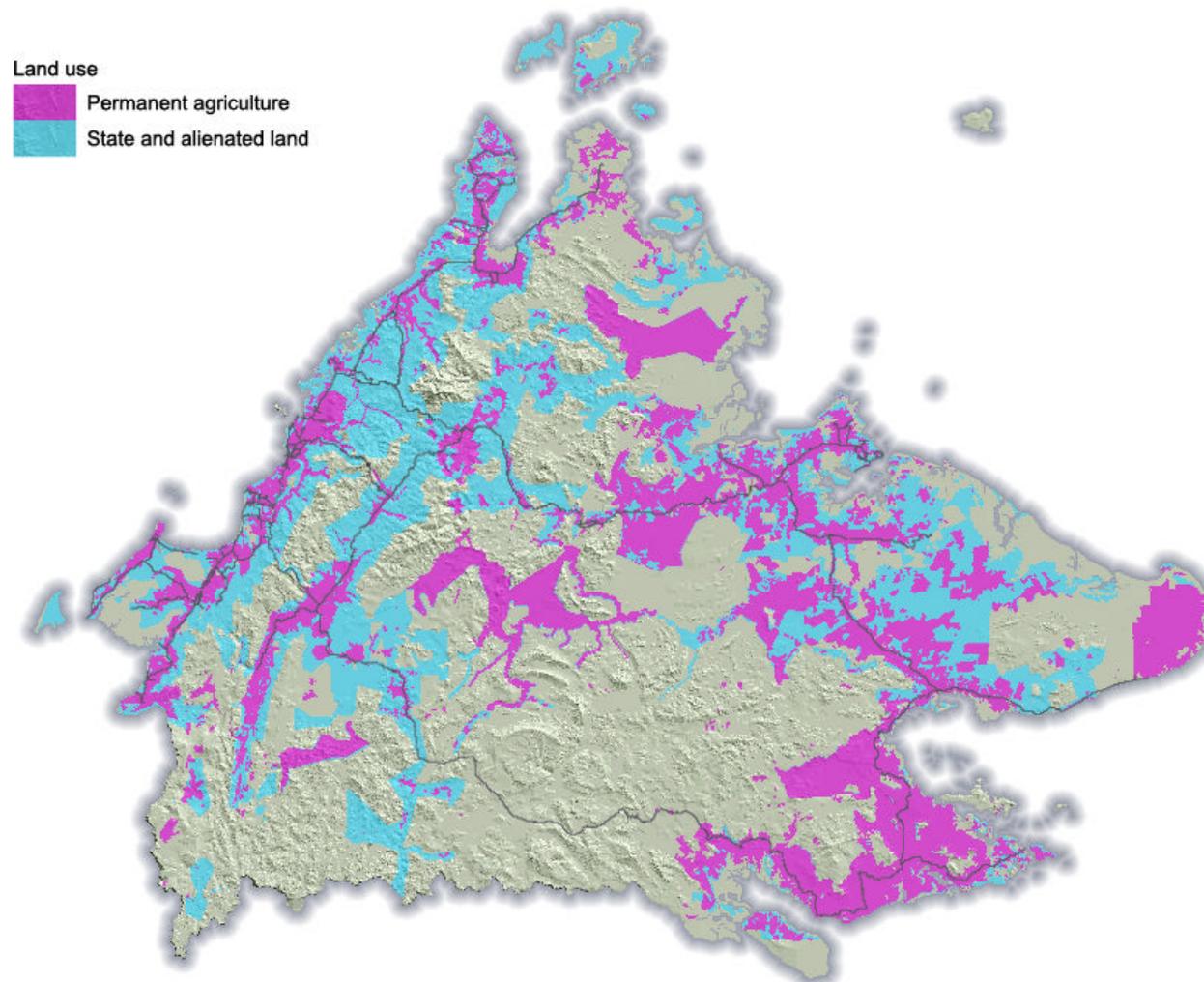
The reserved land, marked red and blue, occupies mainly the interior steep areas of Sabah, while alienated and state land, marked grey, occupies the coastline and the low-lying parts of the interior (Source: Environment Protection Department, adapted from Sabah Forestry Department, 2001)



About thirty per cent of the State 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)



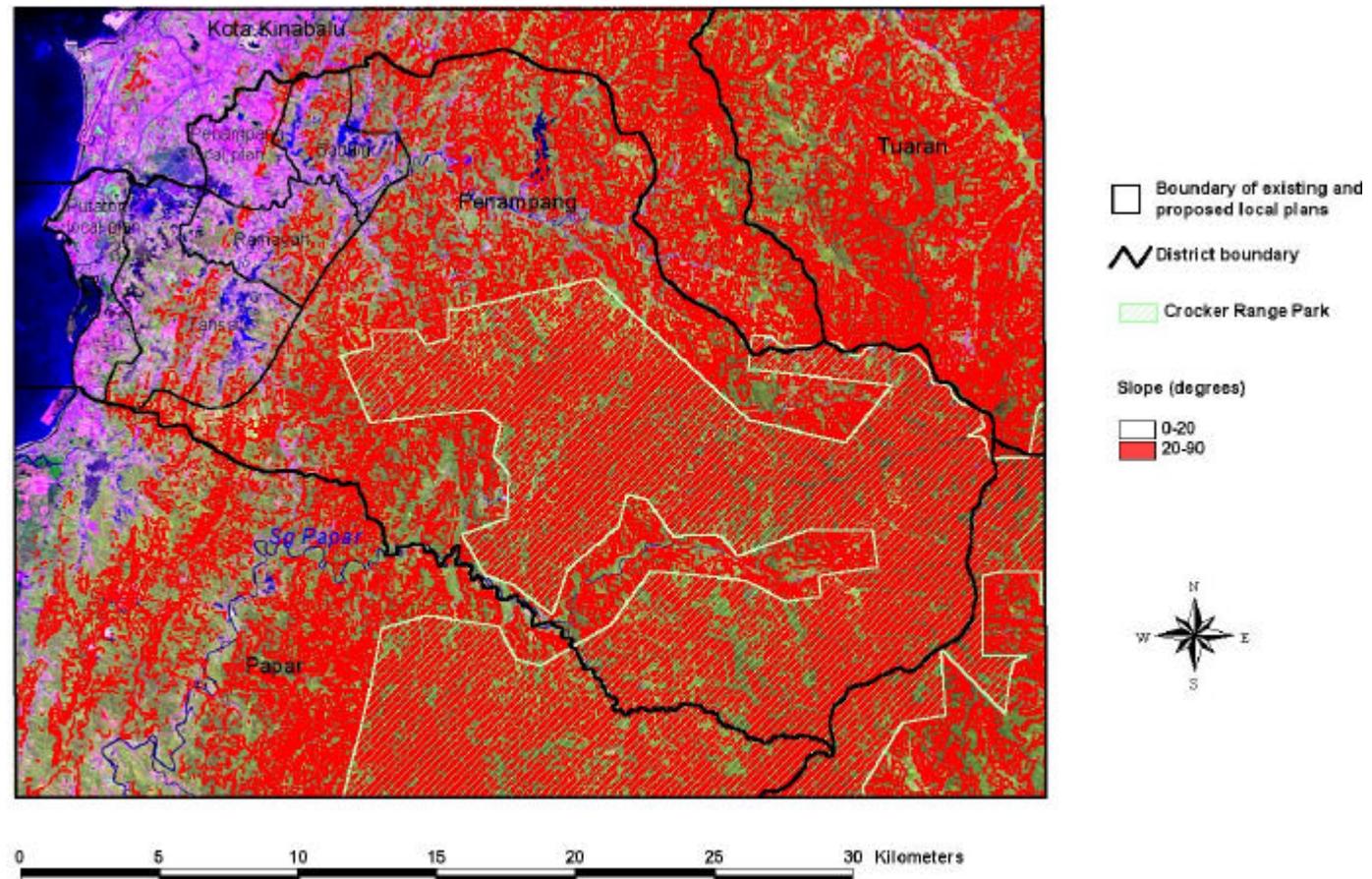
LAND

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)



