WWF

REPORT

HoB

2016

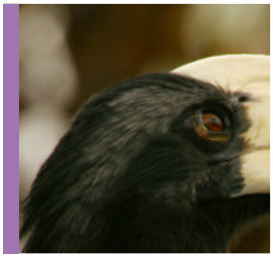
The Environmental Status of Borneo

Stephan Wulffraat, Chris Greenwood,
Khairil Fahmi Faisal & Dicky Sucipto

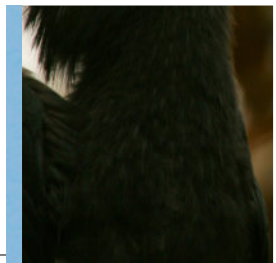
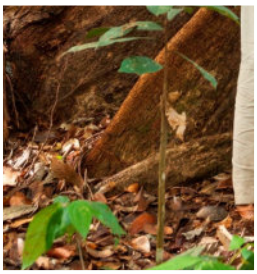








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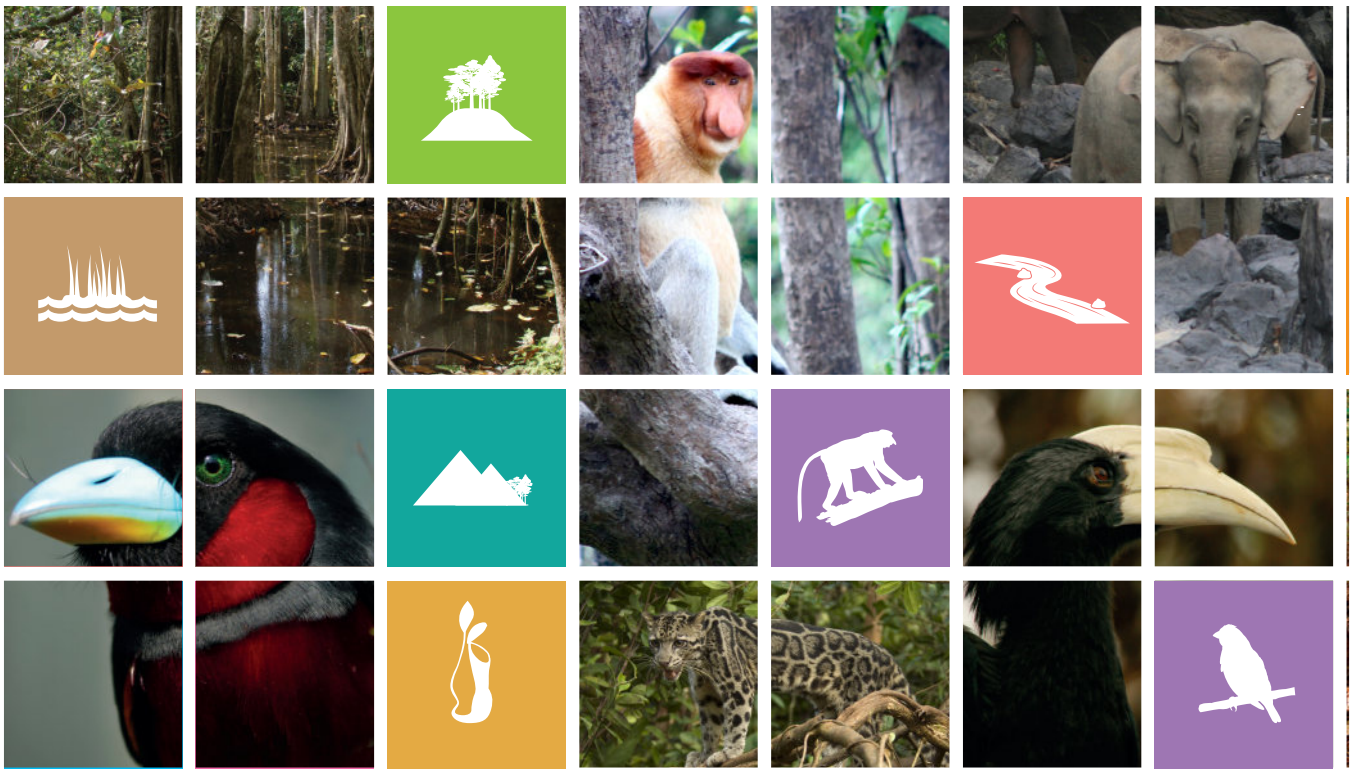

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WWF is one of the world's largest and most experienced independent conservation organisations, with more than five million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

A landscape containing a complex of lowland rainforest, heath forest and upland rainforest at Tumbang Jojang, Murung Raya, Central Kalimantan, Indonesia

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Acknowledgements

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Executive Summary

Borneo has long been recognized by WWF as a globally significant biodiversity 'hotspot'. Representing just 1% of the earth's terrestrial surface, the island is home to an estimated 6% of the world's flora and fauna, including WWF flagship species, orangutan and elephant and endemic species, such as proboscis monkey and countless birds and plants.

A paradise of biological wonder. Described by Charles Darwin as: "One great luxuriant hothouse made by nature for herself."

But, all is not well in paradise!

Borneo's forest and ecosystems are succumbing to the economic and social pressures of life in the 21st century. Many of these pressures are familiar: unsustainable logging, clearance for industrial agriculture and mining - as countries strive to develop their natural resource base.

With the completion of WWF's latest Environmental Status of Borneo report, the effect of these pressures is brought into sharp contrast, revealing dire trends and grave consequences for a 'Business As Usual' (BAU) approach to economic development on the island.

Borneo is in danger of losing its major ecosystems and the valuable eco-services they provide which are critical to the long-term survival of local communities and the economies - both national and regional - of Brunei Darussalam, the Indonesian provinces in Kalimantan, and the Malaysian states of Sabah and Sarawak.

But it does not have to be this way. Whilst detailing the degradation of the islands critical ecosystems, the very fact that the three Borneo governments endorse their monitoring offers hope for protection, restoration and rehabilitation.

And where a gram of prevention is worth a kilogram of reparation, the results of the report reaffirm the value and immediate necessity of 'truly sustainable' development initiatives led by the three governments - with support from the local and international community. Indeed, the findings in this report may be the 'wake up' call that all parties need to double their efforts to protect biodiversity and livelihood opportunities.

WWF's Environmental Status of Borneo 2016 is the third edition of the report which details the environmental health of critical ecosystems and biological plant and animal indicators, from historical records and then in three, five-year intervals, from 2005 to 2015. Using the latest 2015 data, this year for the first time, the report's brief was extended from the area designated as the Heart of Borneo to the whole of the island - a reflection of the cross boundary landscape approach needed to adequately address the loss of natural capital in globally significant environmental hotspots.

The purpose of gathering the data for this project is twofold. The first is to provide for objective and scientifically based long-term monitoring of the biodiversity on the island - as represented by the 'main report' detailing a range of ecosystems and biological indicator species. The second is more subjective from a conservation point of view, providing a focal point for ongoing management of the conservation and development needs of the island and the three countries that govern it.

The second purpose is represented by the Supplementary Report, which presents a summary of the findings of the main report along with extensive recommendations for the future sustainable management of the island.

THE BAD, THE GOOD AND THE INCONVENIENT TRUTH

THE BAD

Continuing the trend observed with the very first Environmental Status report in 2012, Borneo's forests are in decline. Historical forest cover at the turn of the 20th century was 96% of the island. By 2005 this had dwindled to 71% and the latest report indicates by 2015, this had fallen to little more than half the island (55%) - a figure which includes both intact and degraded forest.

This rate of decline is uneven across the ecosystems, with freshwater swamp forest and heath forest down more than 75% of historic levels to around 23% and lowland forest down by more than 50% of historic levels, to 42.3%.

By total area, lowland forest - a critical habitat for the conservation of many unique species - is by far the most converted ecosystem type in Borneo. Ease of access for logging and its suitability for palm oil production and agriculture have made it one of the most endangered habitats on earth. The consequences of any further loss of biodiversity in this ecosystem, projected between 2015 and 2020 to be 10-13 million hectares in a BAU scenario, will be felt on a global scale.

Similarly, certain species are in rapid decline, or face an uncertain future. The orangutan is perhaps the iconic species most closely associated with the tropical rainforest of Borneo. Yet in early 2016, the International Union for Conservation of Nature (IUCN) reclassified the threat status for the Bornean orangutan from 'endangered' to 'critically endangered', due to destruction, degradation and fragmentation of its habitats and hunting.

Between 1973 and 2005, orangutan lost almost half their distribution area due to large scale conversion and forest fire. The 2016 report indicates that between 2005 and 2015 another 9% of that was lost, with significant increased fragmentation of the area that was left.

Proboscis monkey populations are in a similar position with distribution areas estimated to have declined by 30% between 2005 and 2015, due to habitat loss and hunting pressure. The Borneo elephant population is also in trouble. By 2005, the elephant habitat based on forest cover dropped to 37% of its estimated historical distribution, further falling to 31% by 2015.

THE GOOD

The 2016 report does provide good news on some ecosystem fronts.

Upland rainforest and montane forest do not suffer high rates of deforestation, with nearly 90% and 96% respectively of historical coverage still remaining.

Indeed, the area known as the Heart of Borneo has fared far better than the lowlands and coastal areas. Highlighting perhaps the wisdom, forethought and relative success of the three Borneo Member Countries' 2007 historic Declaration to conserve the Heart of Borneo (HoB), an area then covering 22 million, but now 23 million hectares (234,000 km^2) in the centre of the island. Considerable work has been carried out under the HoB banner by the three Member Countries and its local and international supporters, not the least being WWF.

With 2017 being the 10th anniversary of the HoB Declaration, the 2016 Environmental Status report findings may provide the impetus for a renewed focus on Borneo's

environmental issues. A new focus is needed because, if action is not taken, the projections in the report reveal a disturbing reality regarding the future of the island's stunning biodiversity.

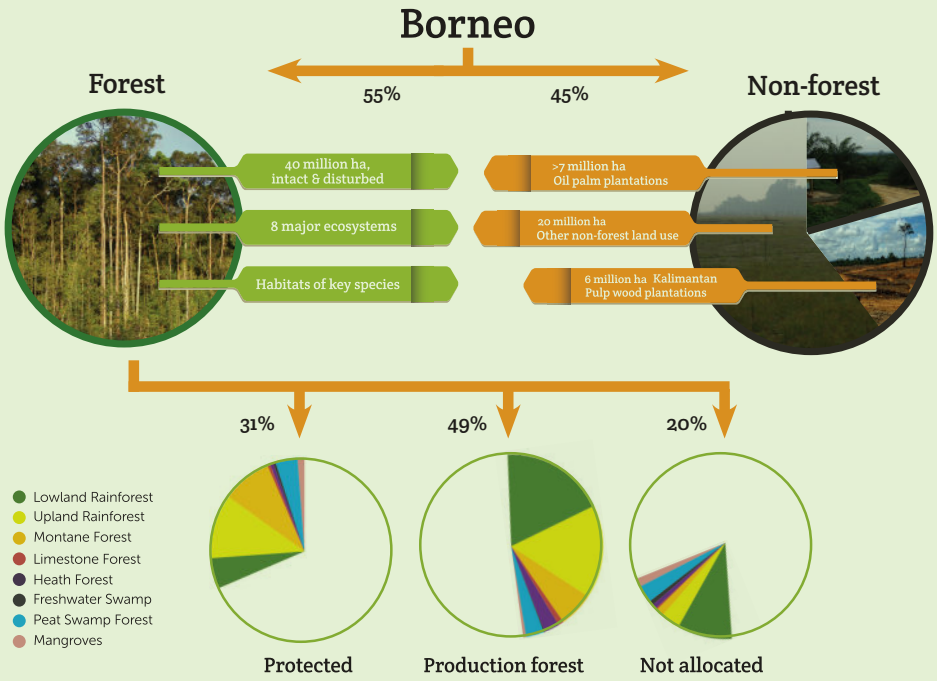
THE INCONVENIENT TRUTH

The inconvenient truth revealed by the report is that it is almost too late for some ecosystems in Borneo. Without unprecedented, concerted and large scale efforts in restoration, reforestation and protection, the majority of the original ecosystem conservation goals set by WWF's team of international and Bornean experts, are rapidly moving out of reach.

For example: Lowland forest, with an original conservation goal of 45% as determined in 2012, was down to 43% in 2015, and is projected to be as low as 32% by 2020. Limestone forest with a conservation goal of 60% declined from 71% to 53%. Freshwater swamp forest at a goal of 40% is down from 45% to 23%; and the original goal of mangrove ecosystems at 60% is now down to 50%. Likewise, the original conservation goals for heath forest and peat swamp forest of 50% and 60% respectively, can no longer be realistically met, unless there is rapid and dramatic policy change to provide enabling factors to reverse the trends.

What's more, according to projections in the report, if the 2005-2015 deforestation rates continue, under a BAU scenario a further 6 million ha of forest may be deforested over the next five year period from 2015 and 2020.

The largest projected deforestation will occur in lowland rainforest and peat swamp forest, but deforestation rates



in heath forest, limestone forest and freshwater swamp forest will also be unsustainably high.

Better news is that for upland rainforest and montane ecosystems, the original conservation goals of 80% and 90% respectively, could easily be achieved with an immediate reduction of deforestation rates. Furthermore, a number of animal indicators such as clouded leopard and banteng which are currently doing well, could thrive under such a scenario, while those under more threat could see a reduction in their risk status. Indeed, almost all the indicators in the report could be significantly improved with concerted and targeted action by the three Member Countries and state and provincial governments, with support from international and local agencies.

THREATS

As part of the analysis, the report looked at the developments and 'threats' currently facing Borneo's ecosystems and not surprising, a number of repeat offenders were identified.

Fire: Fires are a major threat, particularly to peat swamp forest and lowland rainforest and especially at the edges of oil palm plantation areas, where their 'accidental' nature must be questioned as they pave the way for further development of the existing plantations.

Land conversion: Expansion of oil palm and pulpwood plantations and large areas of natural forest destruction inside mining concessions, are major factors in the continued deterioration of Bornean ecosystems.

Inadequate spatial planning: The lack of coordinated spatial planning has resulted in allocation of licenses into environmentally sensitive areas as well as habitats for species that include orangutans and elephants. Spatial planning has a huge role to play in moving away from Borneo's BAU model. The 2016 report notes that 31% of the remaining 40 million ha natural forest is currently allocated for protection (constituting 17% of Borneo's total land area) while 49% is allocated for production forest. The remaining 20% has not yet been allocated or designated for retention as forest. Terms, however, can be deceiving. In Kalimantan, for example, the classification of APL (*Areal Penggunaan Lain*/ Other Land Use) can effectively mean 'allocated for conversion.' Likewise, the 17% of Borneo's land area allocated for protection appears to be in line with the IUCN protected areas targets. However, this figure includes large areas (such as *Hutan Lindung*/Protection Forest) which do not conform to the IUCN definition of a protected forest.

As such, systematic spatial planning that integrates the environmental conservation aspects across the island, a better clarity of classifications based on tighter definitions, as well as rigorous enforcement of forest regulations, would do much to halt the slow march of deforestation across Borneo.

There are continuing difficulties in enforcing protected status. It is essential to remember that even the designated Heart of Borneo landscape was never a 'national park', as many have erroneously perceived it to be. It was always a 'mosaic' of protected areas, wildlife corridors and sustainable land-use areas. The value of the Heart of Borneo approach was that it recognized the need to balance conservation and sustainable development to ensure a secure future for biodiversity, habitat conservation and indigenous livelihoods as well as meeting the ever-present government requirements for development.

STATE AND PROVINCIAL DEVELOPMENTS

The report also provides an update on individual states, provinces and in the case of Brunei, country progress on all relevant biological indicators. Here there is hope for the optimist, but encouragement also for the pessimist. Hope springs eternal in the new protected areas in Sabah, more forest to be retained in Sarawak, ongoing protection in Brunei and more watershed forest cover in Kalimantan, measures that were undertaken during 2016 and therefore outside the scope of this analysis.

However less hopeful are the large natural forest areas not allocated to be retained across the island, as well as the very many locations of illegal forest conversion and expansion by stealth around many of the palm oil plantations.

A WAY FORWARD

There are many responses possible to the challenges ahead. Whilst not prescriptive, the 2016 Supplementary Report puts forward a number of recommendations for state and federal government policy makers, industry, international agencies and civil society.

Key amongst them are:

- Ensure ecological connectivity of the landscapes of Borneo through island-wide spatial planning for effective conservation of biodiversity and ecosystem services.
- Evaluate spatial planning per location or landscape to ensure retention of as much natural forest and species habitats as possible.
- Identify and establish a new baseline for all idle non-forest land, and consider it as the only alternative for new plantations.
- Develop monitoring systems and prescriptive action to ensure that all production forest remain under natural forest cover.
- Expand protected areas to include entire landscapes and better representation of all ecosystems and species habitats.

There are many challenges in adequately enforcing protection: illegal logging, forest fires, conversion to agriculture/palm oil/pulpwood, wildlife trade and mining are among the most difficult of those. The 2007 HoB Declaration was in some respects a line in the sand from which all three national governments acknowledged the need to begin to address these challenges.

The HoB, however, does not exist in isolation and neither do Borneo's endangered species. For example, a majority of orangutans live outside the HoB. The goals for HoB conservation cannot be truly achieved without taking the whole of Borneo into consideration, hence our recommendations span priority conservation across the island.

With 2017 being the 10th anniversary of the HoB Declaration, the 2016 Environmental Status report findings may provide the impetus for a renewed focus on Borneo's environmental issues and challenges within and beyond the HoB.

Elephants in Sabah, Malaysia

Introduction

WWF's *Environmental Status of Borneo 2016* is the third edition of the report which details the environmental health of critical ecosystems and biological plant and animal indicators. The purpose of the status report is to use these indicators in assessing the changing landscape and decline of forest cover by making reference to historical extent, and then in three, five-year intervals, from 2005 to 2015.

The report presented here is an inventory of the changing status of the major ecosystems and key species of Borneo; the land use developments that affect that status; and the current conservation management issues which most directly affect them. The report will serve as the baseline for the Borneo-wide conservation strategy of WWF.

Using the latest 2015 data, this year for the first time, the report's brief was extended from the area designated as the Heart of Borneo to the whole of the island - a reflection of the cross boundary landscape approach needed to adequately address the loss of natural capital in globally significant environmental hotspots. For the first time also, all the protected areas and production forest of Brunei Darussalam, Indonesia and Malaysia in the island of Borneo are shown in one map which therefore enables a better analysis of the overall status of the environment.

The methodology, particularly of forest cover analysis, was improved which implies that the results in this report are not fully comparable to the previous reports. A detailed discussion of methodology can be found on page 172.

In 2016, new government initiatives were being developed with the aim of providing more protection of ecosystems and key species. As the analysis here covers the period up to 2015, the results of the governments' initiatives are not included here. They are expected to provide positive conservation results, which will be reported in the next edition of this publication.

The Environmental Status of the Heart of Borneo 2012 was the first attempt to summarise the current state of the environment of the Heart of Borneo (HoB). It discussed the methods, data collection and the selection of appropriate indicators for analysis. The resulting information generated was set to form the baseline for the long-term monitoring to regularly assess the HoB's status. The report adopted a four-component Conservation Measures framework to generate baseline information that could be used to measure the long-term effectiveness of conservation strategies critical to effective conservation planning across large geographies. The four components were biological targets, threats, conservation management and social well-being.

Overall, the assessment in 2012 indicated that most forest types in the HoB were rated as good or very good. Of particular concern was lowland rainforest, which was under severe threat across the rest of the island of Borneo. Lowland rainforest is prime habitat for pygmy elephant, orangutan and rhinoceros – some of the most endangered species in the world. With the overall good rating, the HoB could be the world's last stronghold for the preservation of these animals and this type of forest.

The Environmental Status of the Heart of Borneo 2014, the second series, was a refinement of assessment done from the first report. The indicators consisted of three types:

- biological indicators, the major ecosystems and selected keystone species;
- threat indicators; and
- conservation management indicators.

These indicators were measured for the second time in 2013, using data from 2012 and 2010. These assessments were used for monitoring, followed by evaluation of effectiveness and formulation of adaptive management. The key finding of the overall threat status indicated that conversion of natural forest into industrial plantations was highest to the ecosystems of both Borneo and the HoB. The total extent of oil palm plantations in 2012 in Borneo was 11.72 million ha; of which 1.03 million ha was inside the HoB. The total extent of timber plantations in 2012 in Borneo was 5.05 million ha; of which 0.49 million ha was inside the HoB. As a result, the standardized annual rate of deforestation of the HoB between 2007 and 2012 was 2.19%, while for the whole of Borneo it was doubled at 4.68%. Lowland rainforest was one of the ecosystems affected most by forest conversion while the other two were heath forest and peat swamp forest.

Why is there a need to monitor the environmental status of Borneo?

The island of Borneo, a mega biodiversity, is recognized as a global conservation priority by WWF. At the beginning of 20th century, 96% of the 74.3 million ha land mass of Borneo was covered by forest. It is home to a great diversity of plant and animal species, ranging from the mast fruiting Dipterocarpaceae giant trees, to orangutan, pygmy elephant and the proboscis monkey. Yet over the last few decades, the lowland portions of the island of Borneo, the forest with the richest diversity of wildlife continues to suffer from deforestation, forest fire, and conversion to industrial scale plantations crops.

In February 2007, the Governments of Brunei Darussalam, Indonesia and Malaysia signed the Heart of Borneo (HoB) Declaration which commits the three governments to a single conservation vision to ensure the effective management of forest resources and conservation of a network of protected areas, productive forest and other sustainable land uses in the upland HoB.

The initial delineation of the Heart of Borneo encompassed all the interior highlands and mountains of the headwaters of the major rivers of Borneo. Later boundaries were expanded to include the foot hills and important intact adjacent lowlands. This interior area, known as the Heart of Borneo (HoB), comprises the upstream sections of all the major river drainage areas of the island. The tropical rainforest of the HoB covers almost 30% of the third largest island in the world and forms one of the largest contiguous forest remaining in all of Southeast Asia. Most of the original forest ecosystems and wildlife of Borneo are still present in HoB and the preservation of this region is being given the highest conservation priority by WWF.

The HoB is also known for the cultural and linguistic diversity of the several ethnic groups of Indigenous Peoples. Local people depend on the forest for a variety of resources including: food, medicinal plants, non-timber forest products for trade, wild game, fish, construction materials and water. The traditional management practices of the indigenous peoples have contributed to sustainable management of natural resources of the island over the last centuries.

The ultimate measure of the success or failure of conservation initiatives will be the ecological health and sustainability of institutions which support that ecological health. Therefore, the development of a monitoring framework which could characterize both the ecological health and conservation status of the HoB was initiated in 2007 following the HoB Declaration. Similar to the previous reports, the objectives for this 2016 report to cover all of Borneo, are to:

1. develop a set of practical indicators that might be representative of the ecological status of Borneo and could be monitored at appropriate time intervals;
2. develop a larger set of indicators that are representative of the overall conservation status of Borneo; and
3. analyse data for those indicators to assess the overall ecological and conservation health of the whole island.

An overview of the status of the environment report 2016 shows a continuing trend observed with the very first Environmental Status report in 2012, Borneo's forests are in decline. From the historical forest cover at 96%, by 2005 this had dwindled to 71% and the latest report indicates by 2015, this had fallen to 55% - a figure which includes both intact and degraded forest (Table A and Forest Cover 2015 map).