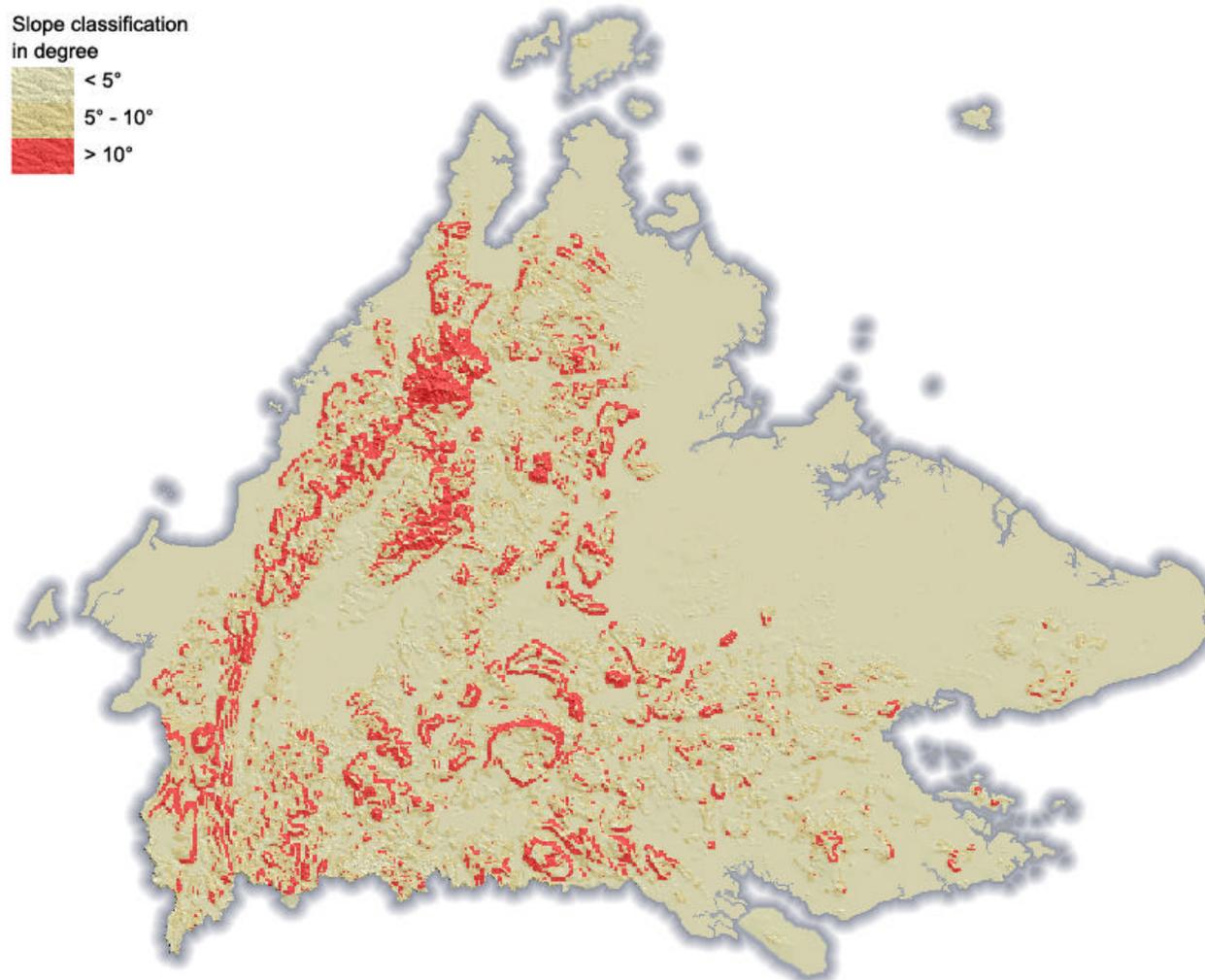
Most of the interior lands of Sabah consist of dissected and steep slopes where tracts of gentle slopes are scattered and rarely extensive.

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)



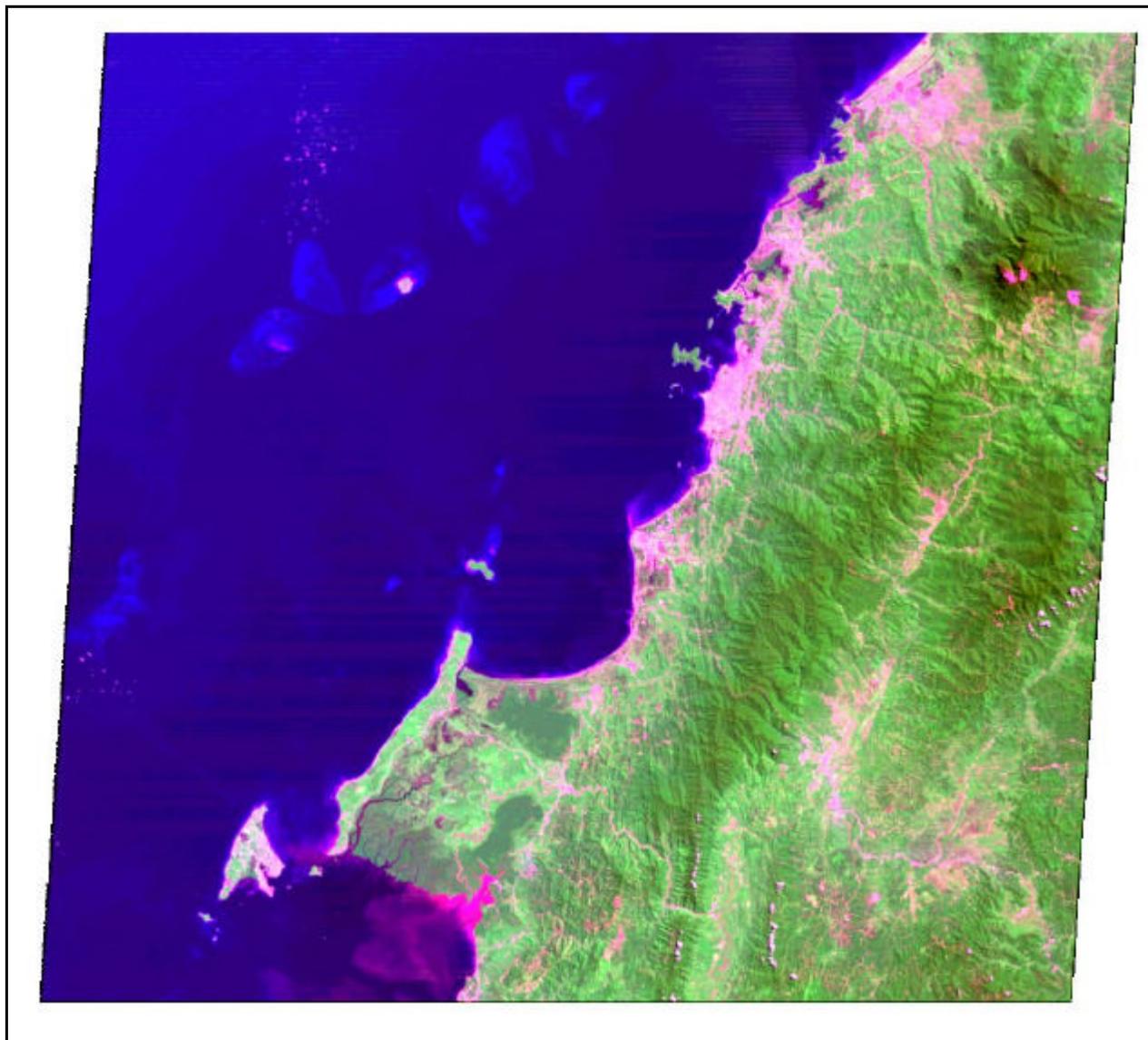
LAND

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

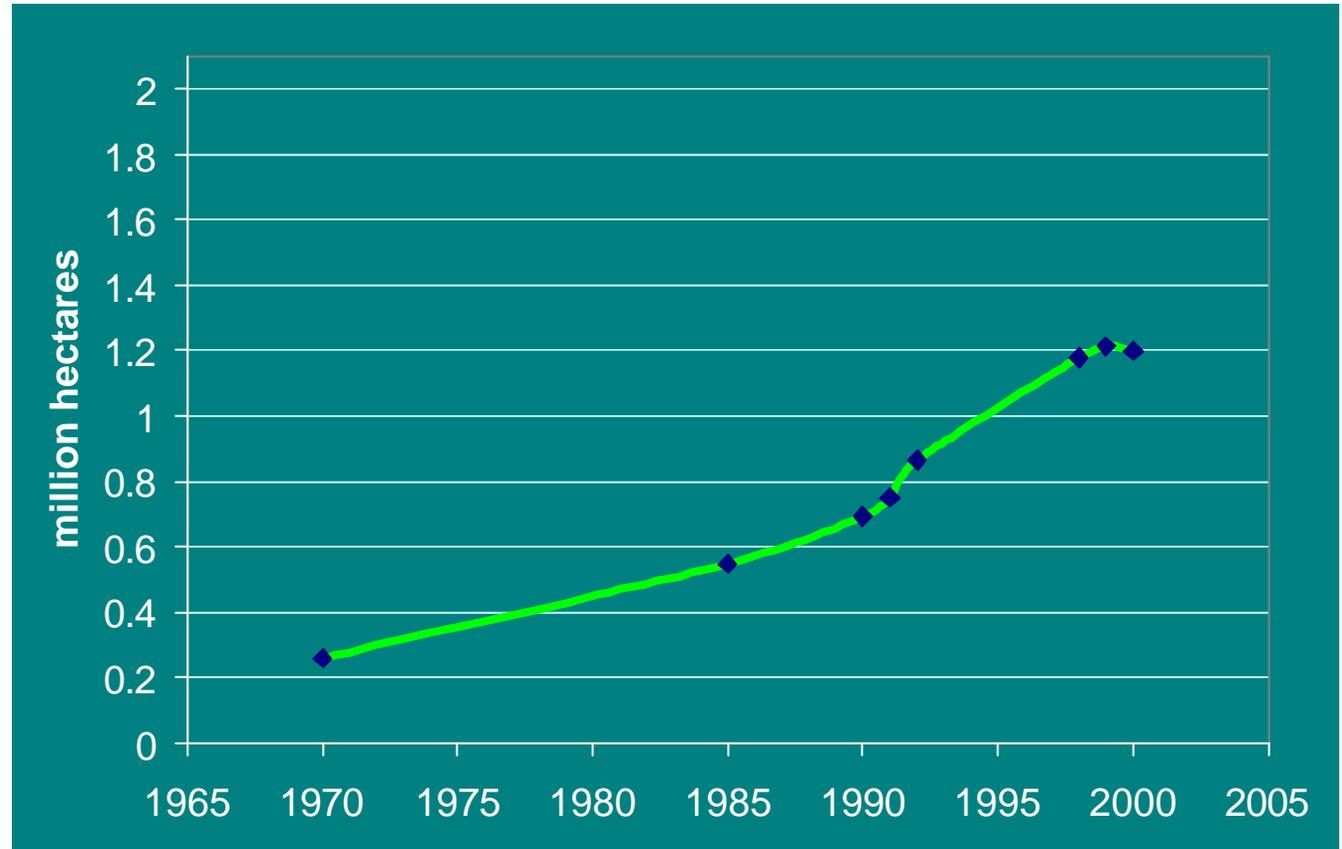


Area 5: Expansion of urban areas indicated through growth in percentage increase of developed land in and around Kota Kinabalu and the District of Penampang, the foremost urban growth area in Sabah

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)



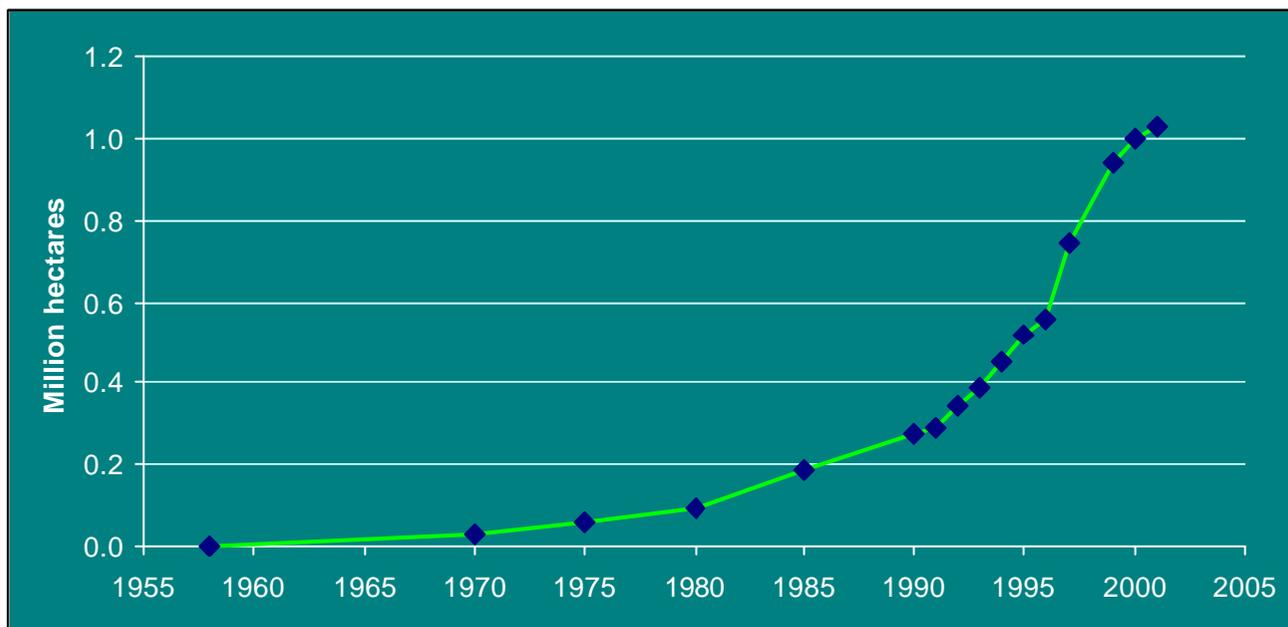
Indicator area 2: Oil palm plantations



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)