Deforestation was extensive and affected much of the lowland rainforest areas. While at a glance the remaining forested area map looks intact, fragmentation was widespread and could lead to further deforestation.

Table A : Forest Cover and Percentage of Historical Extent according to Ecosystem, 2005, 2010 and 2015

Ecosystem	Historical Extent (ha)	Forest Cover in 2005 & % of historical extent		Forest Cover in 2010 & % of historical extent		Forest Cover in 2015 & % of historical extent	
		Ha	%	ha	%	Ha	%
Lowland rainforest	31,180,420	19,338,952	62.0	15,740,581	50.5	13,198,688	42.3
Upland rainforest	13,820,382	13,118,466	94.9	12,664,227	91.6	12,347,960	89.3
Montane forest	6,727,267	6,655,131	98.9	6,553,412	97.4	6,461,895	96.1
Limestone	1,279,195	902,331	70.5	775,266	60.6	675,147	52.8
Heath forest	7,004,188	2,930,249	41.8	2,196,159	31.4	1,624,719	23.2
Freshwater swamp	2,373,142	1,068,219	45.0	746,059	31.4	534,564	22.5
Peat swamp forest	9,417,938	6,490,437	68.9	4,961,696	52.7	3,951,151	42.0
Mangroves	2,580,630	1,653,256	64.1	1,462,689	56.7	1,279,414	49.6
Total	**74,383,159**	**52,093,104**	**70.0**	**45,100,089**	**60.6**	**40,073,538**	**53.9**

This rate of decline is uneven across the ecosystems, with freshwater swamp forest and heath forest down more than 75% of historic levels to 22.5% and 23.2%, and lowland rainforest down by more than 50% of historic levels, to 42.3%.

By total area, lowland rainforest - a critical habitat for the conservation of many unique species - is by far the most converted ecosystem type in Borneo, down from 31.18 million ha of historical extent to only 13.19 million ha in 2015. Ease of access for logging and its suitability for palm oil production and agriculture have made it one of the most endangered habitats on earth. The consequences of any further loss of biodiversity in this ecosystem, projected between 2015 and 2020 to be 10-13 million hectares, in a 'Business As Usual' (BAU) scenario, will be felt on a global scale. For example, the orangutan, the iconic species most closely associated with the tropical rainforest of Borneo has been reclassified by the International Union for Conservation of Nature (IUCN) from 'endangered' to 'critically endangered', due to destruction, degradation and fragmentation of its habitats and hunting.

The 2016 report does provide good news on some ecosystem fronts. Upland rainforest and montane forest retain 89.3% and 96.1% respectively of historical coverage. In a climate change scenario of 2°Celsius and 4°Celsius increment, these higher elevation areas could become the last refugia for species conservation.

Indeed, the area known as the Heart of Borneo in the centre of the island has fared far better than the lowlands and coastal areas. Highlighting perhaps the wisdom, forethought and relative success of the three Borneo Member Countries' 2007 historic Declaration to conserve the Heart of Borneo (HoB), an area then covering 22 million, but now 23 million hectares (234,000 km^2) in the centre of the island. Considerable work has been carried out under the HoB banner by the three Member Countries and its local and international supporters, not the least being WWF.

However, a new focus is needed, because if action is not taken, the projections in the report reveal an 'inconvenient truth' regarding the future of the island's stunning biodiversity. Without unprecedented, concerted and large scale efforts in restoration, reforestation and protection, the majority of the conservation goals set by WWF's team of international and Bornean experts, are rapidly moving out of reach (Chapter 4). According to projections in the report, if the 2005-2015 deforestation rates continue, under a BAU scenario, a further 6 million ha of forest may be deforested over the next five year period from 2015 and 2020.

As part of the analysis, the report looked at the developments and 'threats' currently facing Borneo's ecosystems and not surprising, a number of repeat offenders were identified, mostly due to forest fire, land conversion and inadequate spatial planning.

The report also provides an update on individual states, provinces and in the case of Brunei, country progress on all relevant biological indicators (section 4.3 and Appendix 1). Here, there is hope for the optimist, but encouragement also for the pessimist. Hope springs eternal in the new protected areas in Sabah, more forest to be retained in Sarawak, ongoing protection in Brunei and more watershed forest cover in Kalimantan, measures that were undertaken in 2016 and therefore outside the scope of this analysis.

Urgent attention must be paid to the large natural forest areas not allocated to be retained across the island. As stated above, it is projected that by 2020, 6 million ha

out of a still intact forest of 8 million ha could be converted arising from illegal forest conversion and expansion by stealth around many of the palm oil plantations.

Our aspiration is that the result of this regular environmental analysis would steer the authorities and stakeholders to take effective steps to address the declining state of the environment. Our greatest desire is for the private sector, which is given large concessions to extract natural resources and to establish industrial-scale plantations, to take responsibility as stewards of the environment in using the scarce natural resources wisely.

The WWF's Environmental Status of Borneo 2016 comprises a Main Report and Supplementary Report.

The detailed Main Report (this document) provides for objective and scientifically based long-term monitoring of the biodiversity on the island, detailing a comprehensive range of ecosystems and biological indicator species.

The second, published separately, forms the Supplementary Report that presents a summary of the findings of the main report along with extensive recommendations for the future sustainable management of the island.


FOREST COVER 2015
0
100
200
400 Kilometers
Legend
Rivers
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Boundaries
Forest
National
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HoB Boundaries
South China Sea
Brunei Darusalam
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Balikpapan
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Palangkaraya
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South Kalimantan
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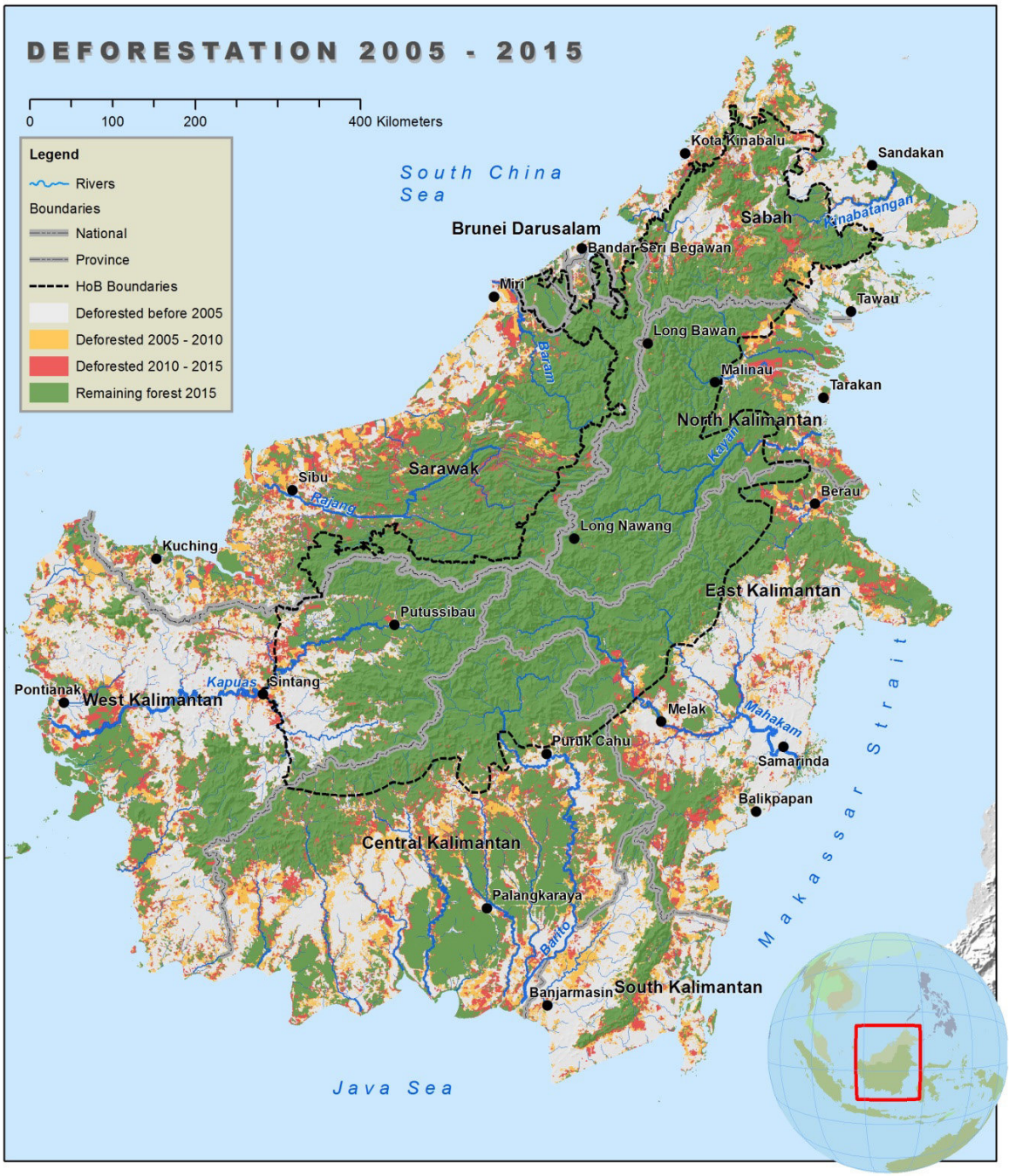
Java Sea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Province
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Deforested 2005 - 2010
Deforested 2010 - 2015
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East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Samarinda
Puruk Cahu
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

Guide to reading this report

Chapter 1: Describes the changes that occurred to the ecosystems and key species (groups) between 2005 and 2015, and offers a comparison with historical data, based on the situation during the 1920s.

Chapter 2: Analyses the current and near-future land cover related developments, some of which are considered threats to the preservation of the ecosystems.

Chapter 3: Explains the current conservation management interventions being carried out in Borneo.

Chapter 4: Projections for 2020 are then made by extrapolating the developments described in the previous chapters.

Chapter 5: Outlines the conservation status of the area designated under the Heart of Borneo (HoB) Initiative.

Chapter 6: Explains the methodology behind the research.

Chapter 7: Conclusions are drawn from an objective observation of the previous chapters

General Note:
The scale of this report represents an 'overview". As such, details are not always included, for example small areas of limestone within lowland rainforest, patches of heath forest within montane forest etc. may not be featured.

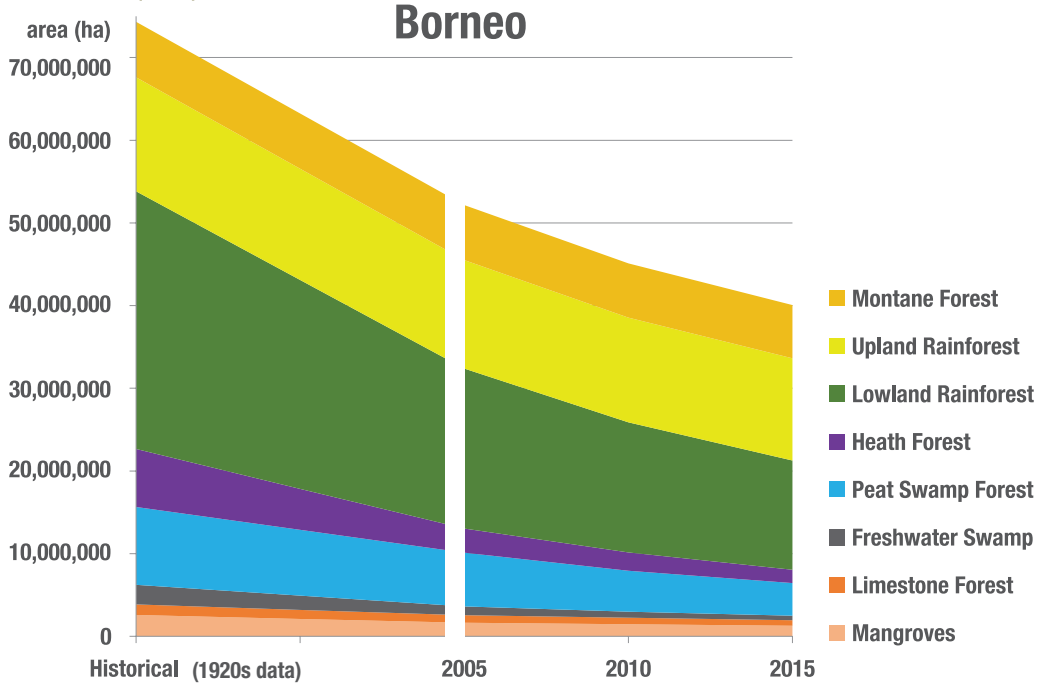
CHAPTER 1

Status of the ecosystems and key species

Most of Borneo was historically covered by forest, in eight major ecosystem types. The historical extent of these various ecosystems can be reconstructed by combining information on geomorphology and historical land use development. Large scale forest conversion throughout Borneo started in the 1950s with the advance of commercial logging and after the 1980s, with the large scale development of rubber, pulpwood and oil palm plantations.

The study presented here deals particularly with the developments between 2005 and 2015, but also looks briefly at the deforestation of the historical extent until 2005. More than 22 million ha of forest in Borneo were already converted before 2005. Deforestation continued at a high rate of 2.65% per annum between 2005 and 2015 – see later chapters for more detailed information. The largest conversions occurred in lowland rainforest ecosystems, with a loss of more than 6 million ha over the ten year period. The ecosystems with the fastest conversion rates and largest relative loss are heath forest, with 23% remaining and freshwater swamp forest, with only 22% remaining. The best preserved ecosystem is montane forest, while the second most preserved is upland rainforest with much still remaining in 2015.

Graph 1: Coverage trends of the eight main forest ecosystem types in Borneo from historical (1920) data to 2015.



Note: Land cover changes of the major ecosystems of Borneo. The graph from historical to 2005 is a simple linear trajectory, while the graph from 2005 to 2015 is a display of the analyses of this study.

Table 1: Comparison of ecosystem area 2015

Ecosystems versus Historical Extent	Area = extent (ha)	
	Historical Extent	2015
Lowland rainforest	31,180,400	13,198,700
Upland rainforest	13,820,400	12,348,000
Montane forest	6,727,300	6,461,900
Limestone forest	1,279,200	675,100
Heath forest	7,004,200	1,624,700
Freshwater swamp forest	2,373,100	534,600
Peat swamp forest	9,417,900	3,951,200
Mangroves	2,580,600	1,279,400
Total	**74,383,200**	**40,073,600**

Table 2: Terrain characteristics of ecosystems identified in this report

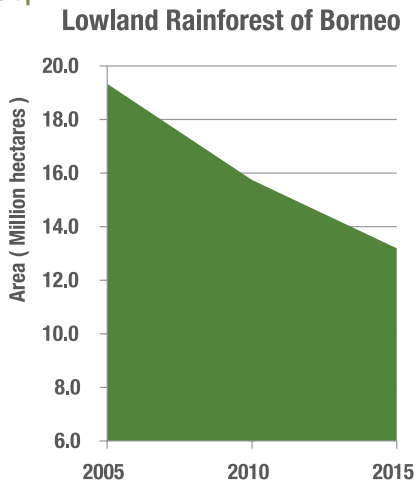
Ecosystem	Main terrain characteristics
Lowland rainforest *Note: Lowland rainforest in Borneo is in a majority of the areas of lowland Dipterocarp forest.*	Elevation range: 0 to 300 m asl; dry land, common geology and soils. *Note: WWF-Malaysia in Sabah used 500 m asl to delineate lowland rainforest, but some scientists working in Sabah keep an elevation range of up to 600 m asl. In this report, we have more narrowly defined the lowland rainforest in order to monitor the status of the real lowland rainforest in its optimum development.*
Upland rainforest (also known as hill forest)	Elevation range: 300 to 800 m asl; dry land, common geology and soils. *Note: Though some scientists working in Sabah apply a 600 to 1200 m asl elevation range. Our status report, however, deals with the whole of Borneo, and in most parts of Kalimantan the range of upland rainforest is at about 300 to 800 m asl.*
Montane forest	Elevation range: above 800 m asl (to 4000 m); dry land, common geology and soils.
Limestone forest	Karst/limestone formations, limestone soils; elevations 0 up to ± 2000 m asl.
Heath forest	Sandstone plateaus, extremely poor white soils; elevations 0 up to ± 2500 m asl.
Peat swamp forest	Soils composed of peat, terrains mostly waterlogged; majority in lowland plains, small upland peat swamps.
Freshwater swamp forest	Depressions inundated by freshwater most of the year, mineral soils; majority along rivers and lakes.
Mangrove	Coastal terrains inundated by seawater daily to a few times a month; elevations ± -5 to 5 m asl.

1.1 Lowland rainforest ecosystem

SNAPSHOT

- Historically, more than one-third of Borneo was covered by lowland rainforest (from 0 to 300 m asl).
- Lowland rainforest is the most converted ecosystem type of Borneo - by 2015, only 42% of historical lowland rainforest remained.
- The consequences of any further loss of biodiversity in the lowland rainforest will be felt on a global scale.
- A hectare of Bornean lowland rainforest may contain 180 tree species.
- Easy access of logging interests and expansion of industrial plantations have meant that despite the importance of lowland rainforest tree species for conservation, they are perhaps the most endangered habitat on earth.

Graph 2



There are only three main regions of tropical lowland rainforest in the world: in Central and South America (Amazon), in West and Central Africa (Congo), and in Southeast Asia (Indonesia, Malaysia and the Philippines). Easy access to lowland rainforest has made them the focus of logging activities, which following further degradation, often leads to full conversion to palm oil plantations or other forms of agriculture. Lowland rainforest has its optimal development at elevations below 200-300 m above sea level. The elevation range for classification used in this and the previous environmental status assessments is 0 to 300 m asl. Another range often applied is a range of 0-500 m asl.

Thus despite its importance, lowland rainforest is perhaps the most endangered habitat on earth.

The biodiversity consequences of any further loss of lowland rainforest ecosystems will be felt on a global scale.

Vegetation reaches its highest diversity in the lowlands with elevation being a key factor in determining species distribution. A hectare of Bornean lowland rainforest may contain 180 species of trees, compared to a temperate forest, where a hectare might just have ten species of trees. The tallest trees in Borneo are found in this ecosystem, reaching heights of up to 70 m and on rare exceptions up to 94 m. In most areas, they are dominated by trees of the Dipterocarpaceae family, which is why they are usually called lowland dipterocarp forest.

Borneo is the distribution centre for the Dipterocarpaceae family comprising 291 species or 75% of the family, which are dominant and important commercial timber species in Southeast Asia (Soepadmo, 1995-2014).

Table 3: Lowland rainforest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
31,180,420	19,338,952	62.0	15,740,581	50.5	13,198,688	42.3

Extent

Historically more than one-third of Borneo was covered by lowland rainforest. In 2005, 62% of the original extent remained (19 million ha). This included degraded forest. Lowland rainforest is the most often converted ecosystem type of Borneo.

Deforestation between 2005 and 2010 was high and not much lower between 2010 and 2015. In 2015, only thirteen million hectares remained, including degraded forest. This implies that from 2005 to 2015, six million hectares were deforested. This has been converted to a mixture of oil palm and pulpwood plantations and agriculture, or remains as unproductive shrubland to be converted at a future date.

Condition

The remaining lowland rainforest ecosystem areas include large tracts of logged-over forest and are not always in good condition. More than 30% of this forest is fragmented. This means that many of these forest are dissected by open areas or remain only as isolated tracts. Large stretches of uninterrupted lowland rainforest are becoming rare in Borneo. Most of the lowland rainforest has been logged over, and forest where the canopy has been completely opened can be considered as degraded.

Connectivity

Much of the remaining lowland rainforest is situated in valleys surrounded by slopes. In the more remote areas, these slopes are part of a mountainous landscape and are often still covered by upland and montane forest. It is through these forest covered slopes that the separated patches of lowland rainforest are connected.

Fragmentation of lowland rainforest is particularly high in West, Central and East Kalimantan, and Sabah and Sarawak. The largest stretches of uninterrupted lowland rainforest are in North Kalimantan, Brunei and the Arabela landscape straddling West and Central Kalimantan.

The tracts of lowland rainforest in the north of Sabah especially below 300 m asl. are rather isolated while most of the tracts in the south are connected by upland forest. In Brunei, nearly all lowland rainforest is connected through upland forest. All lowland rainforest in the interior part of Sarawak is connected by upland and montane forest, but in the coastal part is becoming isolated. The remaining lowland rainforest in the northern part of West Kalimantan is connected by upland forest, but this is often fragmented. Along the northern edges of Central Kalimantan are several isolated areas of lowland rainforest, while other edges are still connected but fragmented. Most of the central area is still connected and in better condition. Nearly all of the lowland tracts on the western side of East Kalimantan are still connected to upland forest of the interior thus providing good opportunities for genetic flows and species migration.

Description by region

Sabah: Most of the state's lowland rainforest was converted during the 1980 and 1990 decades of rapid development, with the smaller remaining patches now subject to conversion at the edges. Still relatively large areas (a total of almost 0.6 million ha) remain in central Sabah as Forest Reserves, particularly Deramakot and the popular tourist area of the Danum Valley Conservation Area.

Brunei: Most of the lowland rainforest is well preserved but conversion at the edges must be monitored to gauge the extent and speed of destruction.

Sarawak: Many of the more accessible areas were converted into plantations between 2005 and 2015 and the conversion focus has now shifted from the coastal flats to the interior lowlands. More promisingly, from a conservation perspective, are the opportunities to preserve lowland rainforest in central Sarawak and the foot slopes and valleys of the upper Rajang. The largest remaining area of lowland rainforest is in the Batang Ai National Park-Lanjak Entimau Wildlife Sanctuary complex and is relatively undisturbed.