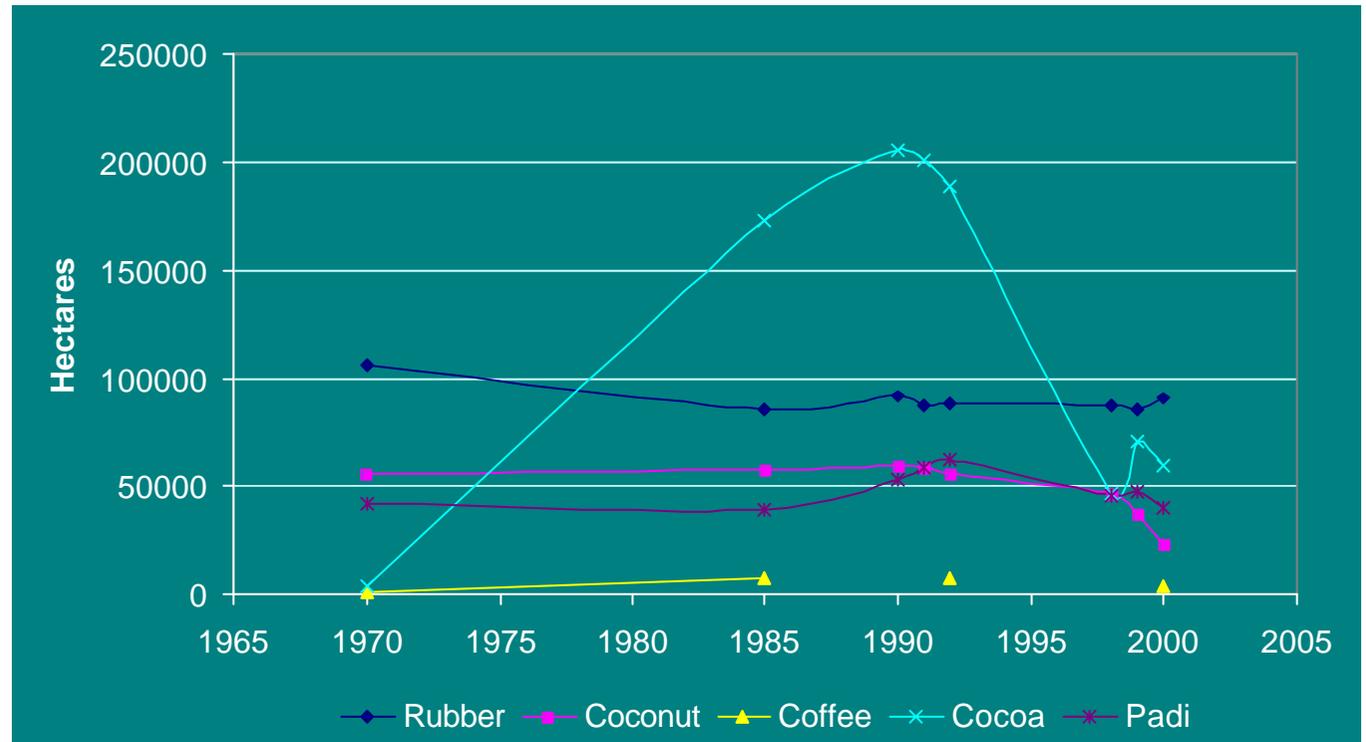
Indicator area 3: Change in crop types

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

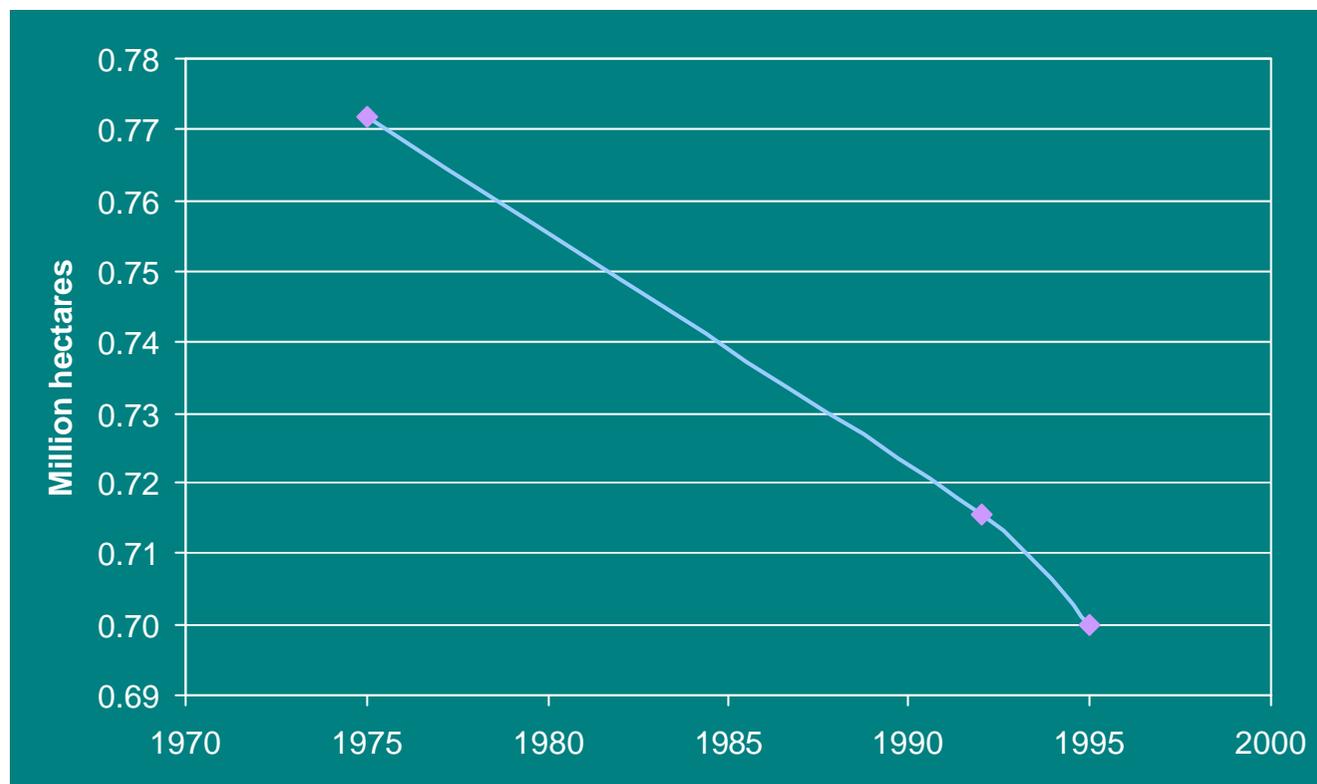
Rubber and padi has remained quite stable land users during the last three decades, at 100.000 and 50.000 ha respectively, while coconut dropped from about 50.000 ha in the mid 1990s to around 25.000 ha in 2000. Coffee has remained stable, however on a small scale, at around 5.000 ha (Source: Department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