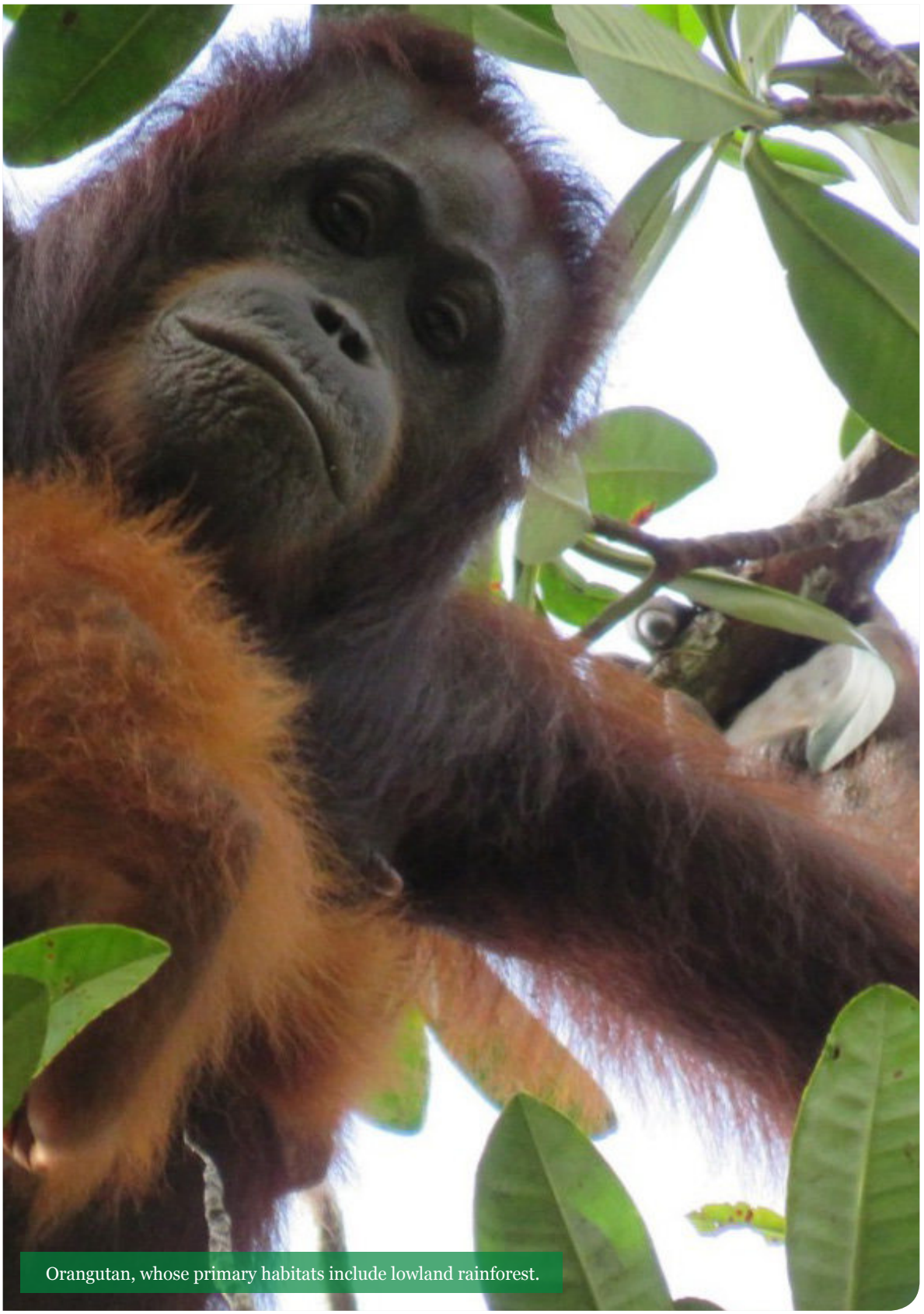
West Kalimantan: A majority of lowland rainforest in this area was converted before 2005 and much of that which had remained, disappeared in the five years from 2010 to 2015, including those areas within the HoB boundary. The only patches now remaining are in the Arabela landscape and in the valleys of mountain foot slopes. Most of the remaining lowland rainforest of West Kalimantan is in logging concessions.

Central Kalimantan: Has the largest area (a total of 3 million ha) of lowland rainforest in Borneo with extensive areas along the foot slopes and in the wide river valleys south of the Bukit Baka-Bukit Raya National Park, near the border of Central and West Kalimantan. However, many parts of these forests have been logged and some are being converted, mainly for agriculture. Large areas of lowland rainforest remain in the northern part of the province with the least accessible of these areas, boasting rainforest still in primary condition. Ongoing conversion is occurring at the southern edges, though most of the remaining lowland forest is in existing logging concessions.

South Kalimantan: The only remaining lowland rainforest in this province lies on the foot slopes of the Meratus Mountains.

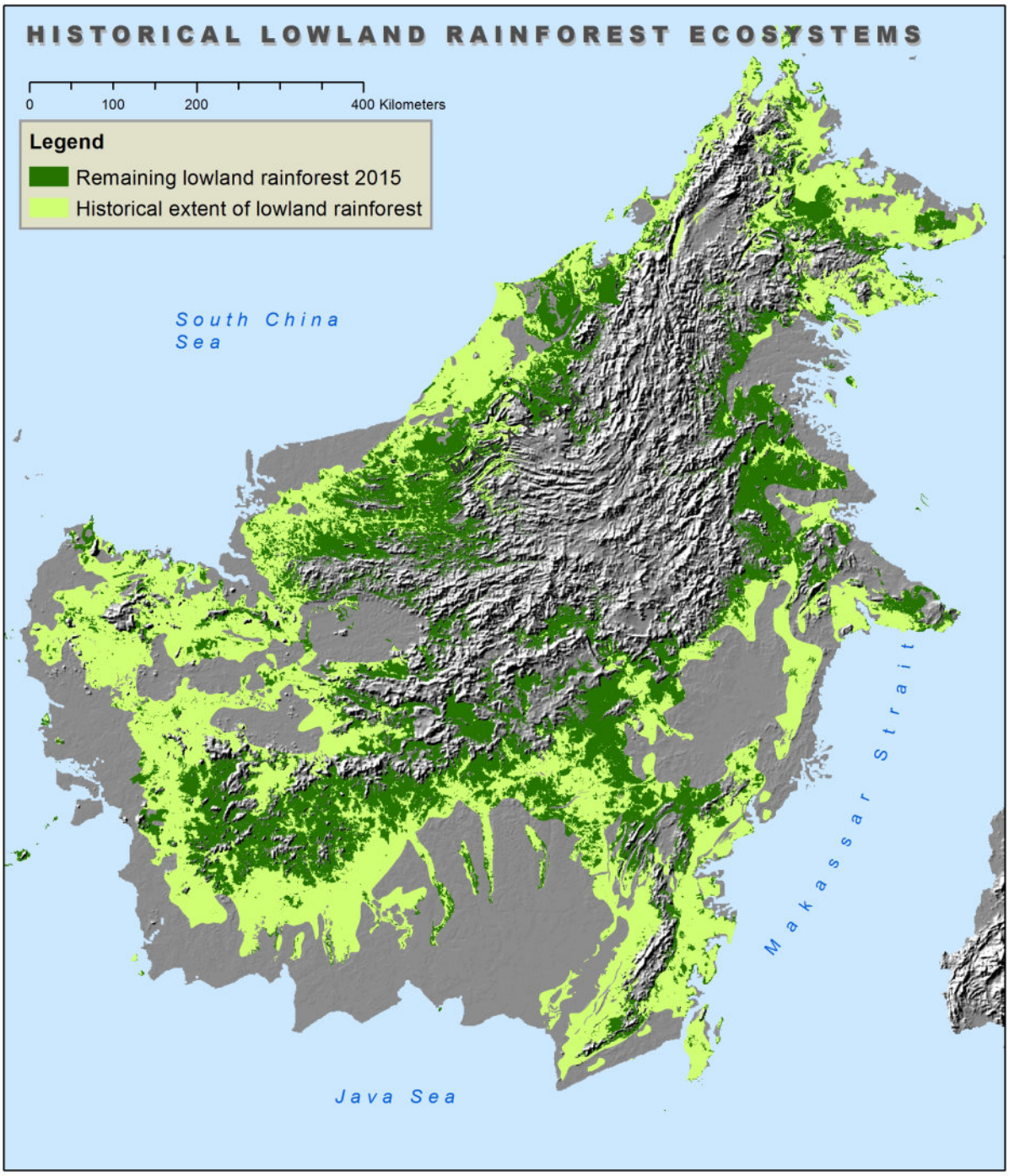
East Kalimantan: Still has vast areas (totalling 1.9 million ha) of lowland rainforest, occurring mainly in the eastern part of the HoB, in the upper Mahakam and the foot slopes of the Paser mountains. Most coastal lowland rainforest in this province was converted before 2005. In the following ten years to 2015, conversion moved further inland.

North Kalimantan: Much of this province comprises of uplands and mountains. Large stretches of good quality lowland rainforest remain in the eastern lowlands of North Kalimantan.



Orangutan, whose primary habitats include lowland rainforest.


LOWLAND RAINFOREST ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining lowland rainforest 2015
Deforested lowland rainforest 2010-2015
Deforested lowland rainforest 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Kejang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purnk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

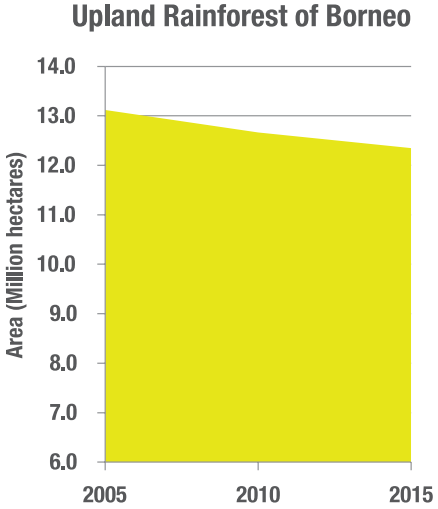

HISTORICAL LOWLAND RAINFOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining lowland rainforest 2015
Historical extent of lowland rainforest
South China Sea
Makassar Strait
Java Sea

1.2 Upland rainforest ecosystem

Snapshot

- Upland rainforest (300 to 800 m asl) represents perhaps the next best hope for conservation of Borneo wildlife.
- About one-fifth of Borneo was originally covered by upland rainforest; nearly 95% of that remained in 2005 and 12 million hectares (89%) remains in 2015.
- The deforested areas are mainly at the edges of uplands with elevations below 600 m asl.
- It is a major habitat for endangered species.
- Deforestation has been much lower than for lowland rainforest and in 2015 upland rainforest became almost as large a remaining ecosystem as lowland rainforest.

Graph 3:



Upland rainforest is between 300 and 800 m asl. The 800 m asl level is generally the elevation in Borneo where the upland forest gradually changes to montane forest. On very poor soils these changes can start as low as 600 m asl. With much of the lowland rainforest in Borneo gone, upland rainforest represents perhaps the next best hope for conservation of Borneo wildlife. Although less complex and poorer in biodiversity than lowland rainforest, it is still a major habitat for many endangered species. The climate in the uplands is cooler than in the lowlands and upland rainforest could become a refuge for species escaping the potential ravages of climate change. The largest portion of upland forest in Borneo is found in the remote interior, covering an area of almost 7.5 million hectares. Here and elsewhere in Borneo, this forest type is faring better than lowland rainforest, as the higher elevation and steeper slopes make these areas less suitable for oil palm plantation and other development. Compared with lowland rainforest, upland rainforest has lower volumes of commercial timber, but with high timber demand, logging of this forest is still highly profitable.

Extent

About one-fifth of Borneo was originally covered by upland rainforest. In 2005, almost 95% of the historical extent still existed. Deforestation has been much lower than for lowland rainforest and in 2015 upland rainforest became almost as large a remaining ecosystem as lowland rainforest.

Table 4:Upland rainforest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
13,820,382	13,118,466	94.9	12,664,227	91.6	12,347,960	89.3

Around 8% (800,000 ha) of historical upland forest cover was lost in the ten years between 2005 and 2015, leaving a little over 89% of the historical cover remaining (12 million ha) in 2015, although a large part of this is degraded. The deforested areas are mainly at the edges of uplands with elevations below 600 m asl.

Condition

More than one quarter (26%) of all upland rainforest is fragmented. This is a very large area of almost three million ha, given that most of the upland rainforest is still remaining. Most of the fragmentation has occurred around hills and lower mountains that are not directly connected to the central montane massif. However, largely due to shifting cultivation, fragmentation is also high along the lower slopes of the central mountains.

Description by Region

Sabah: Has experienced the highest conversion of upland rainforest, particularly for pulpwood plantations, with the central uplands, east of the Crocker Range, mostly converted before 2005. Further conversions for plantation development are planned.

Brunei: The upland in Brunei has had little or no conversion.

Sarawak: Has large stretches of upland rainforest in its interior. Most is under logging concession and allocated as Permanent Forest Estate by the Sarawak government. Conversion is restricted mainly to valleys and river terraces suitable for plantations, in particular the large upland rainforest in the upper Balui and Belepeh watersheds.

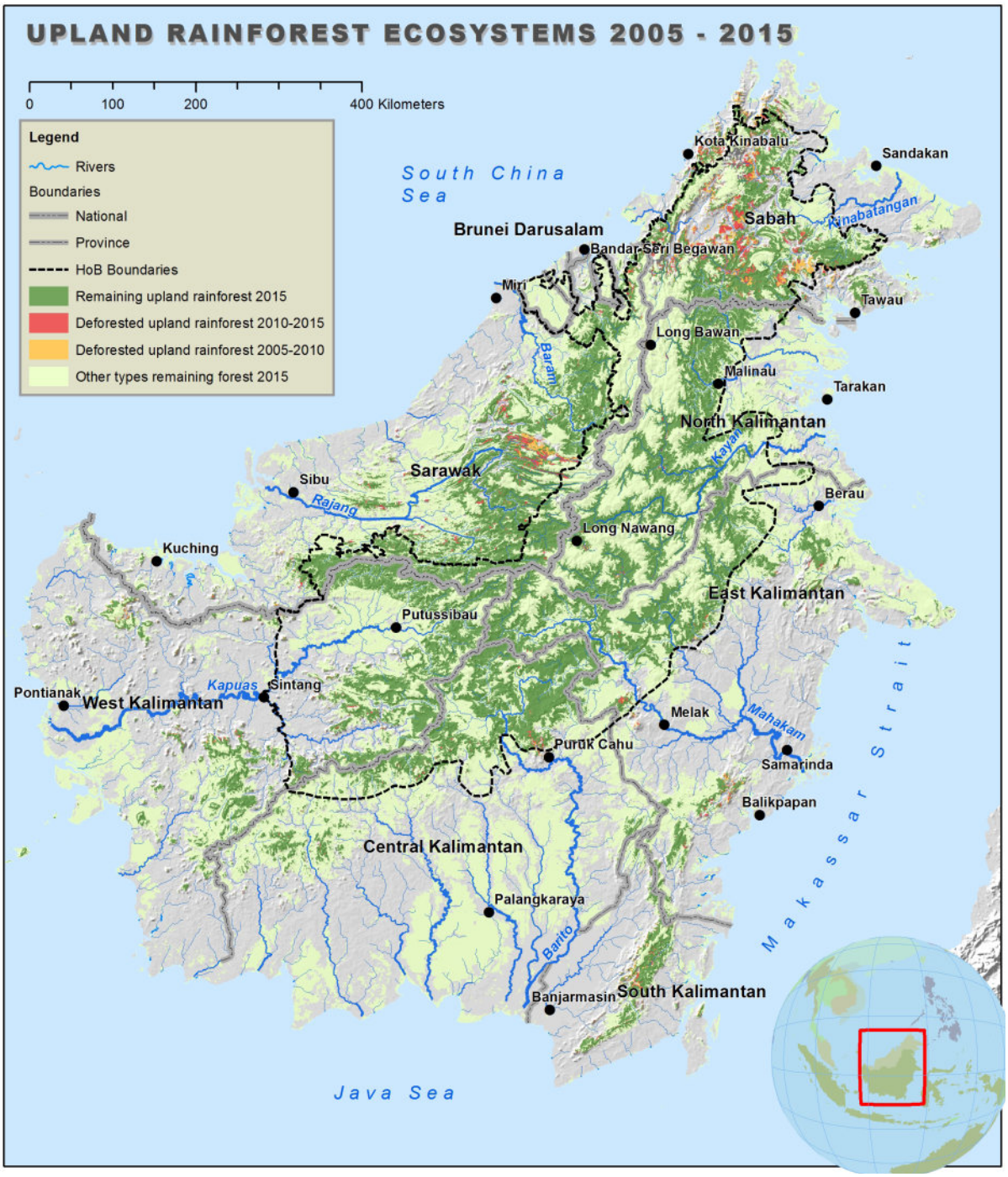
West Kalimantan: Still possesses very large (totalling 1.8 million ha) stretches of upland rainforest in the upper Kapuas and upper Melawi areas in the eastern section of the province. Here conversion has only occurred on the edges for shifting cultivation and timber plantations. Large areas of upland rainforest occurring in the western hills and mountains of the province were converted prior to 2005.

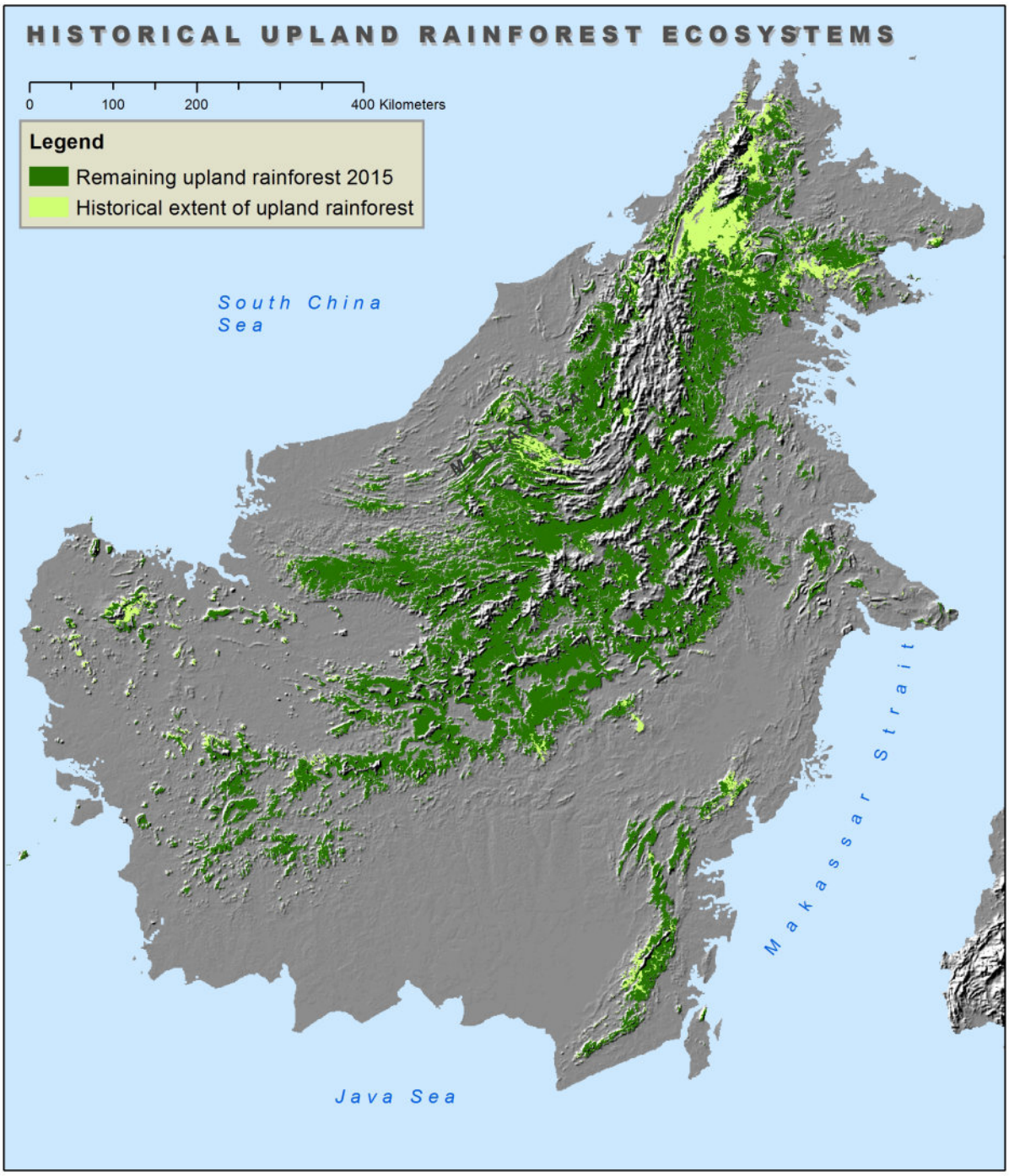
Central Kalimantan: All upland rainforest is found in the northern section of the province and the vast majority of these is still intact, with the exception in the vicinity of Puruk Cahu (where tens of thousands of hectares were converted). Overall though, only patchy conversion has taken place in the province.

South Kalimantan: Despite deforestation in past decades, the upland rainforest cover of the Meratus Mountains is still remarkably intact.

East Kalimantan: Upland rainforest in the more remote locations of East Kalimantan are often still only slightly disturbed. However, there is patchy conversion along the Mahakam and its tributaries, mainly for shifting cultivation. Small scale, but ongoing conversion also exists on the slopes of the Paser Mountains.

North Kalimantan: Patchy conversion exists along the Bahau and Kayan rivers mainly for shifting cultivation.


UPLAND RAINFOREST ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining upland rainforest 2015
Deforested upland rainforest 2010-2015
Deforested upland rainforest 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

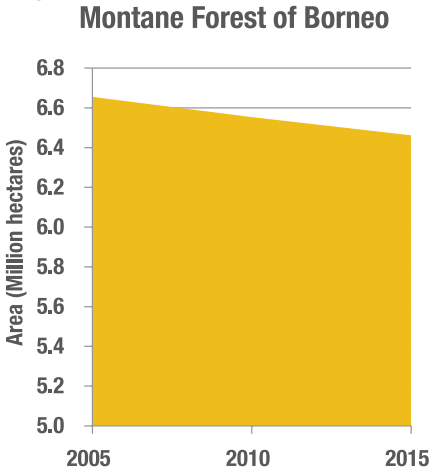

HISTORICAL UPLAND RAINFOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining upland rainforest 2015
Historical extent of upland rainforest
South China Sea
Makassar Strait
Java Sea

1.3 Montane forest ecosystem

Snapshot

- Montane forest is the best preserved ecosystem in Borneo.
- Montane forest contains many unique species, including beautiful orchids and the most spectacular pitcher plant species in the world (Nepenthes).
- About 20% of all montane forest in Borneo appears to be fragmented.
- The protection of montane forest in Borneo will be of major importance to the continuation of healthy watershed functions.
- Between 2005 and 2015, forest cover dropped slightly from almost 99% historical cover to 96% or 6.4 million hectares. This was evidenced mostly on the outer mountain ranges, but also in core areas and particularly in Sarawak.

Graph 4:



Montane forest is found in all the higher elevation ranges between 800 m and 4000 m asl of Borneo. Almost one-fifth of the remaining forest of Borneo is montane. In the Indonesian part of Borneo, this forest is often remote and relatively undisturbed and can take several days of travelling to reach. A journey well worth making, as this forest contains many unique species, including beautiful orchids and the most spectacular pitcher plant species in the world (Nephentes).

Montane ecosystems are usually sub-divided into lower montane, upper montane and sub-alpine zones. All zones were grouped together for the sake of measuring the changes in a practical way. The upper montane and sub-alpine zones comprise about 10% of the ecosystem and here disturbances were almost zero.

Extent

Borneo's montane forest covers around 6.4 million hectares of the island and is predominantly found in the central mountain spine of the interior of Borneo. The montane areas of Borneo are generally in very good condition, with little disturbance and with less than 4% of the historical extent converted.

In 2005, this ecosystem was almost intact with 98.9% of the historical extent remaining. By 2015, the percentage had slightly declined to 96% (6.4 million ha) with more than 200,000 ha lost - mostly at the outer mountain ranges, but also in core areas, particularly in Sarawak.

Table 5: Montane forest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
6,727,267	6,655,131	98.9	6,553,412	97.4	6,461,895	96.1

Condition

About 20% of all montane forest on Borneo appears to be fragmented, which is much higher than expected. There may be two factors affecting this. Firstly, shifting cultivation carried out by communities in the highlands. Secondly, there may be technical issues in the analysis with the high impact of shadows to the spectral reflections of the satellite images.

All in all, the montane ecosystem is still the best preserved ecosystem in Borneo.

This ecosystem can be considered the least threatened within Borneo. However, small-scale conversion needs to be monitored, not only for species conservation but also to avoid erosion, prone to occur in this fragile ecosystem. The protection of montane forest in Borneo will be of major importance to the continuation of healthy watershed functions.