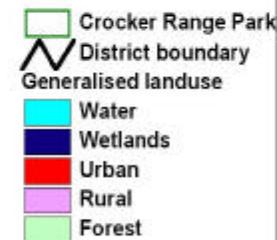
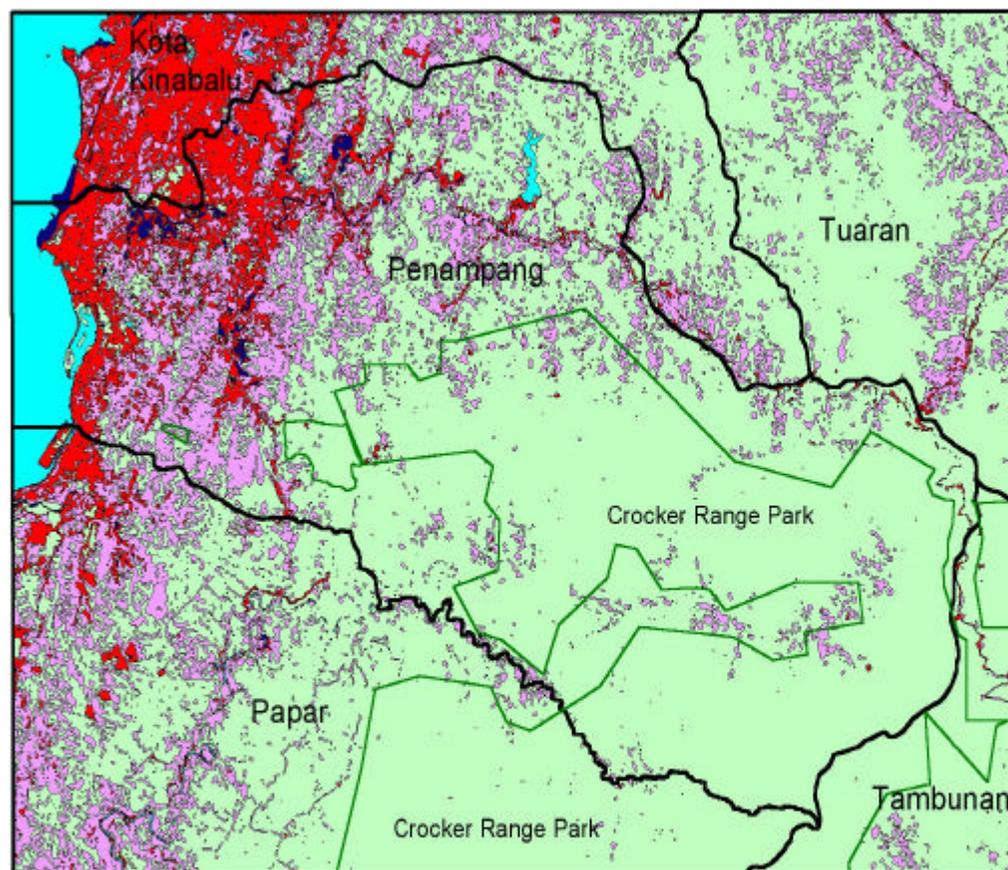
Montane forests decreased from about 770,000 ha in 1970 to about 700,000 ha in 1995 (Source: Sabah Department of Forestry, 2002)



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)



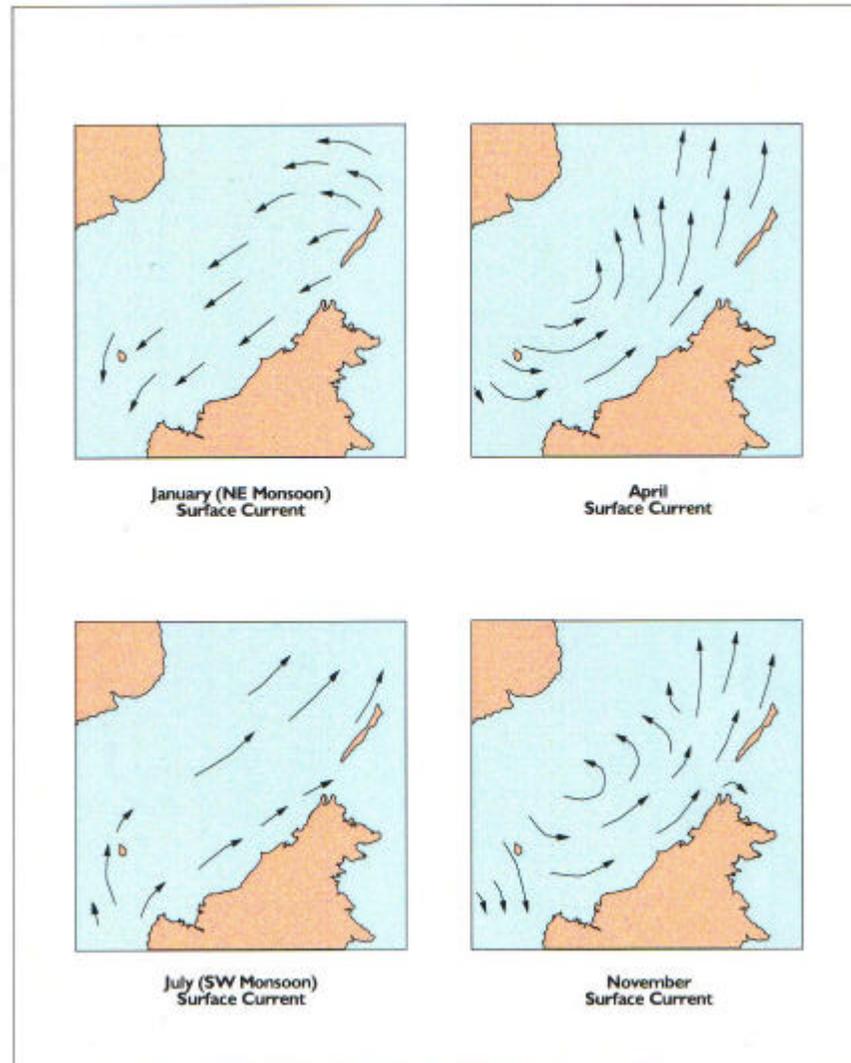
A dramatic landscape photograph at sunset or sunrise. The foreground is dominated by dark, silhouetted trees and bushes. The middle ground shows a line of trees against a sky filled with large, white, fluffy clouds. The sky transitions from a deep blue at the top to a warm orange and yellow near the horizon. The overall mood is serene and atmospheric.