Description by Region

Sabah: The largest conversions of montane forest are on the slopes of Mt Kinabalu, the Crocker Range and upper Padas, where vegetable gardens prevail. Agriculture in the mountains of Sabah is much more prevalent than elsewhere in Borneo because its mountains are taller than in the other regions and its climate is cooler, supporting temperate-vegetable cultivation.

Brunei: The only montane forest in Brunei is found in the uppermost sections of the Temburong district and it is in very good condition.

Sarawak: The development of hydropower dams in Sarawak contributes to fragmentation and loss of forests, for example, the montane forest, where their reservoirs inundate forests or where areas are cleared for the dam and its associated facilities. There is also conversion of large areas of montane forest in the upper Sungai Danum into monoculture plantations.

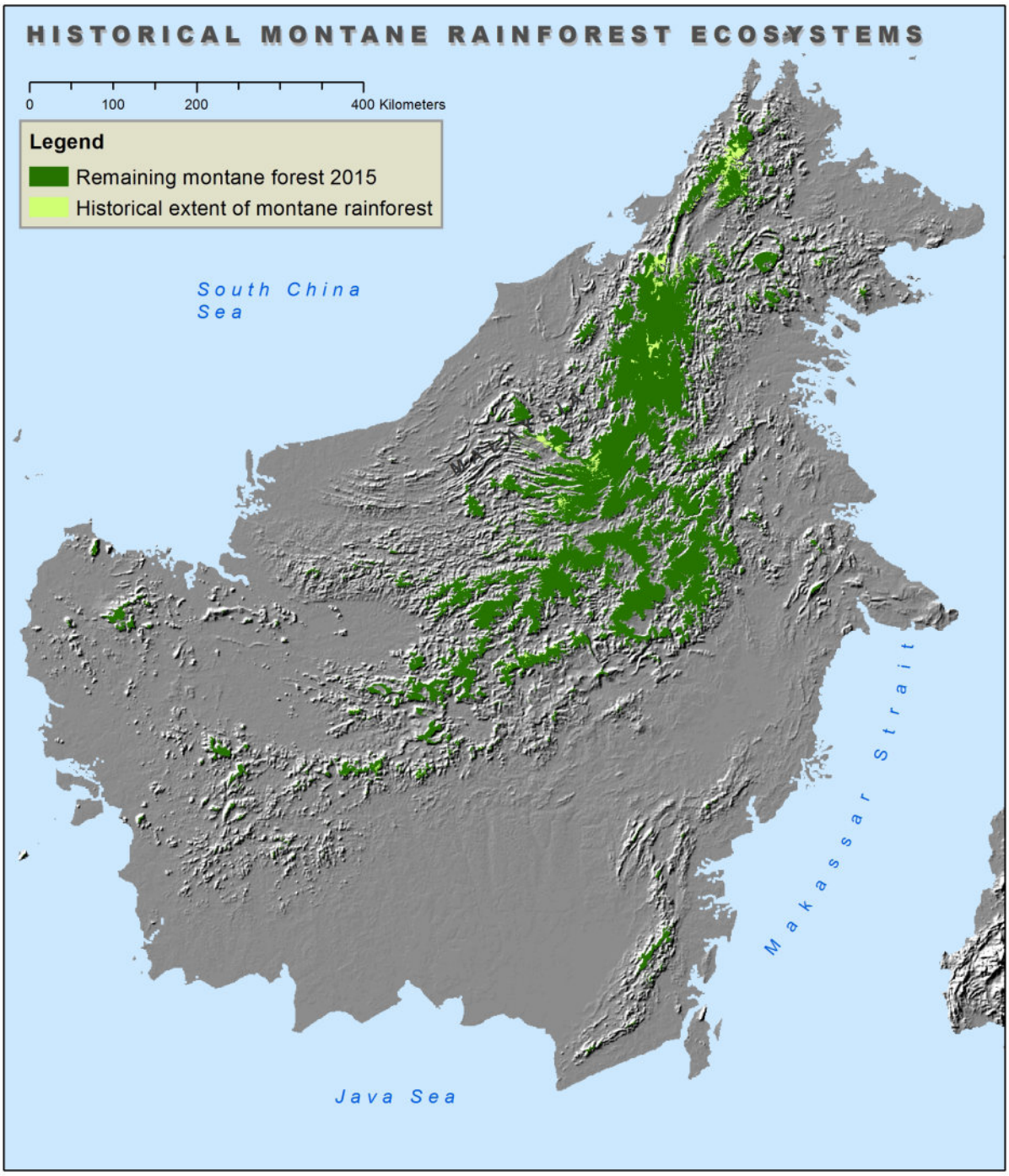
West Kalimantan: Relatively little conversion has occurred, but where it has, it is largely in the isolated mountains in the west of the province and the mountains of the central spine in the east.

South Kalimantan: The Meratus Mountains are completely undisturbed at higher elevations.

East Kalimantan: Very little conversion across the province.

North Kalimantan: Minor conversion at the edges of the forest area due largely to shifting cultivation practices of local communities.


MONTANE FOREST ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining montane forest 2015
Deforested montane forest 2010-2015
Deforested montane forest 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

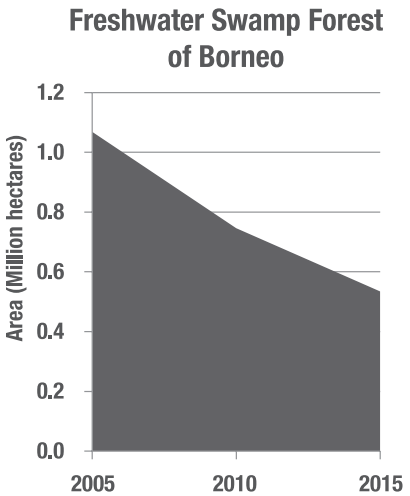

HISTORICAL MONTANE RAINFOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining montane forest 2015
Historical extent of montane rainforest
South China Sea
Makassar Strait
Java Sea

1.4 Freshwater swamp ecosystem

Snapshot

- Freshwater swamp forest is a major habitat for wetland birds, amphibian and reptile species and the proboscis monkey.
- In recent years, this forest type has disappeared at an alarming rate, to the extent that it is now critically endangered.
- Almost half (45%) of the original area of freshwater swamp forest was still present in 2005. By 2015, this had dramatically fallen to 22%.
- Biodiversity is high and many wetland species have freshwater swamps as their sole habitat.
- Great sunsets and easy boat access, could make freshwater swamp locations a great magnet for tourists.

Graph 5:



Freshwater swamp forest is a major habitat for wetland birds and the ever engaging proboscis monkey - most easily identifiable because of its unusually large nose. This ecosystem is also extremely rich in diversity of amphibian and reptile species, many of them endemic to Borneo. These factors, coupled with great sunsets and easy boat access, could make freshwater swamp locations a great magnet for tourists. Biodiversity is high and many wetland species have freshwater swamps as their sole habitat. Borneo has many more aquatic ecosystems but these are not covered in this report due to differences of scale and methodology.

Extent

In recent years, freshwater swamp forest in Borneo has disappeared at an alarming rate - to the extent that this ecosystem is now critically endangered. In high demand for agriculture because of fertile soils and often easily accessed, large areas of freshwater swamp forest are now only found in Brunei and West Kalimantan, though smaller areas are also present along major rivers throughout Borneo.

The historical total area of freshwater swamp forest in Borneo amounted to more than 2 million ha, but conversion of these areas already started centuries ago. This is because freshwater swamp forest, once drained, provides excellent fertile soils for agriculture and, many locations are easily accessed from the rivers.

Almost half (45%) of the original area of freshwater swamp forest was still present in 2005. A strong decline occurred between 2005 and 2010, when more than 300,000 ha were converted. Another 211,495 ha were converted between 2010 and 2015, to the extent that only 22.5% of freshwater swamp forests remain.

Table 6: Freshwater swamp forest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
2,373,142	1,068,219	45.0	746,059	31.4	534,564	22.5

Condition

The largest interior freshwater swamp forest is in Danau Sentarum National Park and its surroundings in West Kalimantan. Despite this area being protected, there is evidence from satellite imagery of conversion occurring. The soils of freshwater swamps are often extremely rich in nutrients and composition can be quite different from one area with the next. Indeed, small riparian freshwater swamps throughout Borneo are often different from each other, therefore it is not sufficient for biodiversity conservation of this ecosystem to rely on the preservation of swamps in one country, state or province of Borneo.

Description by Region

Sabah: Conversion of the larger areas of freshwater swamp forest in Sabah occurred between 2005 and 2010. While the remaining areas are now better protected, conversion of the smaller freshwater swamp forest areas along the Kinabatangan is still of great concern.

Brunei: The largest stretches of freshwater swamp forest in Borneo are found in Brunei. The Brunei Government is setting a good example in protecting these areas, though conversion on the fringes still needs to be controlled.

Sarawak: Large freshwater swamp forest is almost non-existent in Sarawak. Some smaller freshwater swamp forest areas (too small to detect by satellite) may still exist along rivers, but these will provide negligible habitat value.

West Kalimantan: With a dramatic rate of conversion during the past decade, most of the coastal freshwater swamp forest has gone. On the interior of the province, more freshwater swamp areas are still preserved, but conversion is still apparent at the edges.

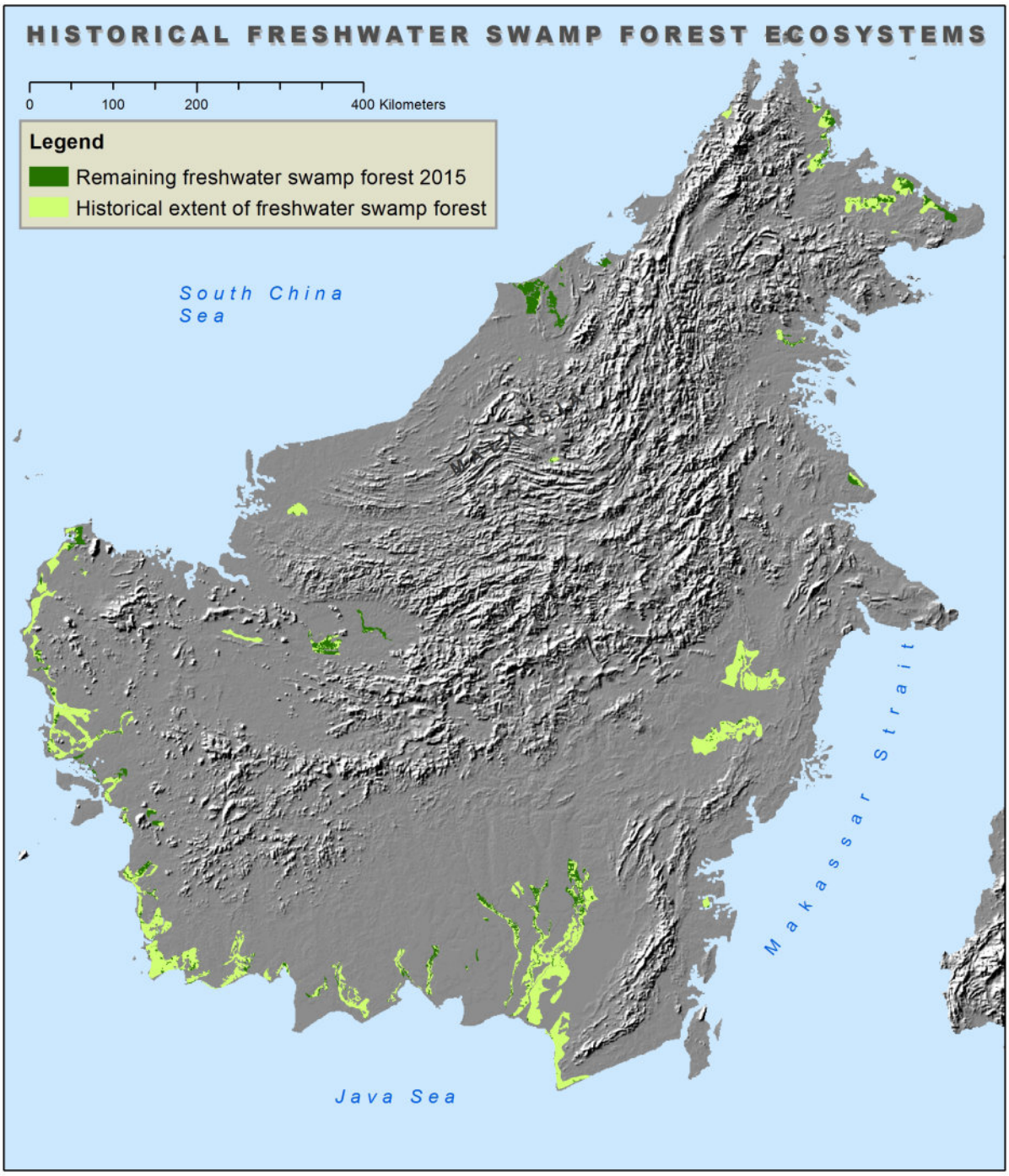
Central Kalimantan: Almost all freshwater swamp forest along the Barito River was converted between 2005 and 2010. There are still small areas in the northern section of the province which are worth protecting.

South Kalimantan: All examples are extinct, with the last remaining area converted between 2005 and 2015.

East Kalimantan: The freshwater swamp forest of East Kalimantan is nearly extinct, with most of it drained and converted in the past decade, mainly for plantations. The last remaining pockets of this ecosystem lay in the vicinity of Mahakam lakes.

North Kalimantan: Freshwater swamp forest in the north of the province is rapidly disappearing from 31,000 ha in 2005 to 16,000 ha in 2015 and in the south, encroaching conversion is easily observed at forest edges.


FRESHWATER SWAMP FOREST ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining freshwater swamp forest 2015
Deforested freshwater swamp forest 2010-2015
Deforested freshwater swamp forest 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Kapuas
Sintang
Pontianak
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

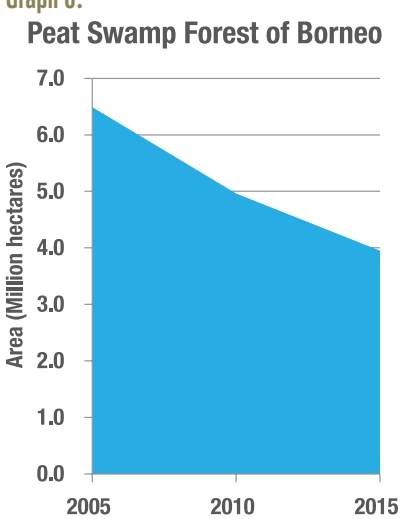

HISTORICAL FRESHWATER SWAMP FOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining freshwater swamp forest 2015
Historical extent of freshwater swamp forest
South China Sea
Makassar Strait
Java Sea

1.5 Peat swamp forest ecosystem

Snapshot

- Peat swamp forest is a major ecosystem in Borneo.
- The peat swamp forest ecosystem is so vitally important as a carbon sink and biodiversity stronghold, it must be a conservation priority to protect as much of that remaining as possible.
- Peat swamp forest is a major habitat for Borneo's unique and endangered proboscis monkey and more than 200 species of bird have been recorded in this ecosystem in Kalimantan alone.
- Large areas across Borneo were converted before 2005, with doubtful success in terms of agricultural production. Pressure for conversion remains, but there are still significant tracts that can still be preserved.

Graph 6:



Peat swamp forest is a major ecosystem in Borneo and is the defining wide landscape in West and Central Kalimantan. Formed in areas where peat accumulation has occurred for thousands of years, this forest type is home to spectacular wildlife including: orangutan, gibbon and the critically endangered freshwater crocodile. It is a major habitat for Borneo's unique and endangered proboscis monkey and more than 200 species of bird have been recorded in this ecosystem in Kalimantan alone.

Species composition and the vegetation structure of the Bornean interior peat swamps is unique and incomparable to the coastal peat swamps. Peat swamp forest is also a major carbon sink. Past efforts at conversion of peat forest to arable land have been the source of major pollution and CO^2 emissions through 'out of control' clearing fires. Large areas across Borneo were converted before 2005, with mixed success in terms of agricultural production (Wijedasa et al, 2016). Denial of long-term issues with agriculture on tropical peatlands will have devastating consequences.

Pressure for conversion remains, but there are still significant tracts that can still be preserved.

The peat swamp forest ecosystem is so vitally important as a carbon sink and biodiversity stronghold, it must be a conservation priority to protect as much of what remains as possible.

Extent

Historically, almost 10 million ha of peat swamp forest existed. Until the early 1990s, most peat swamps remained virtually untouched, as the land was inaccessible and unsuitable for small-scale agriculture.

Table 7: Peat swamp forest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
9,417,938	6,490,437	68.9	4,961,696	52.7	3,951,151	42.0

Since then, logging has been introduced, pursuing valuable timber such as Ramin (*Gonystylus spp.*), while improved drainage has made it possible to develop plantations. Drainage, however, increased the incidence and severity of forest fires, which once started can often burn for weeks underground. As a result during the past twenty-five years, peat swamp forest has undergone a high rate of deforestation, from 69% in 2005 to only 42% of its historical extent remaining in 2015.

Condition

Almost 40% of all remaining peat swamp forest is fragmented. Some of this is natural fragmentation as peat swamps often have stretches of open water and all but permanently inundated terrains with only herbaceous vegetation. The greater portion of this fragmentation is, however, not natural and is caused by fires and activities such as illegal logging and small scale agriculture.

Description by region

Sabah: The only large area (20,000 ha) is found around lower Padas (Klias Peninsular in Sabah) though this has been mostly converted.

Brunei: There is less that 500 hectares of peat swamp forest in Brunei.

Sarawak: During the past decade, much peat swamp forest in the state has been converted to produce arable land (Lahiru S. Wijedasa, 2016). Denial of long-term issues with agriculture on tropical peatlands will have devastating consequences). The largest remaining peat swamp forest now occurs east of Kuching, in a partially protected area called Sedilu-Sebuyau-Lingga, which also contains populations of orangutan, and the Maludam National Park.

West Kalimantan: In the Upper Kapuas/Danau Sentarum and on the west coast, peat swamp forest was quite well preserved until 2010, after which considerable conversion has occurred, particularly in the more accessible sites. At present, there still exists sufficient peat swamp forest with sufficient biodiversity and water balance to support a sustainable ecosystem.

Central Kalimantan: The largest areas of peat swamp forest in Borneo are in Central Kalimantan. However, only in Sebangau and Tanjung Puting National Parks are they protected. Much of the unprotected peat swamp forest is already being converted for plantations. Whilst conversion from the edges inward appears to be small-scale, it is continuous and each year raises the danger of peat fires.

South Kalimantan: This ecosystem is almost extinct in this province.

East Kalimantan: Most of the smaller areas of peat swamp forest that have been easy to covert have been developed, whilst the larger areas, mainly around the Mahakam lakes, which have complicated drainage and thus harder to convert, are still intact.

North Kalimantan: Large stretches of peat swamp forest in the Northern coastal areas around the Sebuku-Sembakung-Sesayap rivers have been developed in the past 5 years.


PEAT SWAMP ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining Peat Swamp Forest 2015
Deforested peat swamp forest 2010-2015
Deforested peat swamp forest 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

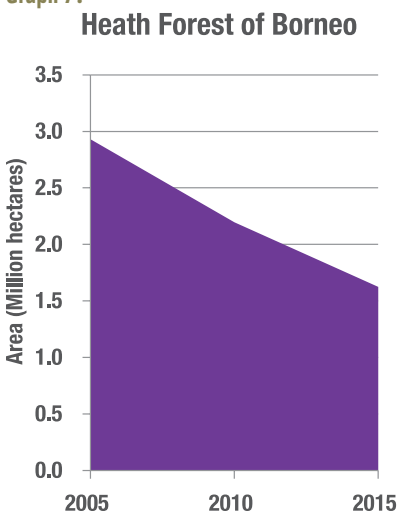

HISTORICAL PEAT SWAMP FOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining Peat Swamp Forest 2015
Historical extent of peat swamp forest
South China Sea
Makassar Strait
Java Sea

1.6 Heath forest ecosystem

Snapshot

- Heath forest is a unique ecosystem that develops on soils that are extremely poor in nutrients.
- Borneo has the widest variety of heath forest in Asia.
- Historically, about 10% of Borneo was covered with heath forest, by 2015 this had been reduced to around 2%.
- Heath forest ecosystem soils are so poor, oil palm plantation conversion on these soils is said to be like hydroculture - producing oil palms that live only on fertilizer and rain.
- The understory of heath forest is often filled with remarkable plant species such as pitcher plants and orchids.

Graph 7:



Heath forest is a unique ecosystem that develops on soils that are extremely poor in nutrients. Whilst not common on a global scale, Borneo has the richest variety of heath forest in Asia and one of the easiest ways to see it is to visit the oldest national park in Sarawak, Bako.

Heath forest consists of dense thickets of small trees with leathery leaves and its understory is often filled with remarkable plant species such as pitcher plants and ground and epiphytic orchids.

Due to the poor soil conditions upon which this ecosystem is formed, once degraded, heath forest may never recover completely, but remain as shrublands for centuries. If disturbances continue, then former heath forest can become almost completely devoid of vegetation, leaving large tracts of exposed white sands. Developers converting this land for arable purposes often find the costs of fertilizer make any form of agricultural production uneconomic. Heath forest ecosystem soils are so poor, oil palm plantation conversion on these soils is said to be like hydroculture - producing oil palms that live only on fertilizer and rain!

Extent

Historically about 10% of Borneo was covered with heath forest. Until three decades ago there were large stretches, hundreds of kilometers wide of heath forest in Borneo, particularly in Central Kalimantan. Many of the large areas had already gone or been reduced in size by 2005, with just under 42% left of the original extent. Between 2005 and 2015 this was further reduced to 23% of the historical extent with much of the land becoming unproductive shrubland.

Table 8: Heath forest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
7,004,188	2,930,249	41.8	2,196,159	31.4	1,624,719	23.2

Condition

More than 60% of the remaining heath forest ecosystem is highly degraded. Logging of a relatively low volume of timber has already had a large impact on this fragile ecosystem, leaving many open spots. The impacts of forest fires would be permanent and the degraded area cannot completely recover into heath forest again.

Description by region

Sabah: The only large areas of heath forest lie in the interior of Sabah where they are found on isolated sandstone plateaus and cuesta mountains. All the most accessible areas have been converted during the past decade and Sabah is in danger of losing its remaining heath forest if no conservation measures are put in place.

Brunei: The heath forest of Brunei is too small to be mapped at the scale used in the overview report.

Sarawak: Until around a decade ago, the largest area of heath forest (in the Usun Apau plateau in the upper Rajang area) was almost undisturbed. However, in recent years, many conversion patches have started to emerge.

West Kalimantan: The province's largest areas of heath forest are protected in the Gunung Palung and Danau Sentarum National Parks. However, small scale conversion is apparent in the southern section of Danau Sentarum. All other heath forest in the province is highly threatened, if not already converted in the past decade.

Central Kalimantan: Large areas in this province were converted between 2005 and 2010, mainly for oil palm. The practice slowed after 2010, most likely due to the realization that growing oil palm on heath forest soils required very high levels of fertilizer. Large areas of heath forest still exist in the central part of the province due to the prevailing sandstone plateaus.