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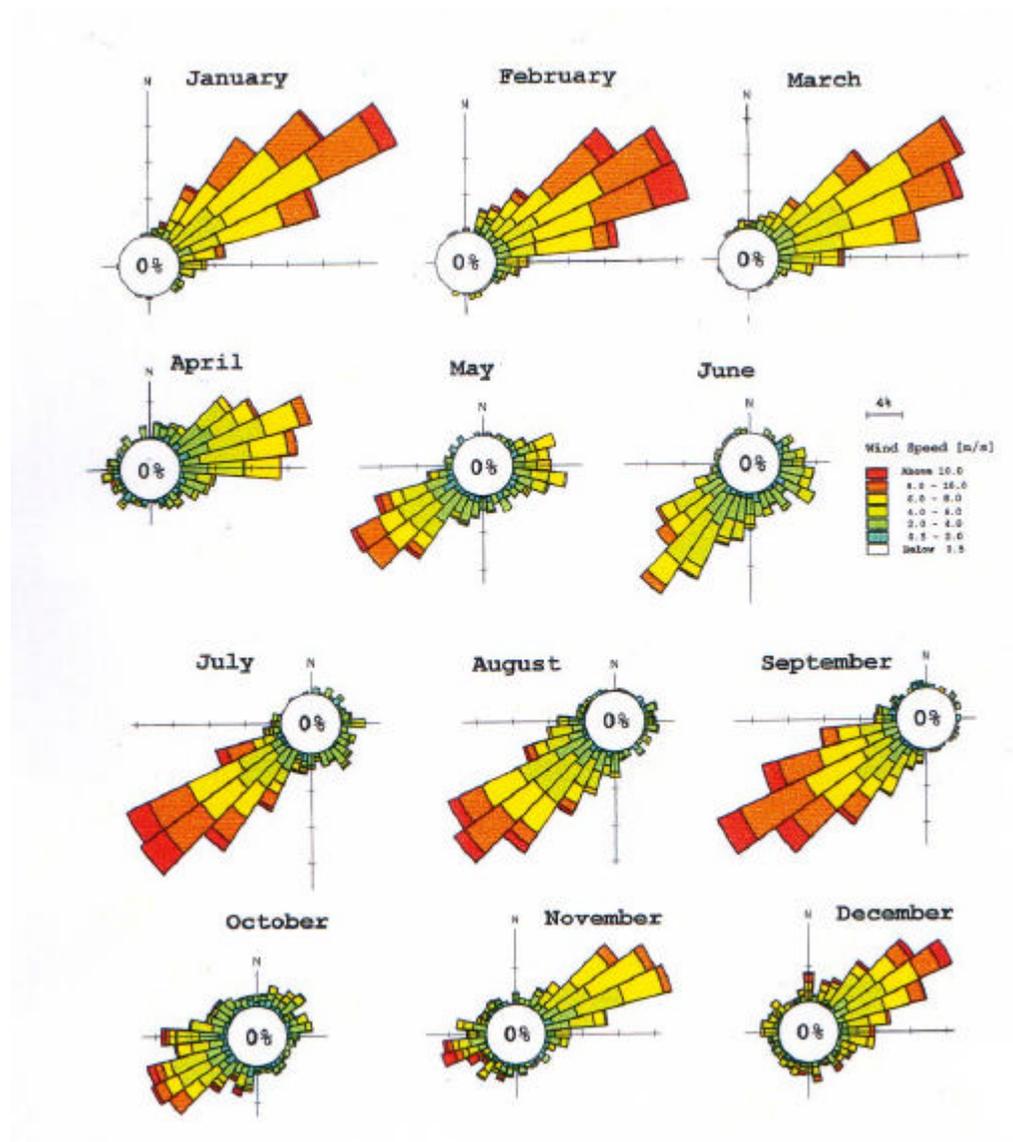
CLIMATE

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.



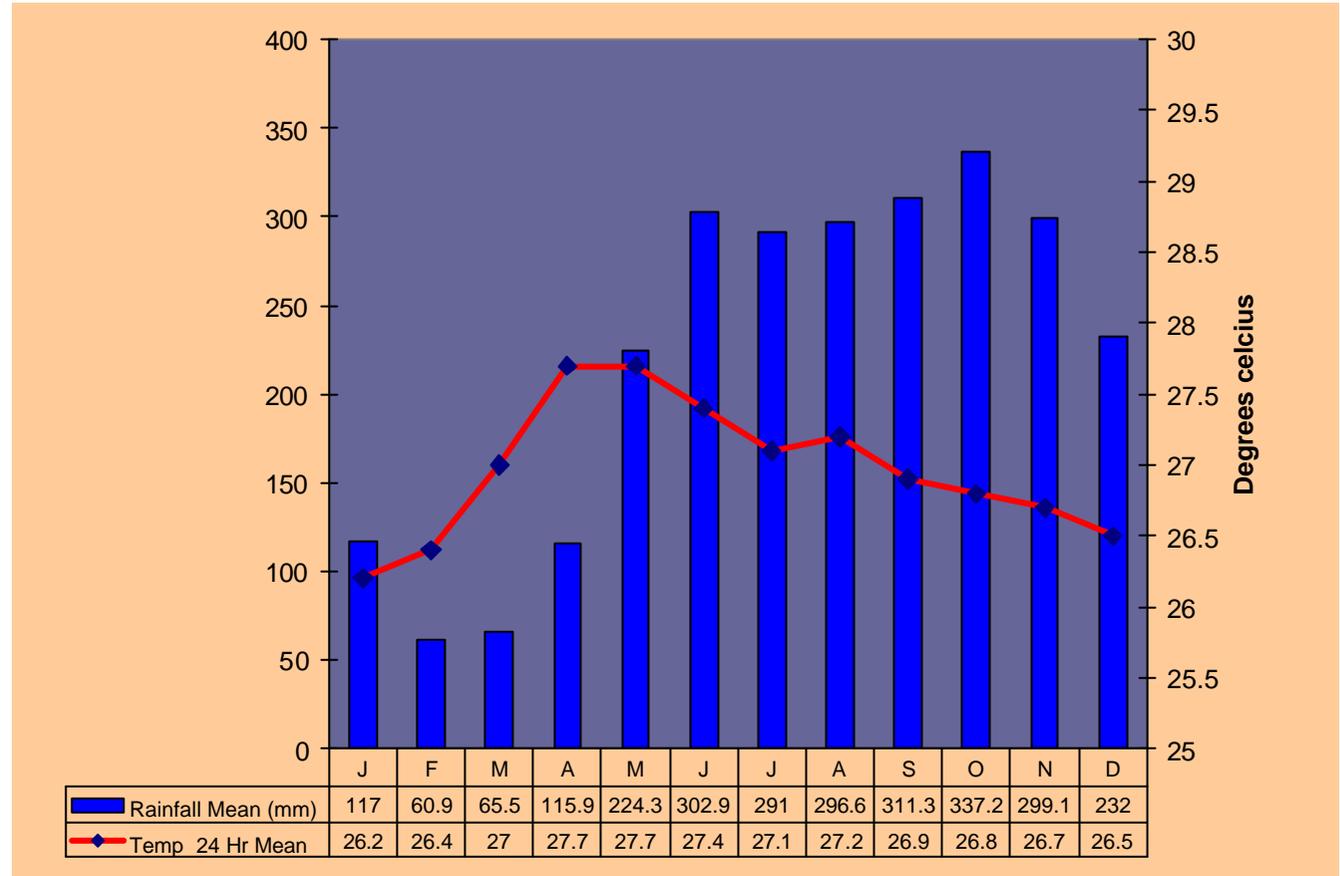
Monthly wind speed and direction off the west coast of Sabah is closely linked to the four seasons, namely, the northeast monsoon from November to April, the southwest monsoon from June to September, and two shorter inter-monsoon seasons of May-June and October (Source: ERM Consult, 1999, based on data 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.