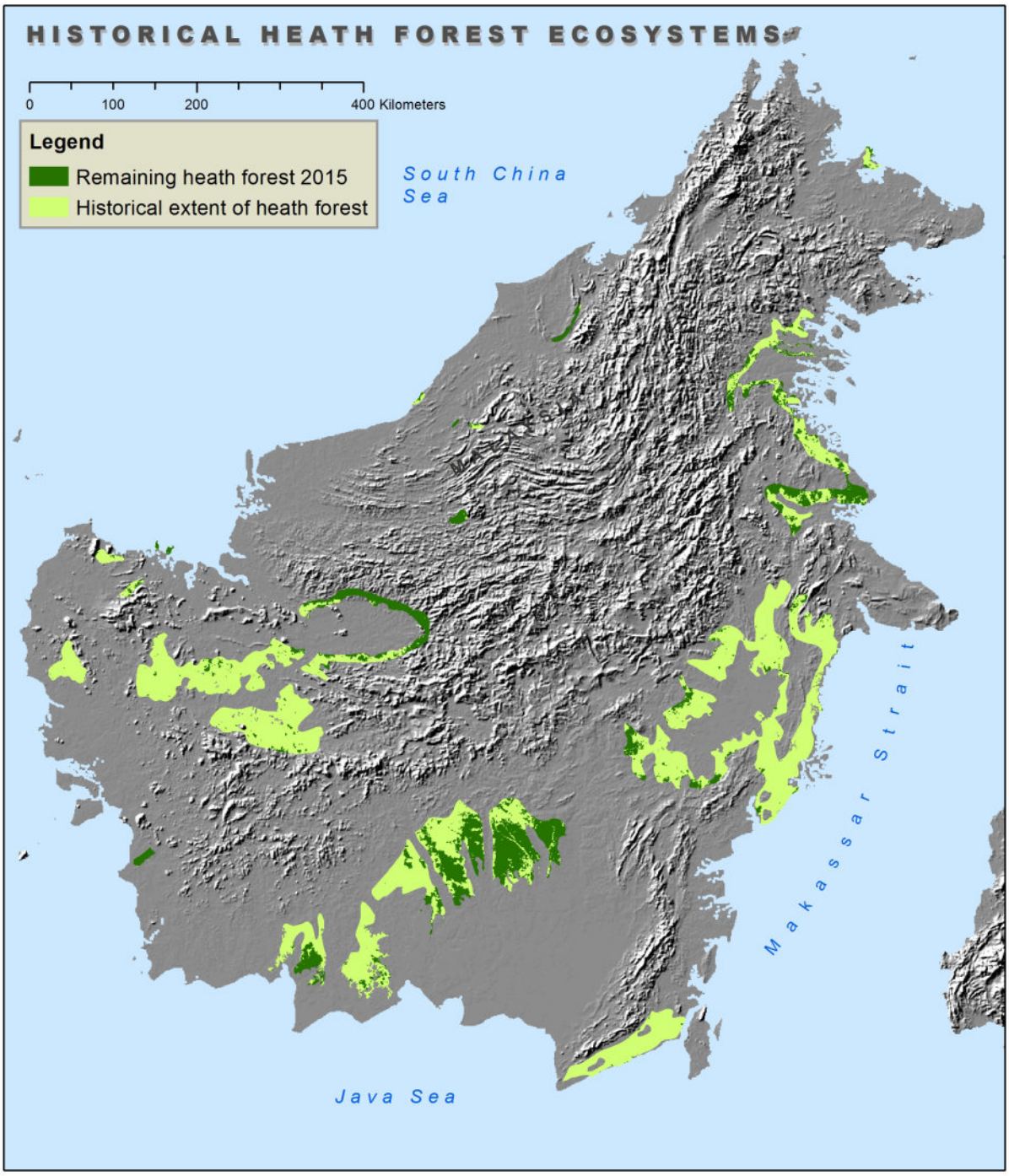
South Kalimantan: Heath forest is extinct in this province.

North Kalimantan: Originally boasting large areas of heath forest on the plateaus behind the coastal plains, this province has suffered dramatic conversion in the past decade. Much of this was for the development of plantations, but other conversion was incidental and unintentional via forest fires and over-collection of firewood and timber.

Notes to map (page 50)

Scattered throughout Borneo are many small tracts of heath forest, often within areas of common lowland, upland or montane forest. These could not be separately mapped due to the scale and resolution of the satellite images.


HEATH FOREST ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining heath forest 2015
Deforested heath forest 2010-2015
Deforested heath forest 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Puruk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

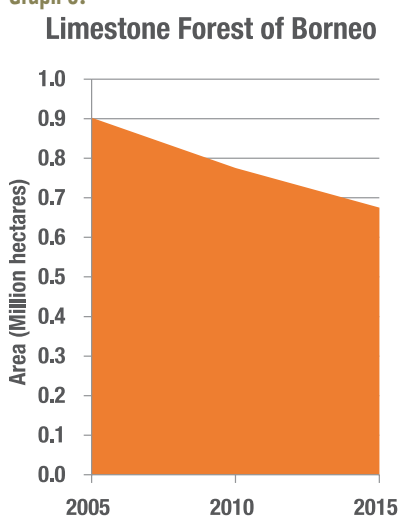

HISTORICAL HEATH FOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining heath forest 2015
Historical extent of heath forest
South China Sea
Makassar Strait
Java Sea

1.7 Limestone forest ecosystem

Snapshot

- Caves within the limestone forest ecosystem are used as nesting sites by the *Collocalia spp*. swiftlets which produce edible nests that fetch very high prices on international markets.
- The limestone habitats in Borneo are known for the high number of endemic species, particularly of invertebrates and lower plants.
- In 2005, more than 70% of the historical extent remained, but by 2015 this had been reduced to 52%.
- Deforestation of limestone forest is almost irreversible, leaving no second chance for this ecosystem, once development begins.

Graph 8:



Smaller limestone formations and outcrops occur scattered throughout Borneo, often in the form of ridges or small hills and even in high upstream areas surrounded by mountains. The ancient coral reef origin of these formations illustrates the complicated geological history of Borneo.

Limestone formations often have remarkable shapes evolved through ages of erosion: strange peaks, sharp ridges, high cliffs and escarpments and the irregular drainage of these locations frequently create waterfalls. Caves within limestone forest ecosystems are used as nesting sites by the *Collocalia spp*. swiftlets which produce edible nests that fetch very high prices on international markets. Even the most remote caves with reasonably large numbers of birds are exploited for this business.

The limestone habitats in Borneo are known for the high number of endemic species, particularly of invertebrates and lower plants. Many of the limestone areas, particulary inside the caves also have high cultural significance containing pre-historical artifacts. Up until the 1960s, small caves were used for burial sites by several Dayak ethnic groups.

The smaller limestone formations on Borneo could not be mapped, but are generally not threatened by conversion due to their remoteness. One of the largest and definitely the best known limestone forest areas is in the Gunung Mulu National Park in Sarawak. The limestone forest of the Mulu area in Sarawak is well preserved, not in the least because of income generated from visitors who want to enjoy the natural beauty. The biggest limestone area in Southeast Asia is in the Sangkulirang peninsula (East Kalimantan) but protection of this unique ecosystem is not yet fully developed.

Table 9: Limestone forest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
1,279,195	902,331	70.5	775,266	60.6	675,147	52.8

It is surprising that the large limestone forest north of Lahad Datu, in the east of Sabah, was converted to agriculture before opportunities for eco-tourism could be explored.

Limestone ecosystems are very sensitive to disturbances because their shallow soils are easily washed away once the plant roots that are keeping it together are removed. Direct conversion of limestone forest is generally not a major threat, as terrains are often too steep or have too many holes, and the soils are usually not suitable for agriculture. However, indirect deforestation is common, often by people working in bird nest caves or nearby villages, collecting timber and firewood. Local fires can also cause almost irreversible damage. Since most of these habitats are small, it is important to keep conversion under control.

The largest limestone areas of Borneo are in East Kalimantan (Sangkulirang) and Sarawak (Mulu). Limestone areas are not suitable for agriculture, but are often used for other purposes, the most radical of which is mining of the limestone itself. Caves in limestone areas are commercially exploited for edible bird nests. Limestone areas can become very dry in extended seasons without rainfall, and are then susceptible to fires.

Extent

In 2005, 70% of the historical extent remained. This was reduced to 52% by 2015. This was partly caused by forest fires as damage by fires is often irreversible in limestone ecosystems.

Condition

A large portion of 34% of the remaining limestone ecosystem is fragmented. This fragile ecosystem is very sensitive to disturbances, particularly fires. Deforestation of limestone forest is almost irreversible, leaving no second chance for this ecosystem, once development begins.

Description by region

Sabah: The only large limestone forest areas are in the vicinity of Madai caves in Lahad Datu and Gomantong caves in the lower Kinabatangan. Most conversion occurred between 2005 and 2010, after which it was well-preserved.

Brunei: No large scale area of limestone forest in Brunei.

Sarawak: Contains the famous limestone forest in the world heritage listed Gunung Mulu National Park, including the adjacent Gunung Buda National Park and the world heritage nominated, Niah caves in the Niah National Park. Despite its fame, there is evidence of some deforestation around Mulu National Park.

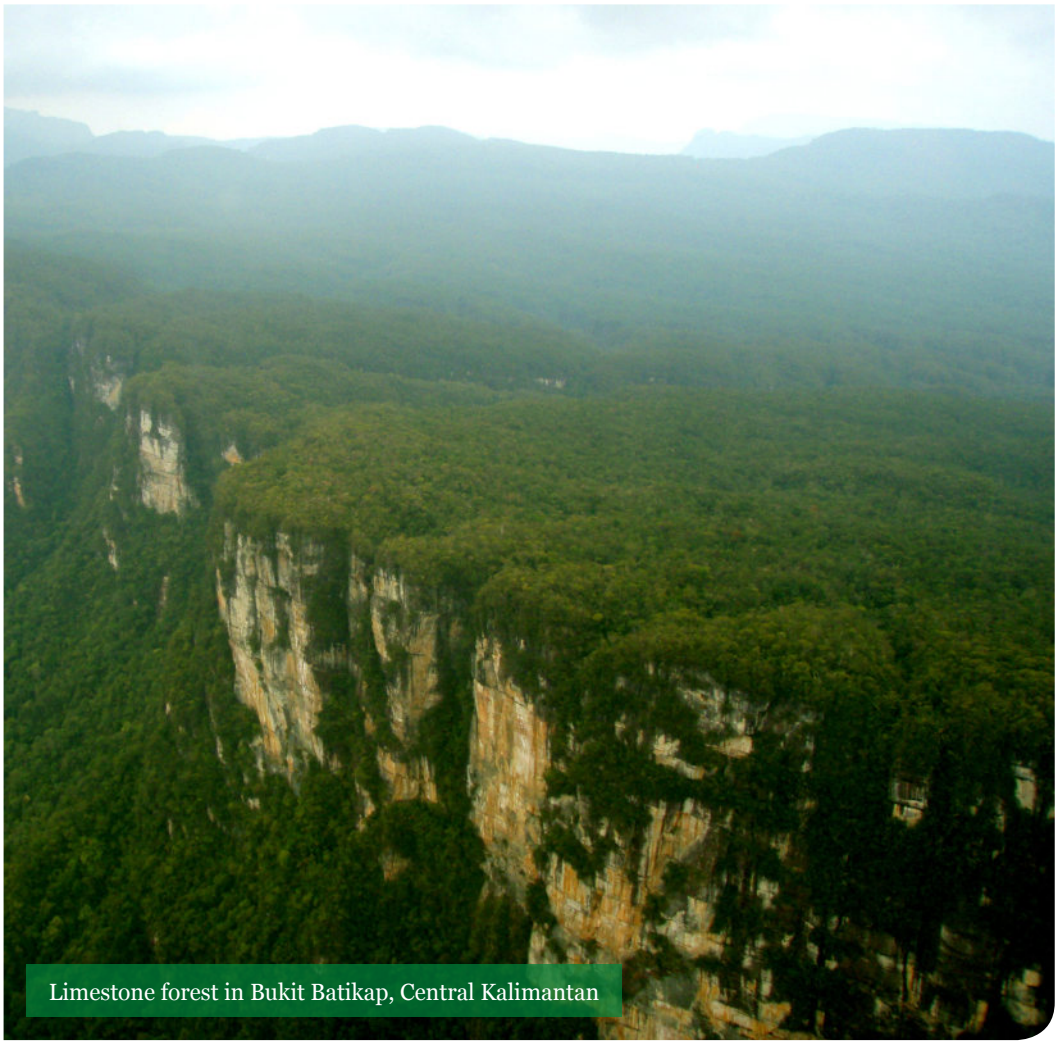
West Kalimantan: Has large limestone ridges in the interior of the province which are largely in good condition.

Central Kalimantan: There are some conversion spots in the northern part of the province, but generally forest cover around the caves is not disturbed due to the lucrative bird's nest business.

South Kalimantan: Limestone forest on the southern slopes of the Gunung Lumut massive has survived with only limited conversion.

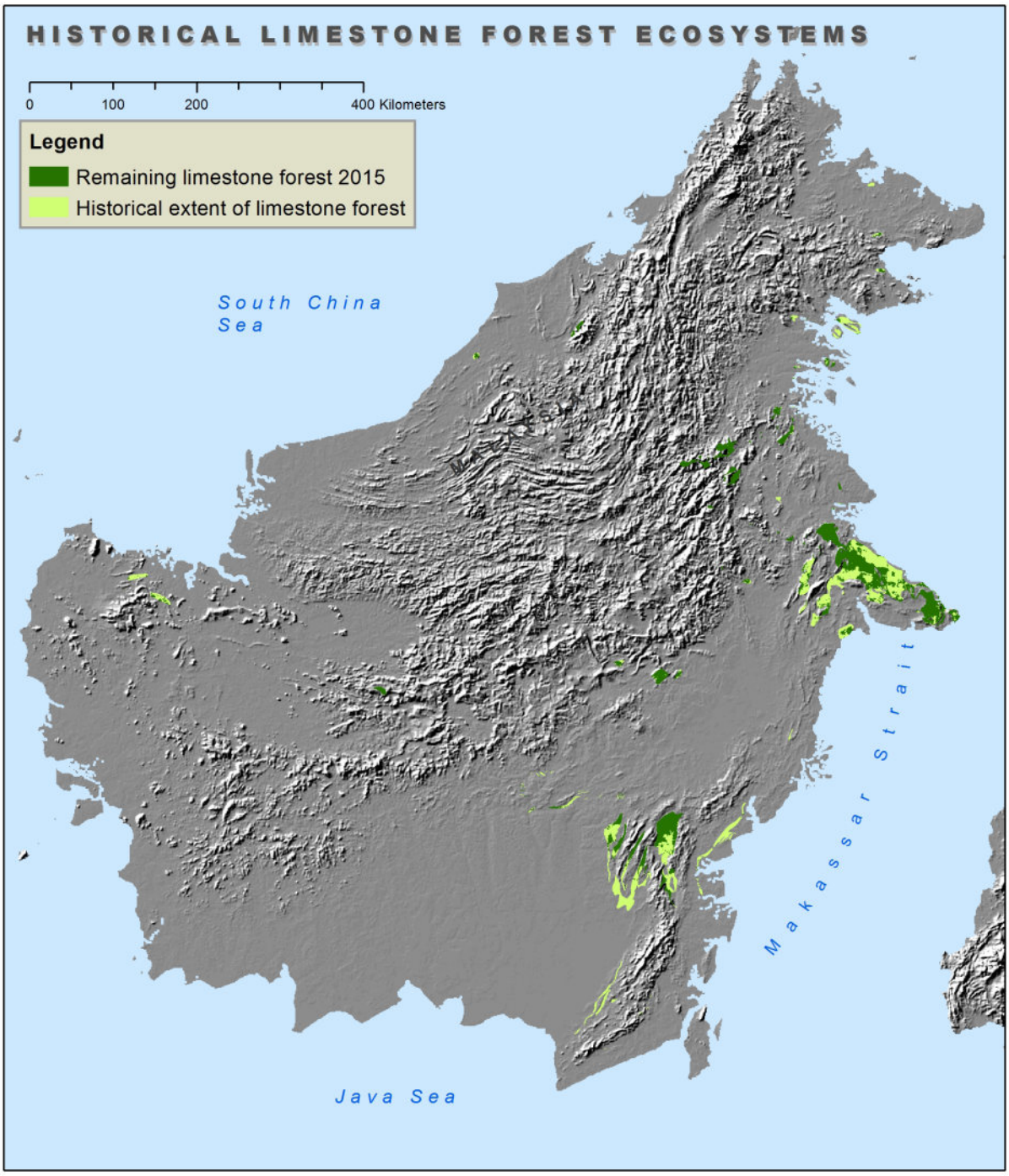
East Kalimantan: The sub-district of Sangkulirang contains the only large population of orangutans known to live in a limestone forest. A population which will become isolated with on-going land use developments which began in 2005 and continue to this day. Scientific investigation of the Sangkulirang landscape has been limited, but already it seems the area is home to several new species. Very large areas are still allocated for conversion, which if they go ahead will leave only a central 'spine' of forest remaining.

North Kalimantan: Very large limestone ridges on both sides of the Kayan river, with disturbance recorded up until 2005, after which only limited conversion registered.



Limestone forest in Bukit Batikap, Central Kalimantan


LIMESTONE FOREST ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining limestone forest 2015
Deforested limestone forest 2010 - 2015
Deforested limestone forest 2005 - 2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Samarinda
Putuk Cahu
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea


HISTORICAL LIMESTONE FOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining limestone forest 2015
Historical extent of limestone forest
South China Sea
Makassar Strait
Java Sea

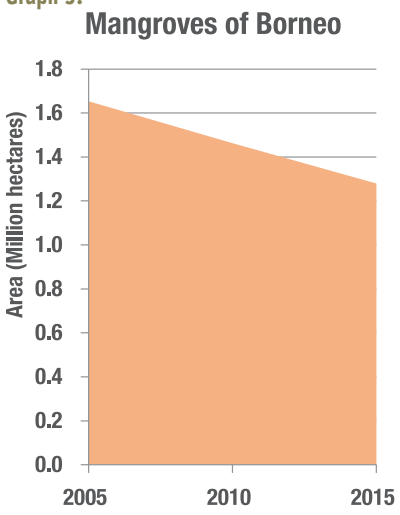
Rainforest in Sabah, Malaysia

1.8 Mangrove ecosystem

Snapshot

- The mangroves of Borneo are among the most species-rich in the world and are a major habitat of proboscis monkeys.
- Conversion of mangrove in Borneo has been rapid, with more than a million hectares of the original mangrove on the island being converted between 1980 and 2000, mostly for commercial prawn farming and fishponds.
- In 2005, 64% of the original mangroves remained, by 2015 that had slipped to less than 50%.
- The tremendous value of mangroves for coastal protection and fish breeding refuges is now widely acknowledged.

Graph 9:



The mangroves of Borneo are among the most species-rich in the world and are a major habitat of proboscis monkeys. Complete mangrove ecosystems consist of 'frontal' and 'rear' or 'back' mangroves. Frontal mangrove is inundated daily by seawater, while 'rear' mangrove is inundated only a number of days each month.

Back-mangroves are actually by far the richest in terms of wildlife species, vegetation structures and variety of habitats. They are also usually the first sections converted due to their easy access, ease of draining and lack of visibility from the waterside. The tremendous value of frontal mangroves for coastal protection and fish breeding refuges is now widely acknowledged, while the value of rear mangroves is less appreciated, though arguably more important.

Extent

All of the muddy coasts of Borneo once had extensive zones of mangroves all over the terrains with tidal influence. Many of these have been converted in the last century, and in 2005, 64% of the original mangroves remained. A steady decline of the total area of mangroves continued between 2005 and 2015, and less than 50% remained in 2015.

Table 10: Mangrove forest: historical extent vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
2,580,630	1,653,256	64.1	1,462,689	56.7	1,279,414	49.6

Condition

Conversion of mangrove in Borneo has been rapid, with more than a million hectares of the original mangrove on the island being converted between 1980 and 2000, mostly for commercial prawn farming and fishponds. Conversion continues across the island.

Description by region

Sabah: Mangrove forest in this Malaysian state is faring well, legislatively placed by government in a special forest reserve class where conversion is not allowed. Some conversion has been recorded at accessible sites, but this may be temporary, which would enable the mangrove to recover. Recently, the mangrove between Kinabatangan and Segama has been protected as a Ramsar site.

Brunei: The mangroves of the Temburong estuary are well-preserved and proudly promoted as a tourist destination.

Sarawak: During the past decade, mangroves of the entire coastline north of Sibu were converted. There remain opportunities to save the rich mangrove areas around the state's capital of Kuching, where a Ramsar site has already been designated, but is currently subject to increasing conversion. Opportunities also exist in Rajang, where the largest remaining example of mangrove ecosystem in Sarawak lies.

West Kalimantan: Most of the relatively smaller mangrove areas throughout the coast of this province have been converted. The wide mangrove areas of Kubu Raya have survived so far and could remain a mangrove ecosystem of major importance, as long as conversion of the back-mangroves can be stopped immediately.

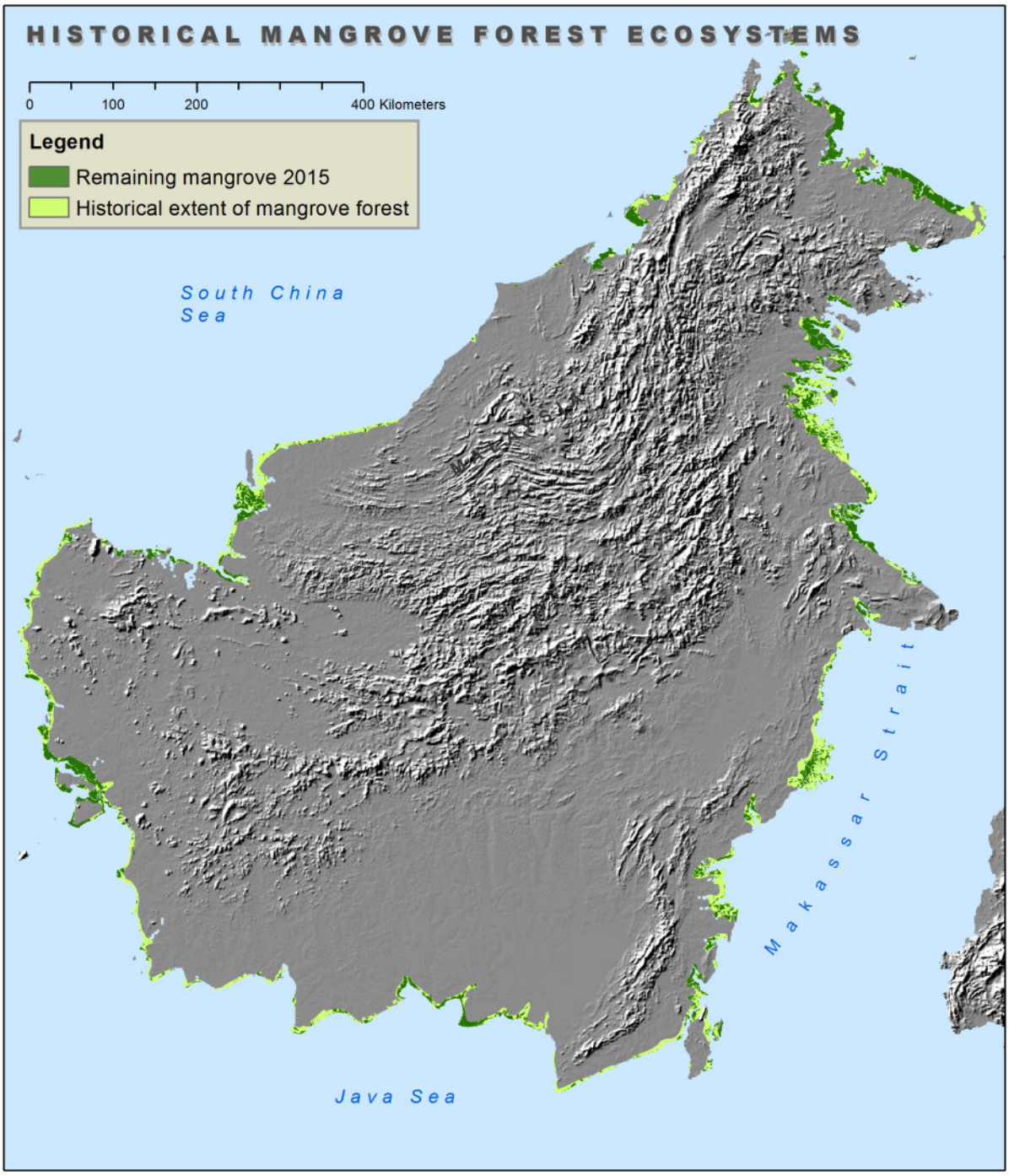
Central Kalimantan: With increasing access to coastal areas, most mangrove conversion has occurred quite recently. The best remaining mangrove forest occurs along the coast, south of Sebangau National Park, but outside this area progressive conversion continues.