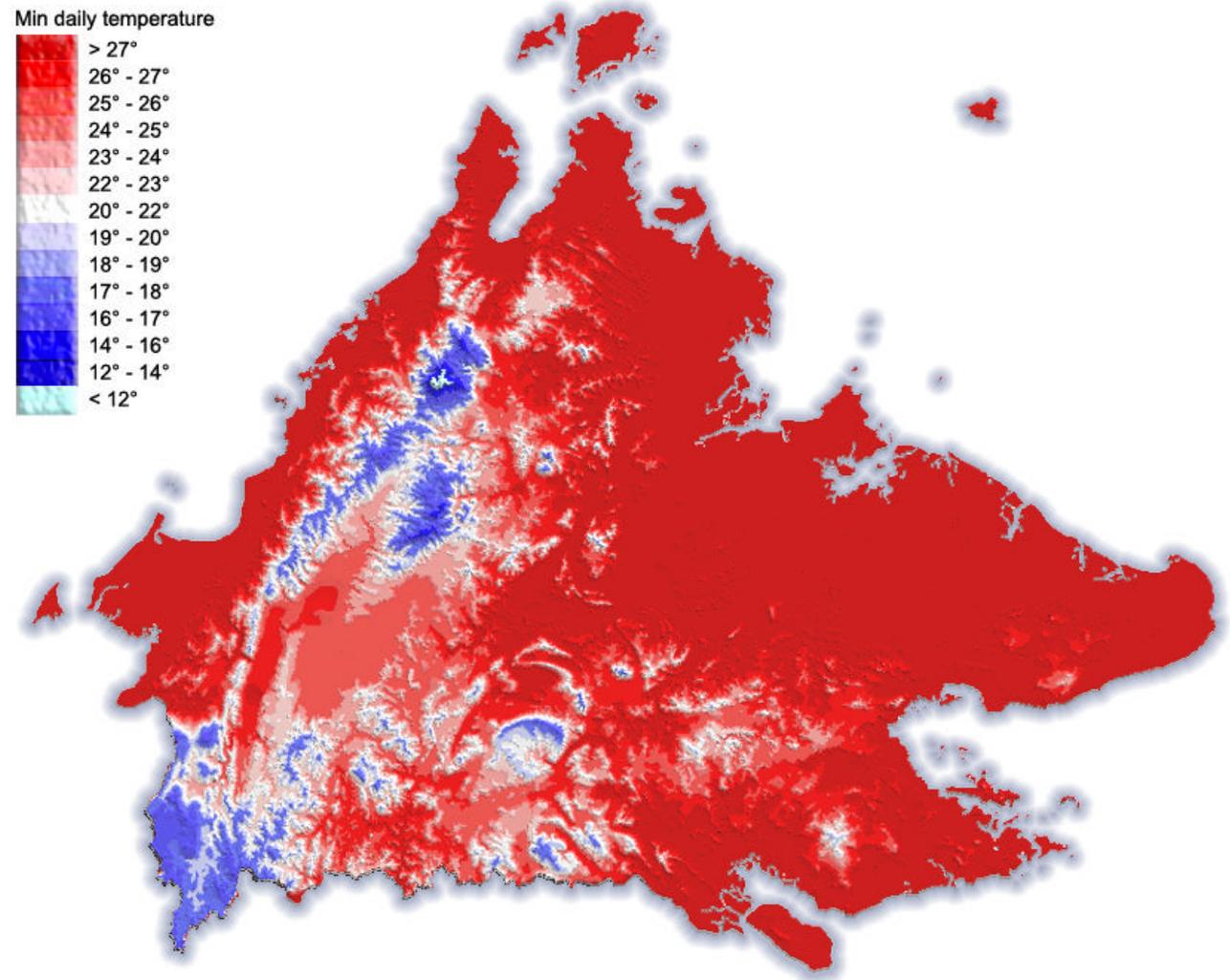
Daily temperature and monthly rainfall profile for Kota Kinabalu from 1968-1995 (Source: Meteorological Department Malaysia)



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)

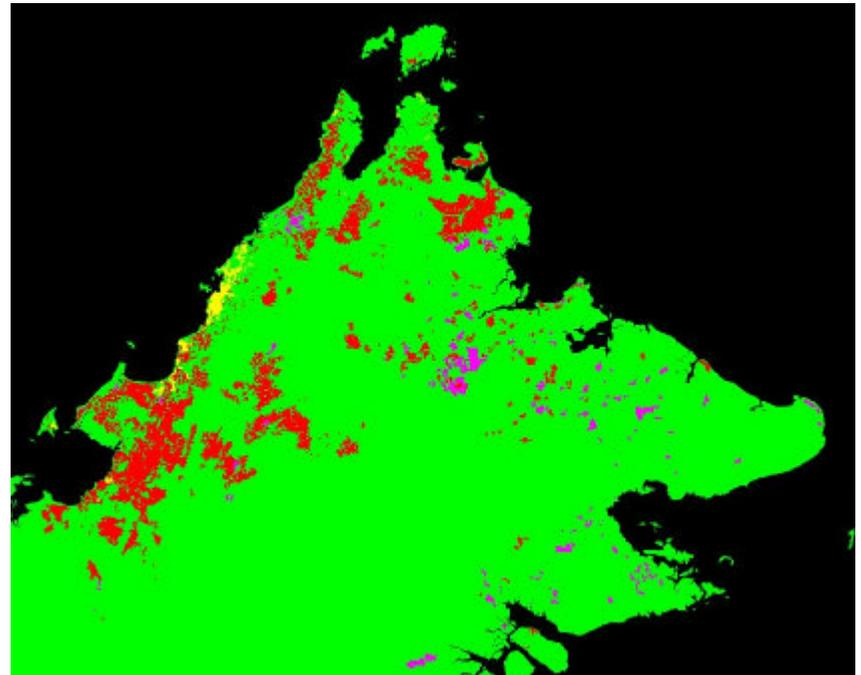
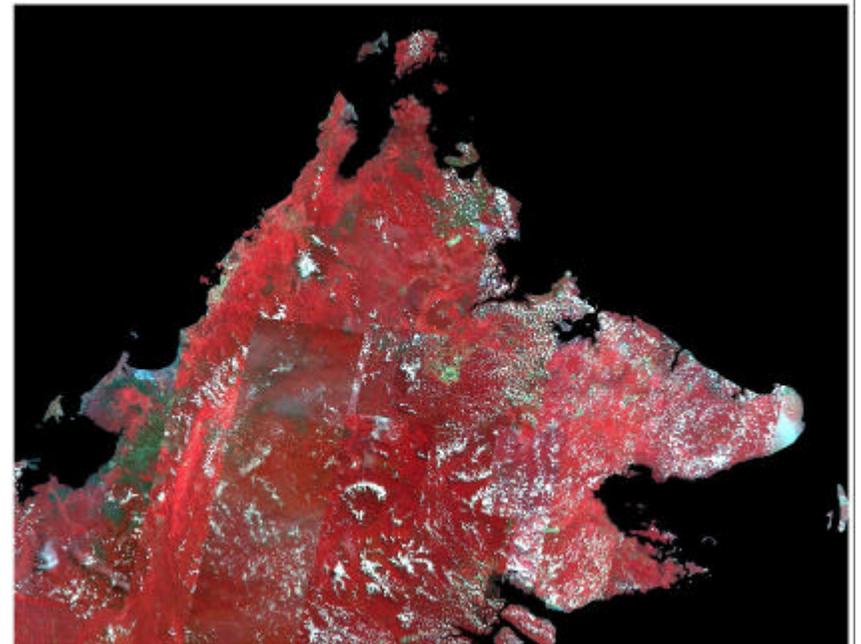