South Kalimantan: Most of the mangrove areas of this province were converted between 1980 and 2000 and the remaining mangroves are still very much subject to conversion. Opportunities exist for preservation on the wide bays of the east coast.

East Kalimantan: Has suffered large and ongoing conversion since the 1990s, particularly along the Mahakam estuaries and in the Tanah Grogot area in the southernmost part of the province. If this continues, little will remain in 10 years' time. On a more positive note the wide mangroves of the Berau estuary are still in remarkably good condition.

North Kalimantan: Until the 1980s almost the entire coast of this province was rich in mangrove forest. Since then many mangrove areas, particularly back mangroves have been converted.


MANGROVE ECOSYSTEMS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining mangrove 2015
Deforested mangrove 2010-2015
Deforested mangrove 2005-2010
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea


HISTORICAL MANGROVE FOREST ECOSYSTEMS
0
100
200
400 Kilometers
Legend
Remaining mangrove 2015
Historical extent of mangrove forest
South China Sea
Makassar Strait
Java Sea

1.9 Viable populations of clouded leopard

Snapshot

- Clouded leopards are the top predator of Borneo, feeding on monkeys, mouse deer, sambar and barking deer, young bearded pigs and occasionally birds and reptiles.
- The clouded leopard can serve as a good indicator keystone species for the survival conditions of many endangered species of Borneo.
- A viable population of clouded leopards, with a size of at least 50 individuals, requires an area of uninterrupted forest blocks with an ultimate minimum size of 300,000 ha.
- Clouded leopards appear to be present in most of the forested areas of Borneo, though they may become extinct in lowland areas without sufficient forest cover.

Clouded leopards are the top predator of Borneo, feeding on monkeys, mouse, sambar and barking deer, young bearded pigs and occasionally birds and reptiles. Morphological and DNA analysis has shown that the clouded leopard from Borneo and Sumatra is a separate species (*Neofelis diardi*) compared to the mainland species (*Neofelis nebulosa*).

Clouded leopards appear to be present in most of the forested areas of Borneo, though they may become extinct in lowland areas without sufficient forest cover. It is, however, notoriously difficult to document leopard presence in an area, as surveying this cautious animal is complicated. The clouded leopard is a secretive animal, always avoiding humans, and thus seldom encountered. It spends much of its time in the tree canopies and is more active at night than during daytime. Relatively few records exist, and the ones that do are mainly from areas where long-term research programs have been conducted such as in Sabah. While direct sightings of the clouded leopard are rare, camera traps are often successful in confirming their presence.

The total number of clouded leopards in Borneo can only be established by very rough estimations, which we refrain from doing. Instead we attempt to map the extent of habitat required for viable populations.

The territory of each individual is large with hardly any overlap, and clouded leopards roam over rather large distances in search for prey. The range of habitats is wide – from coastal peat swamp forest, to mountain ridges more than 1500 m asl.

To be viable, clouded leopard populations require not just a minimum area but, just as importantly, large and intact areas of forest in good condition. Thus, as Borneo's forest becomes ever more reduced in size and increasingly fragmented, a critical conservation priority for the species will be to maintain and re-establish connectivity via habitat corridors between clouded leopard populations, particularly those residing within core protected areas. In view of this, some areas of forest predicted as being suitable habitat types for the clouded leopard might indeed be too small and/or isolated from a viable population to hold the species indefinitely.

Indeed, forest fragmentation is the major threat to viable populations of this species. Where forest is fragmented, individuals can still be sighted but numbers will gradually decrease until they become locally extinct. This makes the species a good indicator of internal forest connectivity and overall forest quality.

Table 11: Distribution area for clouded leopard: Historical vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
68,150,000	49,850,399	73.1	41,108,538	60.3	35,782,459	52.5

Based on the territory needed by each animal, its characteristics, and the assumption that a population should number at least 50 individuals to remain viable in the long term, it is possible to estimate the area needed for viable leopard populations. The map of suitable clouded leopard habitats was produced by applying an algorithm that takes into account the areas of uninterrupted forest blocks that are theoretically large enough to support a viable population of clouded leopards; citing Hearn et al (2016), "a large proportion of surveys (six of 10) estimated less than 1.9 per 100 km^2". This would imply that a viable population of clouded leopards, with a size of at least 50 individuals, requires an area of connected forest blocks with an ultimate minimum size of 2632 km^2. Since habitat and prey density conditions are not always ideal, a minimum size of 3000 km^2 was used in our calculations.

Clouded leopards can live in a wide range of habitats but occur in low densities and are generally hard to detect. The map shows the probable distribution of viable populations. And this map is also a critical indication of connectivity of forest blocks.

A loss of more than 14 million ha of forest between 2005 and 2015 would have reduced the size of viable populations of clouded leopard in Borneo. This was indirectly caused by connectivity losses throughout Borneo, with the exception of parts of the remote interior of West and East Kalimantan.

Unlike other keystone species such as orangutan and elephant, clouded leopards occur in most parts of Borneo.

The clouded leopard can serve as a good indicator species for survival conditions of many endangered species of Borneo. By preserving the habitats for viable populations of this top predator, many other animal and plant species will be protected simultaneously.

Nonetheless, protected area status does not guarantee safety for the clouded leopard as local people can still enter these forest to hunt bearded pigs and deer. If they come across a clouded leopard they will kill the animal for its valuable skin and fangs.

Description by region

Sabah: Central Sabah has seen many of its forests being converted into plantations of rubber, pulpwood and oil palm. A drop in numbers of clouded leopard is to be expected in Sabah, not because the area was completely deforested, but because it became fragmented and much less connected than before. The Kinabatangan watershed was particularly strongly affected and although solitary animals will continue to live there for many decades, this species might in the end disappear in this area.

Brunei: Very little habitat lost.

Sarawak: The upper Balui and Malarang sub-watersheds in Sarawak became strongly fragmented with large areas opening up between 2007 and 2010.

West Kalimantan: Much of the lowland forest has disappeared or remains only in small, unconnected areas, so clouded leopards may become locally extinct in most of the lowlands of this province.

Nearly all of the western part of the HoB, particularly the area west of Danau Sentarum is severely fragmented. In the Arabela landscape of West and Central Kalimantan, future reduction of the range of clouded leopards could be expected due to the high level of fragmentation from the edges.

Central Kalimantan: The overall picture for this province is comparatively better than other provinces of Kalimantan, although the deforestation and fragmentation in the upper Seruyan are ongoing.

East Kalimantan: Potential clouded leopard habitat appears to have become highly disturbed, specifically towards the eastern part, threatening the future survival in this province. Several cases of solitary leopards entering villages or fields have been reported from these areas.

South Kalimantan: No reports of clouded leopards.

North Kalimantan: Large habitat for viable populations lost in the eastern part of the province.

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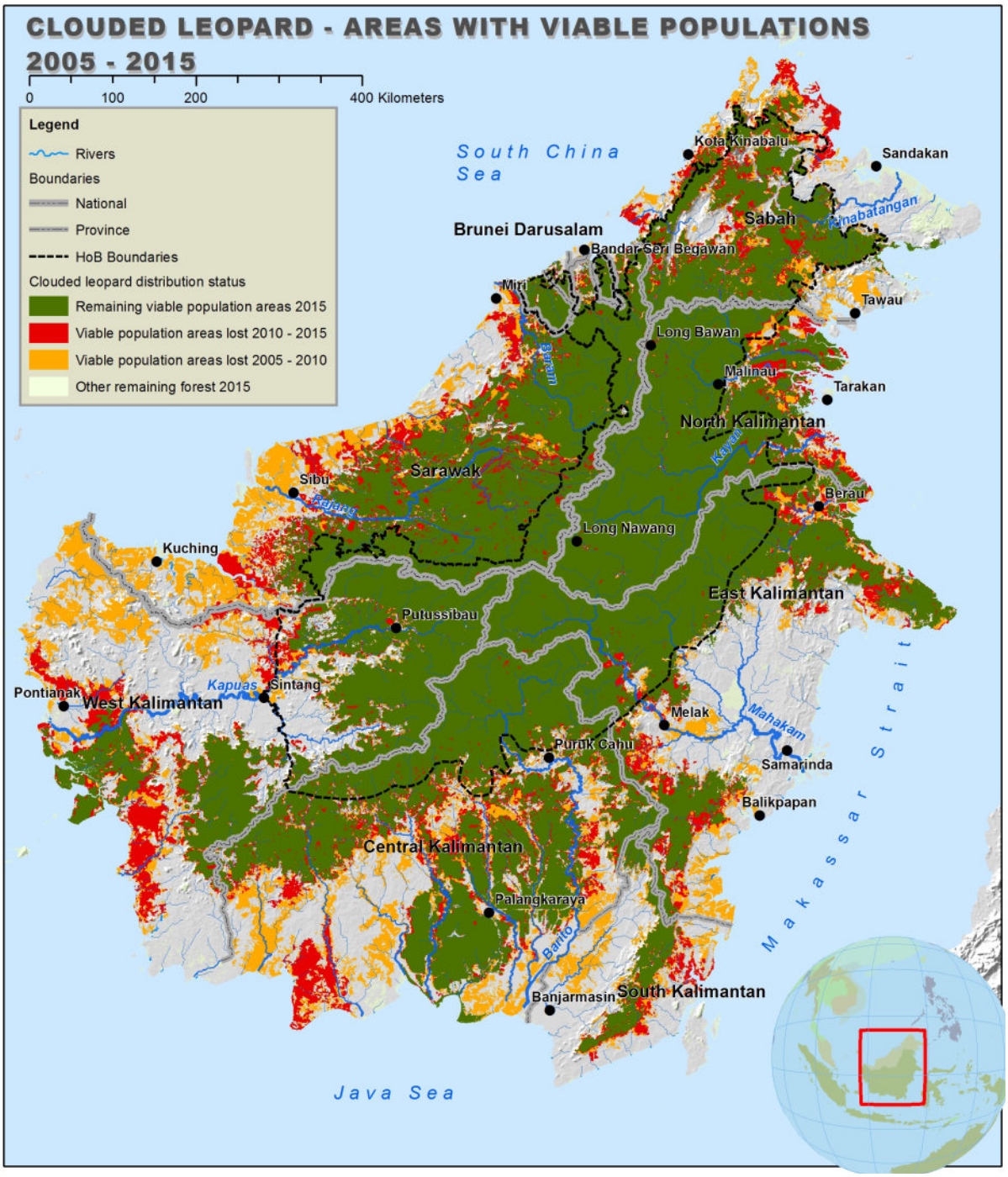

CLOUDED LEOPARD - AREAS WITH VIABLE POPULATIONS
2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Clouded leopard distribution status
Remaining viable population areas 2015
Viable population areas lost 2010 - 2015
Viable population areas lost 2005 - 2010
Other remaining forest 2015
South China Sea
Kota Kinabalu
Sandakan
Brunei Darusalam
Bandar Seri Begawan
Sabah
Kinabatangan
Miri
Tawau
Baram
Long Bawan
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Kapuas
Sintang
Pontianak
West Kalimantan
Melak
Mahakam
Puruk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.10 Banteng

Snapshot

- Once present in most parts of South-East Asia, banteng distribution is now limited to small, scattered populations in Myanmar, Laos, Thailand, Java and Borneo islands.
- One of Borneo's largest mammals and one of the last wild cattle species in the world, the banteng is an unquestionable part of the ecosystem, prompting many to believe that its conservation deserves more attention.
- As forest edge dwellers, reduction in forest cover does not necessarily mean a reduction in banteng numbers.
- However, Banteng are very sensitive to human presence and would avoid areas with disturbance. The reduction of 12% in forest cover of banteng habitat where the wild species of banteng can graze means its survival is threatened.
- Preservation or replanting of green belts inside plantation concessions could help movements of this species in between their habitats, as there is little evidence of banteng destroying oil palms.

Once present in most parts of South-East Asia, banteng distribution is now limited to small, scattered populations in Myanmar, Laos, Thailand, Java and Borneo islands. One of Borneo's largest mammals and one of the last wild cattle species in the world, the banteng is an unquestionable part of the ecosystem, prompting many to believe that its conservation deserves more attention.

Banteng are grazers and browsers, feeding on grasses, herbs and shrubs. They strongly prefer more open areas (even 'man-made' grasslands) without dense canopy cover, but need to retreat to the forest for hiding and resting.

Good records of banteng are scarce, and the total number of animals is completely unknown. The distribution of banteng was largely unknown in 2005, but a preliminary distribution map could be made based on extrapolation of reliable records. The historical extent is unknown; ancient records of banteng from coastal plains indicate that it was probably much larger than in 2005.

The map on page 68 shows the reduction of forest cover of the estimated distribution areas of banteng. This does not necessarily indicate habitat reduction, since banteng are forest edge herbivores and show a clear preference, if not requirement, for large open spots in forest environments. However, the reduction of 700,000 ha between 2010 and 2015 is large, and most of this was converted into plantations. Banteng can graze in plantations but are very sensitive to human presence, so may not survive.

Table 12: Distribution area for banteng: historical vs 2005 - 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of 2005	area (ha)	% of 2005	area (ha)	% of 2005
unknown	5,449,599	100	5,066,185	93	4,779,667	88

Some domestication of wild banteng might have occurred and they might have interbred with domestic cattle. The major cattle of Kalimantan, the so-called Bali cattle, look very much like banteng. Domestic bulls are, however, dark-brown, while the banteng bull is black.

The historic distribution of these wild cattle is still not completely understood, but it is assumed they were formerly more widespread in the coastal regions of Borneo that have since been cultivated. They now occur in low densities and scattered groups throughout the areas indicated on the map.

Banteng do not like frequent disturbance by humans; and will move out of areas where agricultural conversion is occurring. There is evidence that a reduction of banteng habitat in places such as Sabah is due to oil palm development. Preservation or replanting of green belts inside plantation concessions could help movements of this species in between their habitats, as there is little evidence of banteng destroying oil palms.

Description by region

Sabah: The presence of banteng herds is relatively well documented for Sabah, including the Maliau, Kinabatangan and Tabin conservation areas.

Brunei: No recent records of banteng presence.

Sarawak: No recent records of banteng presence.

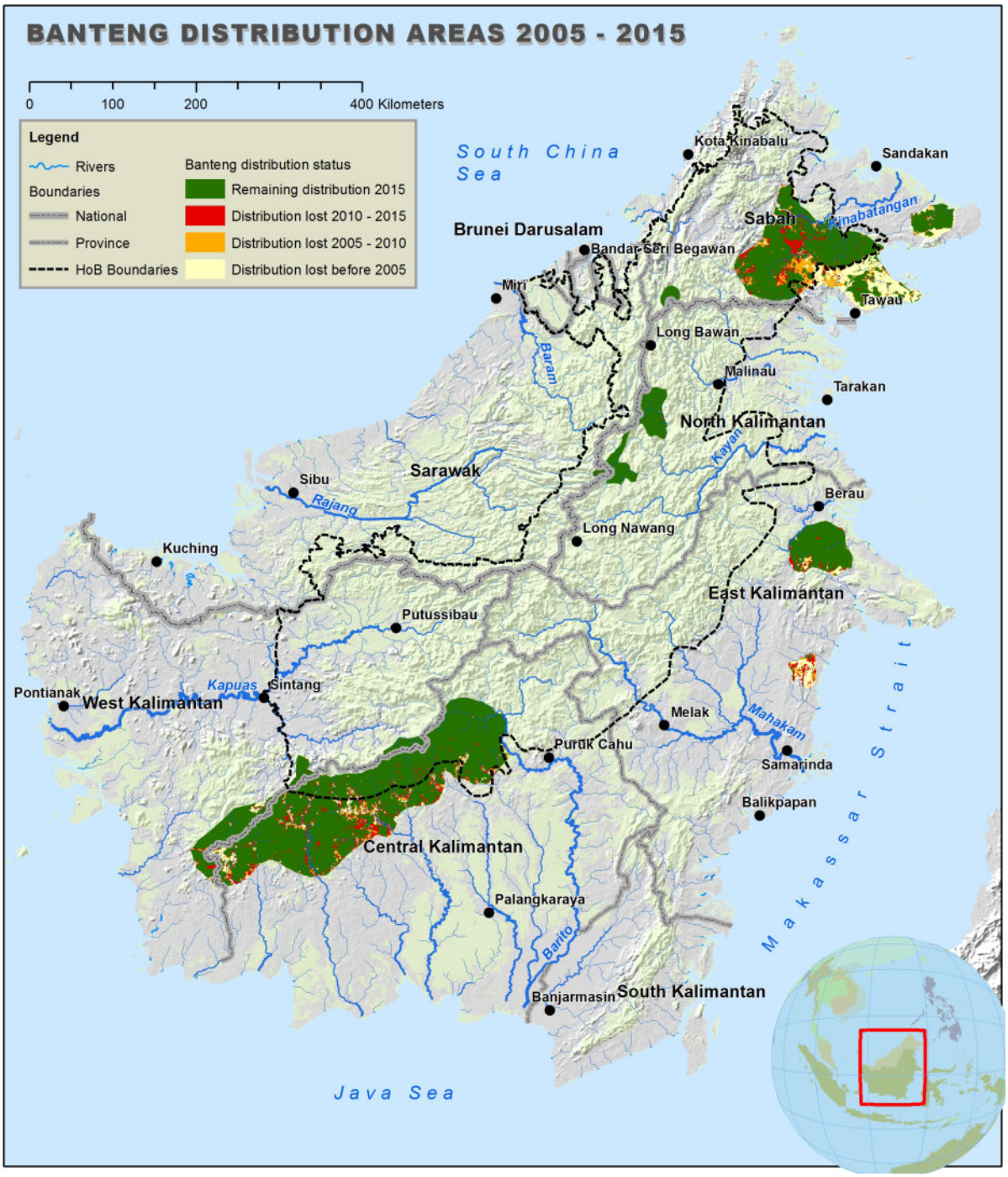
West Kalimantan: Found in the southernmost parts of West Kalimantan.

Central & East Kalimantan: Numerous historical records of banteng exist for East Kalimantan and also for the northern part of Central Kalimantan. A number of these populations appear to have gone locally extinct since then. Banteng are hunted in an opportunistic way for their meat but particularly for trophies.

Northern Kalimantan: One of the largest populations of banteng in Borneo lives in and around the grasslands of the upper Bahau of Kayan Mentarang National Park. This is an area of former cultivation that is still kept open by frequent burning by local communities.

South Kalimantan: No recent records of banteng presence.

© Sabah Wildlife Department


BANTENG DISTRIBUTION AREAS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Banteng distribution status
Remaining distribution 2015
Distribution lost 2010 - 2015
Distribution lost 2005 - 2010
Distribution lost before 2005
South China Sea
Kota Kinabalu
Sandakan
Sabah
Tinabatangan
Brunei Darusalam
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.11 Orangutan

Snapshot

- The orangutan is perhaps the mammal most closely associated with the tropical rainforest of Borneo.
- In early 2016, IUCN reclassified the threat status for the Bornean orangutan from 'endangered' to 'critically endangered', due to destruction, degradation and fragmentation of its habitats and hunting.
- Sustainably managed forest can often still support orangutan populations, in fact, about 75% of all orangutans live in forest outside protected areas.
- Between 1973 and 2005, orangutans lost almost half of their distribution area to large scale conversion and forest fires. Between 2005 and 2015, a further 9% was lost, reducing the habitat to around 9.3 million hectares. In recent years, conversion of orangutan habitat has been restricted by legislation in many parts of Borneo.

The orangutan - the 'old man of the forest' - is Asia's only species of ape and perhaps the mammal most closely associated with the tropical rainforest of Borneo. Three sub-species of orangutan in Borneo are distinguished: *Pongo pygmaeus wurmbii, Pongo pygmaeus morio* and *Pongo pygmaeus pygmaeus*.

P. pygmaeus is the sub-species with the smallest numbers - rapidly falling until 2010 - after which the population stabilized. The subspecies *morio* was considered the least threatened, but in recent years its habitat and distribution have diminished more than expected.

The total numbers of orangutans in Borneo is estimated at 54,000 individuals, of which 75% live outside protected areas.

In prehistoric times, orangutans may have ranged throughout Borneo, only limited by elevations too high to provide suitable habitats. In the 1930s, before the start of large-scale logging, the reconstructed distribution range was already much smaller than the theoretical prehistoric distribution.

In early 2016, IUCN reclassified the threat status for the Bornean orangutan from 'endangered' to 'critically endangered'. The reclassification was based on two main issues which are driving Bornean orangutan populations into sharp decline: (1) destruction, degradation and fragmentation of their habitats, and (2) hunting.

The first reliable map of orangutan distribution was produced in 1973 (Gaveau et al, in IUCN 2016). The 2005 distribution map on page 71 was based on the 2004 IUCN distribution map, with corrections for forest conversion.

As orangutan prefers lowland rainforest and peat swamp forest, the great extent of deforestation in such forest habitats (see page 30 and 46) correspondingly affected their habitat. Between 1973 and 2005, their distribution area had been reduced by almost half to 11 million hectare. Over a ten year period from 2005 to 2015, deforestation continued, leaving 9.3 million ha or 47.5% of the 1973 orangutan distribution area.

The reduction in forest area has severe impact on the population. An important part of their diet is fruit, and as most tree species in Borneo only bear fruit during relatively short periods, they require large areas to forage for sufficient food. The reduction in forest area therefore correlates with the increasing loss of orangutan habitat.