Periods of drought in Sabah are infrequent. However, there has been a statistically significant increase in the frequency and severity of droughts since the 1960s. Some aspects of these droughts have been linked to the global environmental phenomena such as El-Nino Southern Oscillation Event (ENSO), 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 satellite image of Sabah after the 1997-98 forest fires (Source WWFM, 1999, image mosaic comprises of SPOT satellite images, April-July 1998)

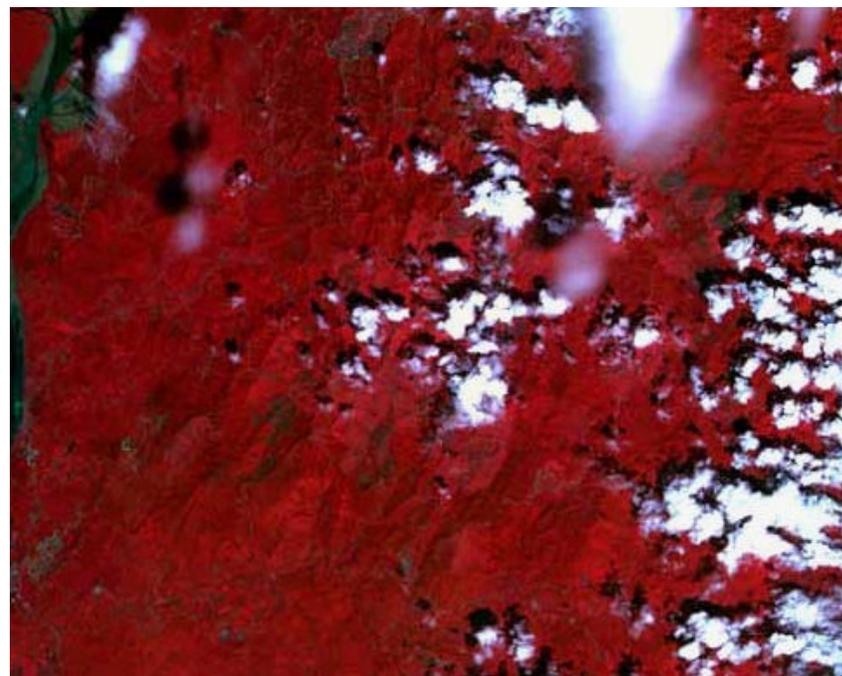
Burn scar map derived from the above image showing forest areas burnt by fire are (marked in red). The southwestern Sabah, including extensive areas of secondary forest near Beaufort and Sipitang, suffered the worst fire damage (Source: WWFM, 1999)



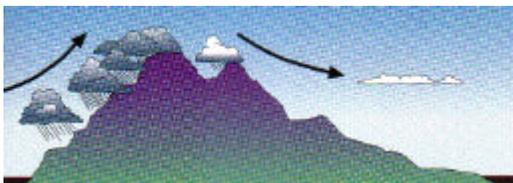
A satellite image covering about 40km by 30km over the west coast of Sabah acquired in 1997. The town of Sipitang is located to the left of the image. Healthy vegetation is represented by red colours, showing that most of the area comprises of full forest cover, although some of the forests are disturbed 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)

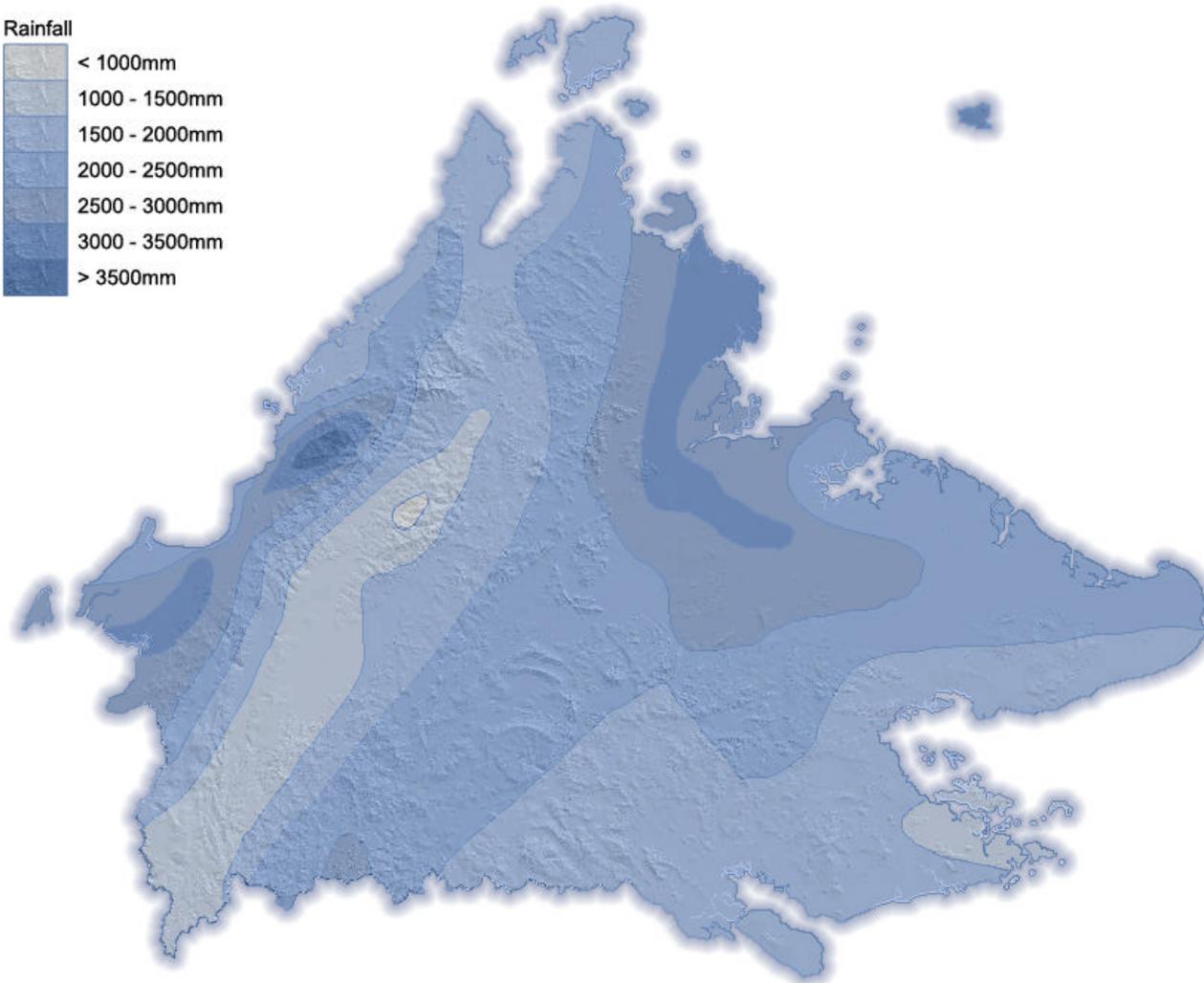
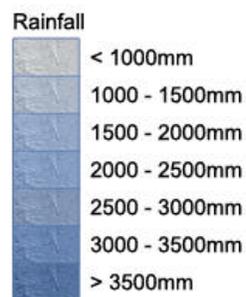


Average total annual rainfall varies considerably in different parts of Sabah and Borneo. The lowest annual rainfall amount recorded to-date by the Meteorological Department throughout Malaysia was 1151 mm in Tawau in 1997, while the highest annual rainfall recorded fell in the same year; 5293 mm in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