Table 13: Distribution area for orangutan: 1973 vs 2005 - 2015

1973	2005		2010		2015	
area (ha)	area (ha)	% of 1973	area (ha)	% of 1973	area (ha)	% of 1973
19,644,600	11,075,095	56.4	9,998,009	50.9	9,327,304	47.5

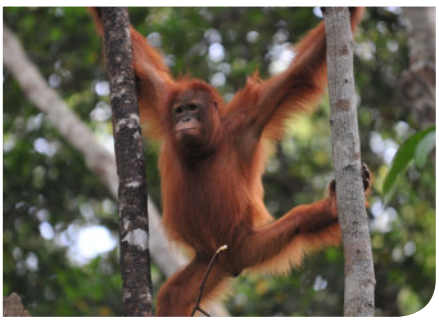
During the establishment of plantations, even though efforts have been made to retain High Conservation Value Areas (HCVA), the loss of the larger foraging forest areas could not support the orangutan population that remains. It is hoped that legislative restriction against conversion of orangutan habitat in many parts of Borneo will lead to reduction of forest loss. While protected areas offer the best conservation measure, forest managed in a sustainably manner for logging can often still support orangutan populations. In fact, 75% of all orangutans live in such forest outside the protected areas.

Description by region

Sabah: It is estimated that more than 60% of the orangutan population in Sabah is now within production forest, which are designated to produce timber by selective cutting.

Approximately two million ha of orangutan habitat were converted before 2005.

The exception being around Sabah's Danum Valley-Imbak Canyon-Maliau Basin Conservation Area, where the habitat condition is still good. Indeed, there is more than 500,000 ha of forest in Ulu Segama, Danum Valley, Malua, Kuamut, Tangkulap, Deramakot, Kinabatangan, Kulamba, and Tabin that still contain orangutans at high density. However, everywhere along the edges, conversion has occurred.

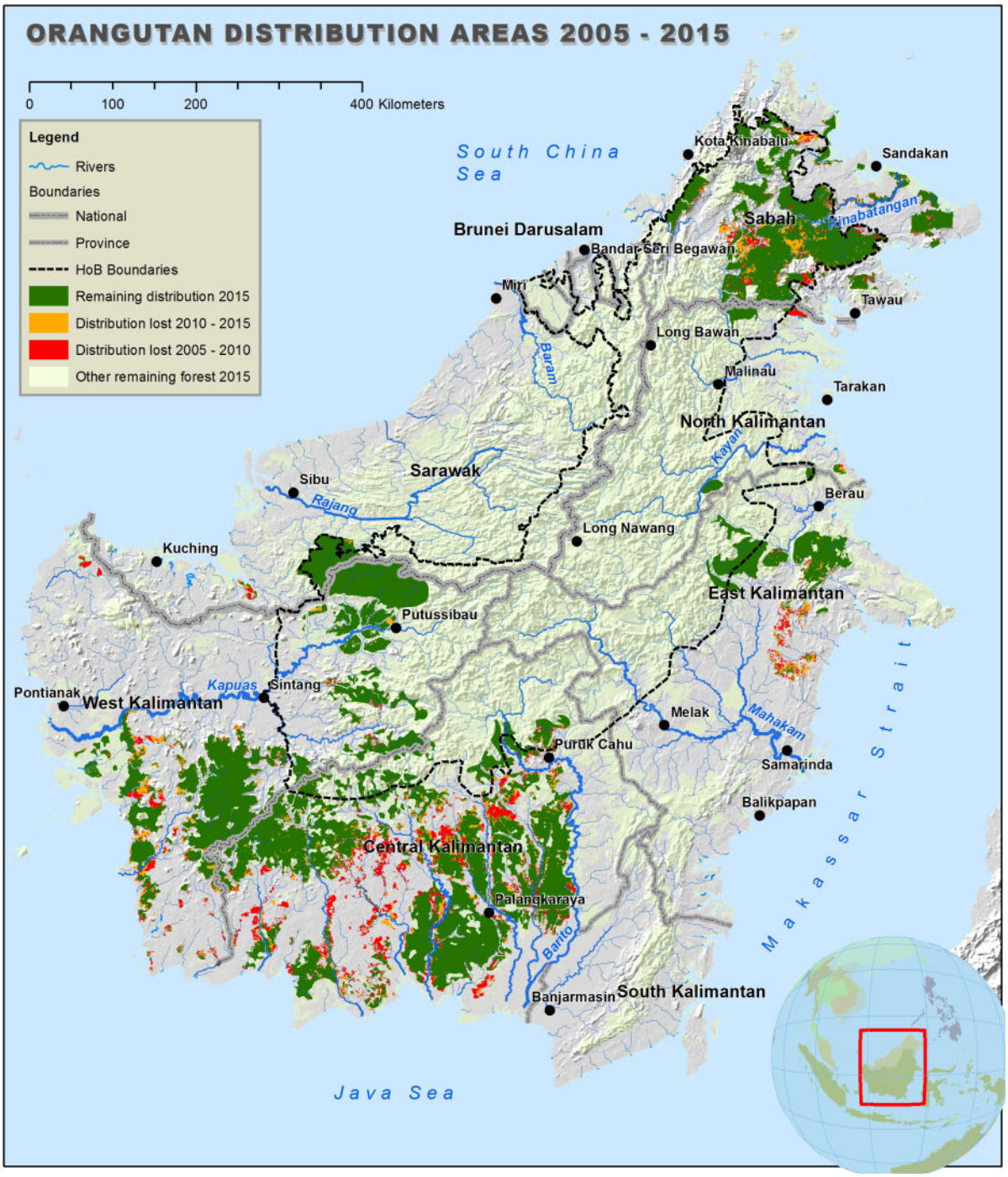


© WWF-Indonesia/Kalimantan Tengah

Sarawak: Orangutan populations persist only in the south, particularly in the Lanjak Entimau Wildlife Sanctuary, Batang Ai National Park, proposed Ulu Menyang Conservation Area, and the Sedilu-Sebuyau-Gunung Lesung National Parks.

Indonesian part of Borneo: Orangutan habitats have had mixed fortunes over time. There are around 5,800 individuals in Sebangau National Park and around 11,000 individuals in the Arabela landscape according to WWF-Indonesia's Central Kalimantan Program survey in 2015. The former is a national park (protected), the latter is mainly production forest, with hopefully sustainable forest management and orangutan conservation. In West Kalimantan, many tracts of orangutan habitat were converted in the corridor of Danau Sentarum and Betung Kerihun National Parks. In the HoB part of Central Kalimantan, many large patches of orangutan habitat in the upper Seruyan were converted before 2007, and again on a smaller scale, between 2010 and 2012. Both partly as a result of expanding plantations.

Individual orangutans are still living in a number of conservation forest strips. We can still see many opportunities for retaining connectivity of the remaining orangutan populations by preserving and restoring the remnant corridors. However, even plantation companies that set aside conservation areas can often only secure the survival of a handful of individuals. Hunting by plantation workers and local communities may also be a key factor in a drop in orangutan numbers in certain areas.


ORANGUTAN DISTRIBUTION AREAS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Remaining distribution 2015
Distribution lost 2010 - 2015
Distribution lost 2005 - 2010
Other remaining forest 2015
South China Sea
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Brunei Darusalam
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.12 Proboscis monkey

Snapshot

- Easily identifiable due to its unusually large nose, the proboscis monkey is found mainly in rear mangroves, riparian forest and swamp forest. They spend the night mostly in trees along the banks of rivers or lakes.
- The presence of proboscis monkeys in areas in Borneo is usually well known due to its remarkable appearance and easy observation, making it an appealing tourist attraction.
- The conservation of this endangered species gets relatively little attention compared to other species, such as orangutans.
- Proboscis monkey populations continue to decline in many areas, particularly due to loss of habitat and hunting pressure.
- Distribution areas are estimated to have declined by nearly 30% between 2005 and 2015.

The proboscis monkey (*Nasalis larvatus*), or long nosed monkey is an endangered primate species endemic to Borneo. Easily identifiable due to the male's unusually large nose, it is found mainly in rear mangroves, riparian forest and swamp forest with their resting places mostly along the banks of rivers or lakes.

The presence of proboscis monkeys in areas in Borneo is usually well known, due to its remarkable appearance and easy observation from boats, which make it an appealing tourist attraction.

Three decades of research on the proboscis monkey has considerably increased the knowledge of its ecology and behavior, but the conservation of this species gets relatively little attention compared to other species, such as orangutans.

The total number of individuals in Borneo is not clear. According to IUCN, there are less than 1000 proboscis monkeys left in Sarawak, and Sabah has only one large population in Kinabatangan. Numbers from Indonesia are not known.

Proboscis monkey populations continue to decline in many areas, particularly due to loss of habitat and hunting pressure. The current status of the species needs to be assessed and evaluated for each location as the situation has changed rapidly during the past decade.

An overall evaluation revealed that although some of the large populations in coastal areas are under protected status, most others are under severe pressure of habitat conversion, mainly through aquaculture development in East Kalimantan and plantations in West Kalimantan.

Very few of the interior populations, found along the major rivers and lakes are protected. The riparian populations, which are generally small, are threatened by agricultural conversion in many locations.

Scattered populations of proboscis monkey appear in suitable habitats throughout Borneo. These habitats are nowadays often isolated and not connected. The historical distribution was probably much higher, but this cannot be calculated as it cannot be assumed that all suitable habitats were indeed populated by proboscis monkeys. For instance, proboscis monkeys are observed in some sections of peat swamp forest, but are absent in other sections, the reasons for which, are still subject to discussion among researchers, though probably related to distances from rivers with drinking water.

Table 14: Distribution area for proboscis monkey: historical vs 2005 – 2015

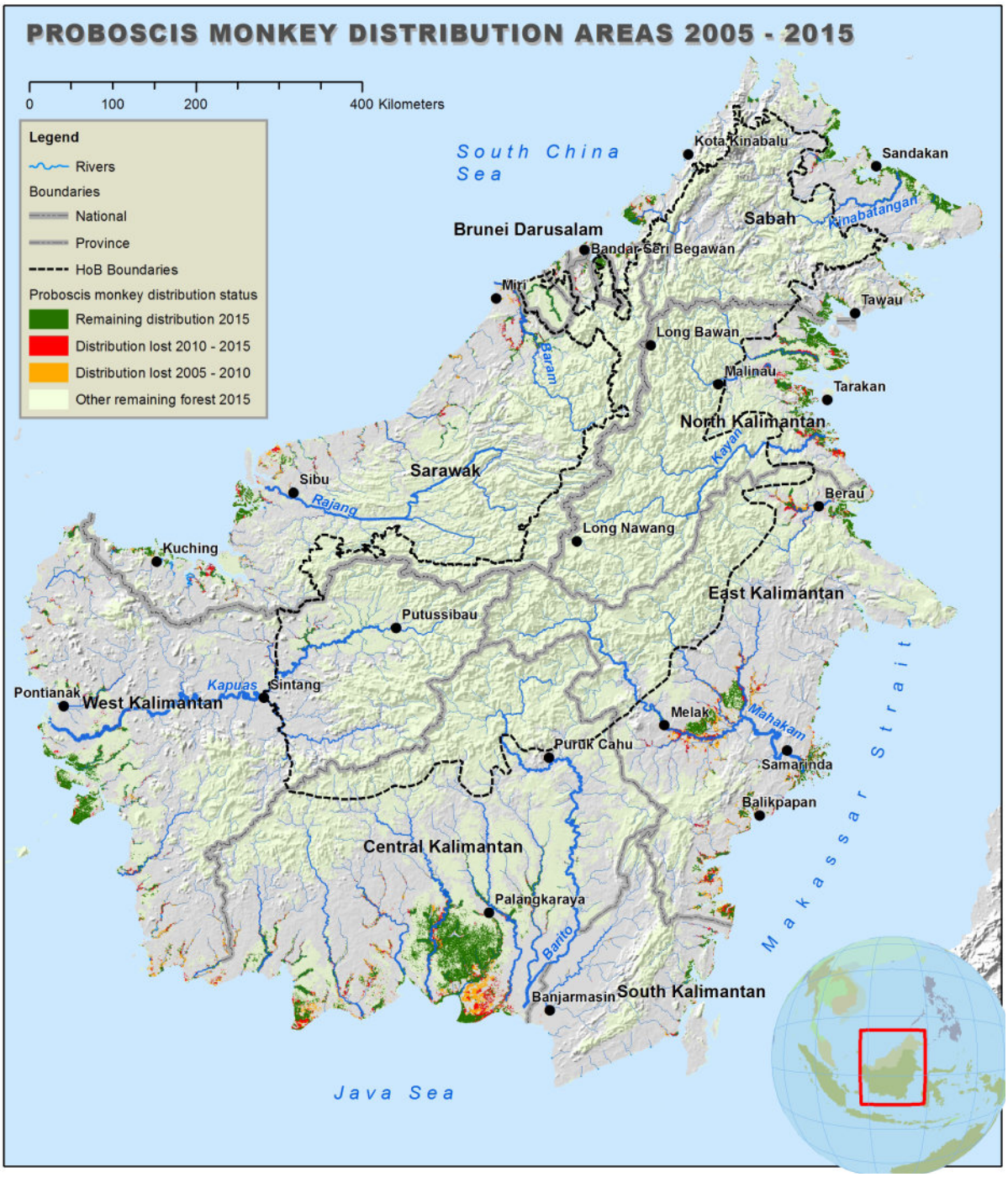
Historical	2005		2010		2015	
area (ha)	area (ha)	% of 2005	area (ha)	% of 2005	area (ha)	% of 2005
unknown	3,013,430	100	2,533,765	84	2,126,339	71

The distribution map for 2005 was based on records of proboscis monkey in all the mapped locations.

The total distribution area is much smaller than most of the other primates of Borneo including orangutans. Between 2005 and 2015, it decreased nearly 900,000 ha, a decrease throughout Borneo of almost 30% in 10 years. This was caused mainly by conversion of freshwater swamp forest and back-mangroves. The conversions are often not noticed in the field because they are hidden from view by the central mangroves, dominated by Rhizophora and Bruguiera species.

Regional distribution

Hunting is a major threat in many areas in Kalimantan and can devastate smaller populations. This is particularly the case with commercial hunting, in which hunters will endeavor to sell as many proboscis monkeys as possible. In Sabah, Sarawak and Brunei, the proboscis monkey is only incidentally hunted and has become an iconic species. In some places in Kalimantan (e.g. Tarakan, and Balikpapan) proboscis monkey images have started to appear frequently on promotional material, perhaps indicating a new found appreciation of the species as a tourist attraction.


PROBOSCIS MONKEY DISTRIBUTION AREAS 2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Proboscis monkey distribution status
Remaining distribution 2015
Distribution lost 2010 - 2015
Distribution lost 2005 - 2010
Other remaining forest 2015
South China Sea
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Brunei Darusalam
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.13 Bornean elephant

Snapshot

- The total elephant population appears to be stable, but the distribution and suitable habitats have been further reduced during the past five years, due to deforestation.
- Bornean elephants are found only in the south-east of Sabah and the upper north of North Kalimantan.
- By 2005, elephant habitat (based on forest cover) had dropped to around 37% of its estimated historical distribution. By 2015, this figure had dropped to around 31%.
- Favourite food items for elephants in Borneo are wild banana and ginger species, *Arenga undulatifolia* palms, as well as the hearts of young oil palms - causing many conflicts in newly established plantations.

The elephants of Borneo (*Elephas maximus borneensis*) are believed by some, to be a distinct sub-species of elephant, different from other sub-species in the region. Found exclusively in the eastern part of Sabah and the northernmost part of North Kalimantan, their origin is still a topic of discussion. One school of thought is that they may be Javanese elephants introduced via Sulu (Philippines) to northeast Borneo, while the Java elephants have become extinct. For more information, see the 2012 edition of the Environmental Status Report.

The historical distribution area, before the conversions began in the 1920s is not completely clear as the information is based on fragmented records. It is however estimated at 2.7 million ha, which includes distribution of solitary male elephants.

The total elephant population appears to be stable, but the distribution and suitable habitats have been further reduced during the past five years, due to deforestation.

The total number of elephants was approximately 1500 individuals in 2016.

Elephants have a strong preference for lowland and riparian forest, including (shallow) swamps in these ecosystems. These habitats do not necessarily have to be in primary condition, and elephants often use secondary vegetation that has a higher portion of herbaceous plants on which they feed. Their favourite foods include: wild bananas, wild ginger species, *Arenga undulatifolia* palms, as well as the hearts of young oil palms, causing many conflicts with newly established plantations. Clear cut areas are mostly avoided by the elephants, unless it is part of a customary route for which they do not have alternatives.

Elephant historical distribution is based on estimates from 1920, before large-scale forest conversions began (Ambu et al, 2003). By 2005, the extent of forested elephant habitats had decreased by nearly 65%. By 2015, a further loss of nearly 155,000 ha occured, leaving close to 31% of historical cover.

Since elephants can forage well in shrub land, which would be classified as non-forest according to our forest coverage analysis, the remaining total extent of all elephant habitats should be larger than the distribution area shown in Table 15. However, the conversion of vast forest into plantations, many of which are surrounded by electric-fencing, has rendered these areas out of bounds to the elephants.

Table 15: Distribution area for Elephant: historical vs 2005 – 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of historical	area (ha)	% of historical	area (ha)	% of historical
2,761,000	1,007,607	36.5	916,620	33.2	852,702	30.9

The current and potential disruption of connectivity between the separate elephant populations that inhabit fragmented areas is a major concern.

Regional distribution

In recent years, many elephants have moved into the Kinabatangan area in Sabah. The connectivity between the remaining populations is also still decreasing, particularly between the Kinabatangan and the central Sabah forest reserves.

Elephant groups in the eastern and southernmost part of Sabah might become cut off by plantation developments. A large population in the Kinabatangan area is virtually isolated by now. It is estimated that about 800,000 ha of elephant habitat with forest cover and inside forest reserves and protected areas is left in Sabah.

The total elephant population is slowly decreasing, caused by low population growth and occasional killing of elephants.

The connectivity between Sabah and the North Kalimantan habitats of Tulin Onsoi Sub-District is also threatened. As the population needs to move between this habitat and the southernmost part of Sabah to find sufficient food, a loss of connectivity could result in the disappearance of all the elephants of Indonesian Borneo. Alternatively, deforestation which largely occurred between 2010 and 2015 in the central area of Kuamut sub-watershed in Eastern Sabah, may eventually cause the effect of splitting the major elephant population in two.

The elephants of North Kalimantan are found only in the Nunukan district, mainly in the Tulin Onsoi Sub-District. Part of this habitat is under logging concessions, but an essential section which is in the migration routes of the elephants is currently being converted to oil palm and pulpwood plantations.

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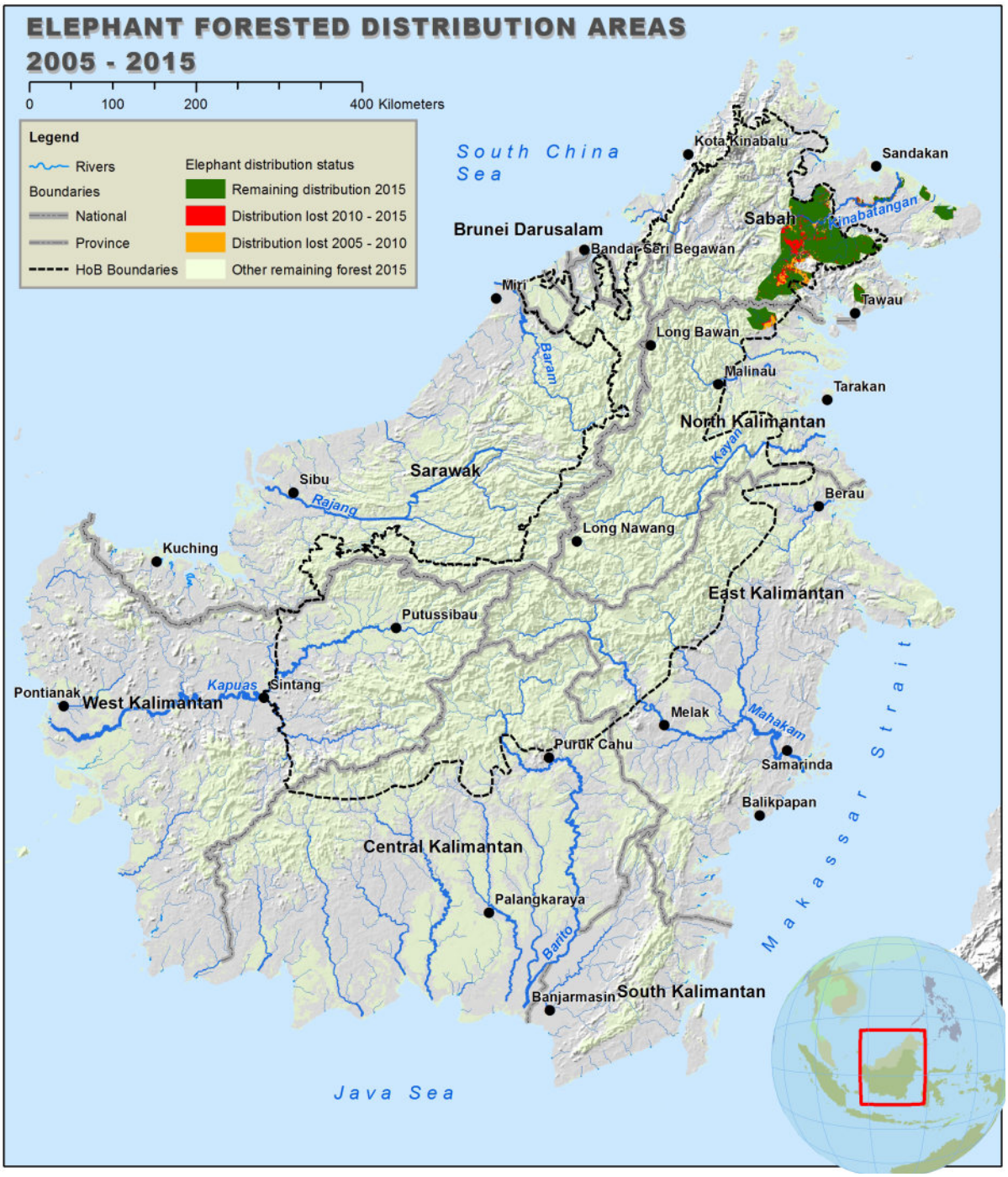
ELEPHANT FORESTED DISTRIBUTION AREAS
2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Elephant distribution status
Remaining distribution 2015
Distribution lost 2010 - 2015
Distribution lost 2005 - 2010
Other remaining forest 2015
South China Sea
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Brunei Darusalam
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.14 Sumatran rhinoceros

Snapshot

- The major issue to conservation of the rhinoceros in Borneo is not the lack of habitat or decreasing distribution range, but quite simply the very low number of remaining individuals.
- Historically, two-horned rhinos (*Dicerorhinus sumatrensis*) occurred throughout Borneo, but by the 1980s nearly all had disappeared.
- In 2013, rhinos were rediscovered in East Kalimantan and later on other reliable records were found in Central and West Kalimantan.
- The population size has not increased. Attempts at breeding have so far been unsuccessful and are now shifting to producing embryos by in-vitro fertilization.

Centuries ago, two-horned rhinos (*Dicerorhinus sumatrensis*) occurred throughout Borneo, but by the 1980's nearly all had disappeared.

Until 2012, the only known remaining distribution areas of the two-horned rhinoceros of Borneo were in Sabah. In 2015, after intensive survey efforts over the previous three years, it was declared that the rhino was extinct in the wild in Sabah. Although some unconfirmed records existed from Kalimantan.

In 2013, rhinos were actually rediscovered in East Kalimantan, and later on other reliable records were found in Central and West Kalimantan. This led to the production of the extrapolated distribution map as shown on page 79. The area is the probable range of wandering individual rhinos, but the total number is unknown.

The total distribution area of these rhinos was mapped for 2005 and the forest cover of this area was analysed for 2010 and 2015. The forest cover has gradually decreased particularly between 2010 and 2015, when more than 500,000 ha became deforested. The remaining rhinos in Tabin, Sabah, have habitats available but are actually in captivity now.

Notwithstanding efforts for captive breeding, the population size has not increased so far. It would theoretically still be possible for some of the remaining rhinos to move to additional suitable habitats in the interior of Sabah, although they will have to cross through a fragmented forest landscape.

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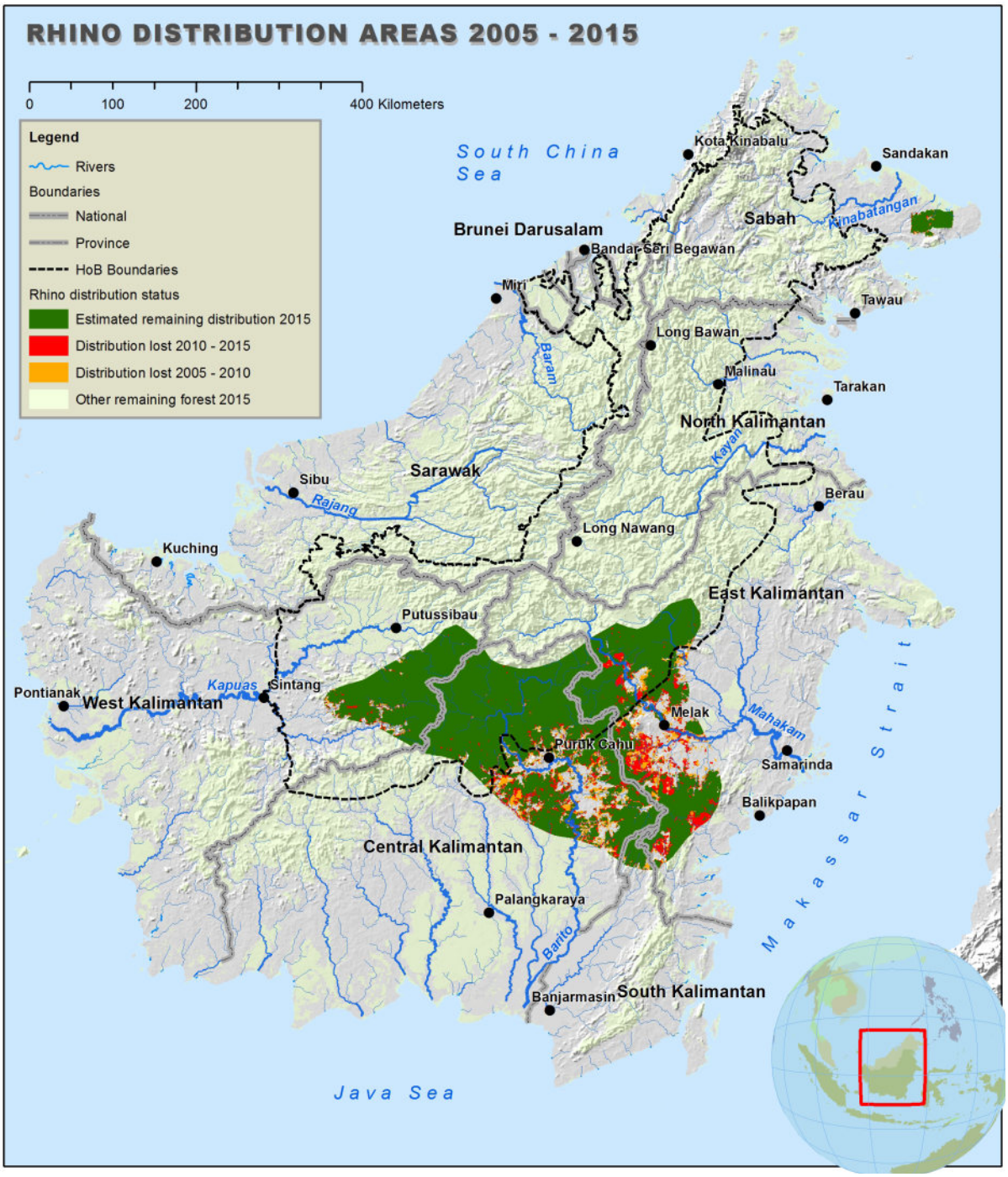
Table 16: Distribution area for Sumatran rhino: historical vs 2005 – 2015

Historical	2005		2010		2015	
area (ha)	area (ha)	% of 2005	area (ha)	% of 2005	area (ha)	% of 2005
unknown	7,300,303	100	6,713,895	92	6,207,270	85



Note: The remaining rhinos in Tabin are in captivity now.

1.15 High concentrations of endemic Fagaceae *

Snapshot

- In Borneo, the Fagaceae family is found in nearly all forest ecosystems, except mangroves and freshwater swamp forest.
- Borneo has more than 40 endemic species, with the highest concentrations occurring mainly in wide forest areas in the mountains.
- Endemic species of Fagaceae are of lower commercial value compared with endemic Dipterocarpaceae.
- The species composition of Fagaceae in the western part of Borneo is different to that in the eastern part.

The Fagaceae is an important plant family with a worldwide distribution. It includes the beeches (*Fagus spp.*), chestnuts (*Castanea spp.*) and oaks (*Quercus spp.*) which are important species in the temperate forest of Europe and America. In Borneo, the family is found in nearly all forest ecosystems, except mangroves and freshwater swamp forest.

Some of the common Fagaceae species, such as *Lithocarpus conocarpus*, are spread throughout Borneo, but most of the endemic species have a limited distribution. The highest concentrations of endemic Fagacaeae occur mainly in wide forest areas in the mountains. The lower commercial value of endemic Fagaceae species in comparison to endemic Dipterocarpaceae reduces the pressure on harvest of these species.

Montane forest is particularly rich in Fagaceae specie, with endemic varieties concentrated at an elevation range of approximately 1000-1600 m asl.

Borneo has more than 40 endemic species, most of which are found in the uplands and montane areas of the island. Hyper-endemism (where a species only occurs in one to three places) is probably not an issue with the Fagaceae, as most of the montane areas are wide and connected.

Fagaceae are also common in upland forest, particularly in areas with less fertile soils. In lowland forest, Fagaceae are usually common smaller trees of the lower canopies.

The map of 'high concentrations of endemic species' was made by combining geomorphology information with distribution records from literature and field surveys. However, many of these areas particularly in Kalimantan have not yet been fully explored, and species new to science might show up in the future. Most of the locations are within protected areas and therefore reduction of these areas would be limited.

The historical area is probably only slightly higher than the 2005 area, as forest conversion in the mountains has been limited to a few areas. In 2015, 98% of the 2005 baseline distribution area remains intact, although some 30,000 ha has been converted, mainly in vegetable-growing areas in Sabah and hydropower dam construction in Sarawak.

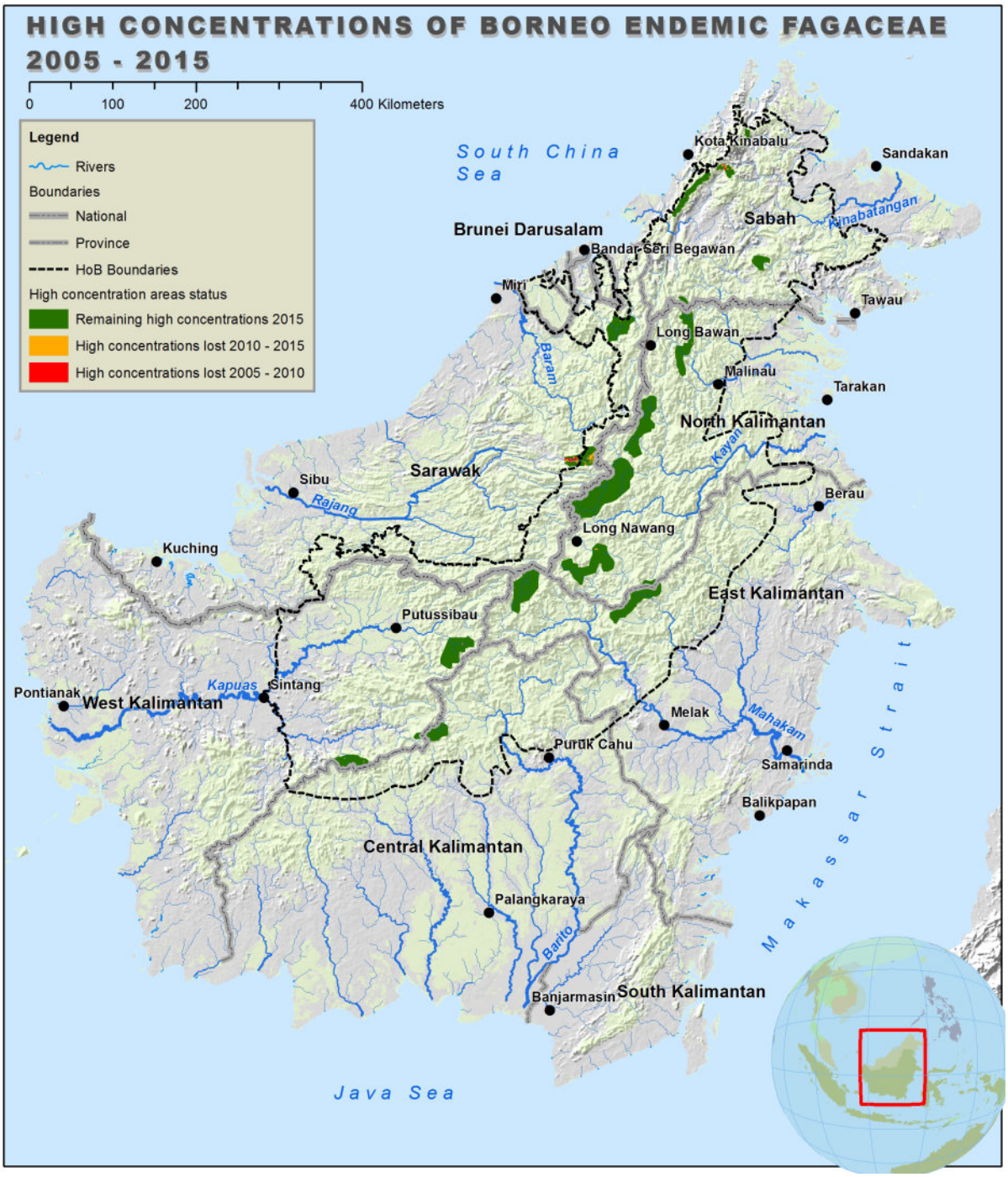
*** High concentration refers to more than five endemic species in a 100 ha forest block.**

Table 17: Distribution area of high concentrations of endemic Fagaceae

Historical	2005		2010		2015	
area (ha)	area (ha)	% of 2005	area (ha)	% of 2005	area (ha)	% of 2005
unknown	1,278,695	100	1,267,873	99	1,255,020	98

Regional distribution

The majority of the species is most likely represented in protected areas of the HoB, particularly the state parks of Kinabalu and Crocker Range in Sabah, Kayan Mentarang National Park in North Kalimantan and Betung Kerihun National Park in West Kalimantan. The locations in the upper Kapuas area of West Kalimantan should be monitored.


HIGH CONCENTRATIONS OF BORNEO ENDEMIC FAGACEAE
2005 - 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
High concentration areas status
Remaining high concentrations 2015
High concentrations lost 2010 - 2015
High concentrations lost 2005 - 2010
South China Sea
Kota Kinabalu
Sandakan
Brunei Darusalam
Bandar Seri Begawan
Sabah
Kinabatangan
Miri
Tawau
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Tarakan
North Kalimantan
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Sarawak
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Putussibau
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Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.16 High concentrations of endemic Dipterocarpaceae *

Snapshot

- Borneo is world renowned for its many endemic Dipterocarpaceae species, that is found only in Borneo.
- Some species are classified as 'hyper-endemic', meaning they are found only in a single site.
- Dominating lowland and upland rainforest, the Dipterocarpaceae includes several well-known timber trees with high commercial value.
- Certain locations have high concentrations of endemic species with more than five species in a 100 ha forest block, in which the analysis in this section specifically refers to.
- Borneo has several 'high concentration' areas, with only limited reduction during 2005-2015, which is quite remarkable as most of the locations are outside protected areas.
- Logging companies usually group several species in single classes, such as red or white meranti.
- Logging concession managers now have greater skills in recognizing locations with a rich diversity of Dipterocarpaceae. Perhaps for this reason, conversion rates of forest in these areas throughout Borneo are much lower than conversion of lowland rainforest in general.

The family name, from the type genus, *Dipterocarpus* is derived from Greek (*di* = two, *pteron* = wing and *karpos* = fruit) and refers to the distinctive two-winged fruit of the species. The Dipterocarpaceae is one of the most important plant families of Borneo. Its tree species dominate lowland and upland rainforest with several being well-known timber trees with high commercial value. Logging companies usually group several species in single classes, such as red or white meranti.

Borneo is particularly renowned for its many endemic Dipterocarpaceae species. These endemic species are found only in Borneo and they grow usually in the wide lowland valleys and the foot slopes of wide uplands. Certain locations have high concentrations of endemic species with more than five species in a 100 ha forest block.

Of special interest are the lowlands of Central Kalimantan, Brunei and Danum valley in Sabah and its surrounds. Some species are classified as 'hyper-endemic', meaning they are found only in a single or a few small areas and are of increasing interest to the academic world. These species deserve special attention as they are easily threatened by extinction. A prospect all the more disturbing when one considers that some species may disappear before they are actually discovered by science.

In what might be a saving grace for the endemic species, logging concession managers now have greater skills in recognizing locations with an extremely rich diversity of Dipterocarpaceae and might be more willing to set aside small reserves within their concessions. Perhaps for this reason, conversion rates of forest with high concentrations of endemic Dipterocarpaceae throughout Borneo are much lower than conversion of lowland rainforest in general.

*** For this species, high concentration refers to more than five endemic species in a 100 ha forest block.**

Borneo has several areas with high concentrations of endemic Dipterocarpaceae, with only limited reduction during 2005-2015, which is quite remarkable as most of the locations are outside protected areas. Their remoteness makes these locations less accessible for logging and less attractive for plantations. More accessible areas such as the upper Kelai and Segah in Berau in East Kalimantan, were partly converted between 2010 and 2012.

It is likely that Dipterocarpaceae had many more locations with high concentrations of endemic species that have been lost as a result of lowland rainforest conversion. Unfortunately, these historical locations will never be known.

Table 18: Distribution area of high concentrations of endemic Dipterocarpaceae

Historical	2005		2010		2015	
area (ha)	area (ha)	% of 2005	area (ha)	% of 2005	area (ha)	% of 2005
unknown	1,821,069	100	1,809,460	99	1,773,102	97

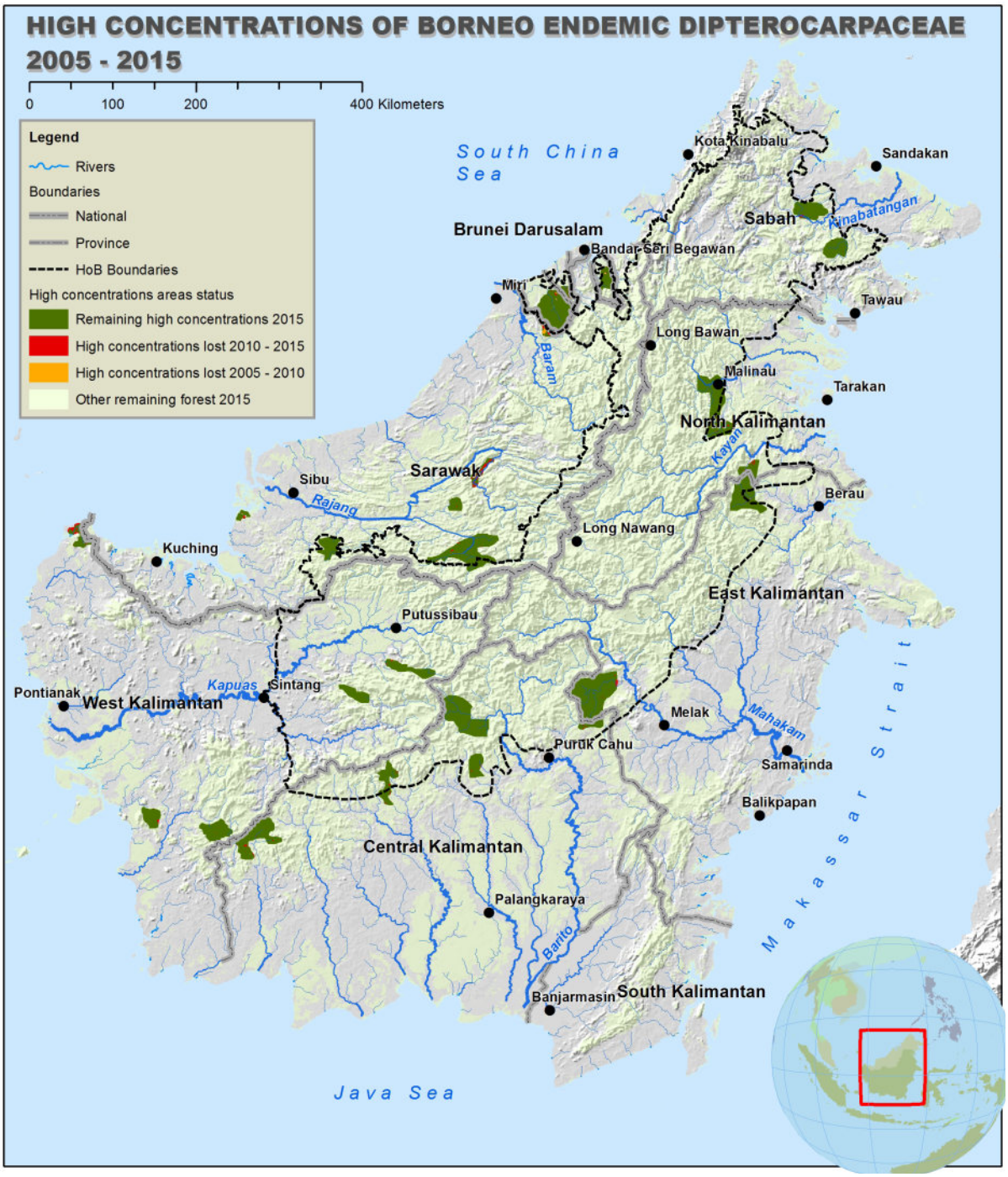
With the 2005 figures not representing historical coverage due to lowland rainforest conversion, the remaining areas since then have mainly been preserved. Patchy conversion occurred in a number of locations, particularly in West Kalimantan, causing a total reduction of nearly 50,000 ha between 2005 and 2015.

Note for map, page 85

The high concentrations of endemic Dipterocarpaceae represented on the map were produced by combining geomorphology information with distribution records from literature and field surveys.

It is a first attempt, displaying the most-often mentioned locations, but far from complete. Dipterocarpaceae is one of the best studied tree families and more information is becoming available on distributions of individual species. Updates on distribution of Borneo-endemics will be processed in the next version of this report.

A number of small (<200 ha) protected areas in Malaysia which were often established due to high concentrations of endemic species, could not be displayed on the map due to scale issues.


HIGH CONCENTRATIONS OF BORNEO ENDEMIC DIPTEROCARPACEAE
2005 - 2015
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400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
High concentrations areas status
Remaining high concentrations 2015
High concentrations lost 2010 - 2015
High concentrations lost 2005 - 2010
Other remaining forest 2015
South China Sea
Kota Kinabalu
Sandakan
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Kinabatangan
Brunei Darusalam
Bandar Seri Begawan
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Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.17 High concentrations of endemic Nepenthaceae *

Snapshot

- The famous pitcher plants of Borneo, the *Nepenthes* species, are unique. The Nepenthaceae is one of the best researched plant families of Borneo.
- Certain endemic *Nepenthes* species are hyper-endemic: found only in one area. The giant *Nepenthes rajah*, for example, is solely found near the summit of Mt. Kinabalu.
- Endemic Nepenthaceae is a good indicator for the condition of fragile ecosystems and can serve as an indicator of the effectiveness of their conservation management.
- The collection of plants for the international trade is a major threat to endemic *Nepenthes* species in areas without protected status.
- Between 2005 and 2015, Borneo lost nearly 400,000 ha (32%) of its historical coverage, mainly due to conversion and forest fires in peat swamp forest along the lower Baram in Sarawak and the lower Kapuas in West Kalimantan.

The famous pitcher plants of Borneo, the *Nepenthes* species, are unique. The Nepenthaceae is one of the best researched plant families of Borneo. Some 35 species occur, of which 24 are found only in Borneo. Nearly all of these endemic pitcher plants of Borneo have a very limited distribution, often confined to fragile specific habitats such as high mountain summits and heath forest. Some species are found in only one or few locations. A number of locations have three or more endemic species growing close to each other, which in this case is considered a high concentration.

Most of Borneo's mountain summits are home to at least one species. *Nepenthes* are adapted to these conditions, being able to extract nutrients from insects and other animals that get caught in their specialized pitchers.

Their very specific habitat requirements make the endemic Nepenthaceae a good indicator for the condition of fragile ecosystems. Indeed, the status of the endemic pitcher plants in a protected area serves as a guide to the effectiveness of its conservation management.

Certain endemic *Nepenthes* species are hyperendemic: found only in one area. The giant *Nepenthes rajah*, for example, is solely found near the summit of Mt. Kinabalu.

The rarest *Nepenthes* species are generally well protected, though even within protected areas, special attention is warranted as disturbance by visitors and illegal collectors still occurs. The collection of plants for the international trade is a major threat to endemic *Nepenthes* species in areas without protected status. This is a major issue that has led to the near extinction of *Nepenthes clipeata* in the wild.

Concentrations of endemic Nepenthaceae were mapped mainly by using the distribution records from literature and field surveys, specifically: Nepenthes of Borneo by Charles Clarke. The records from the montane areas of Indonesian Borneo are additional from WWF surveys.

*** High concentration refers to more than three endemic species in a 100 ha forest block**

Table 19: Distribution area of high concentrations of endemic Nepenthaceae

Historical	2005		2010		2015	
area (ha)	area (ha)	% of 2005	area (ha)	% of 2005	area (ha)	% of 2005
unknown	1,230,000	100	1,123,785	91	831,033	68

A large total reduction of nearly 400,000 ha occurred between 2005 and 2015. Mainly due to conversion and forest fires in peat swamp forest along the lower Baram in Sarawak and peat swamp forest along the lower Kapuas in West Kalimantan. The montane locations are all protected and have undergone little disturbance.

Description by Region

Sabah: A number of tracts of *Nepenthes* were converted between 2007 and 2010 - mainly along the eastern edges of the Crocker range, outside the national park. Some conversion also occurred in the upper Padas area.

Central Kalimantan: Several tracts were converted between 2004 and 2011 along the southern slopes of Bukit Baka - Bukit Raya National Park. This area appears now to be better protected with no further conversion recorded.

North Kalimantan: Areas were converted in the mountain ridge north of Wa'yagung in Kayan Mentarang National Park and in the southern part of the Apokayan. Landslide activity has removed *Nepenthes* in some areas. However, a recovering landslide terrain, where the top soil has disappeared, is actually a good habitat for certain *Nepenthes* species which are often among the first recolonizing plants.

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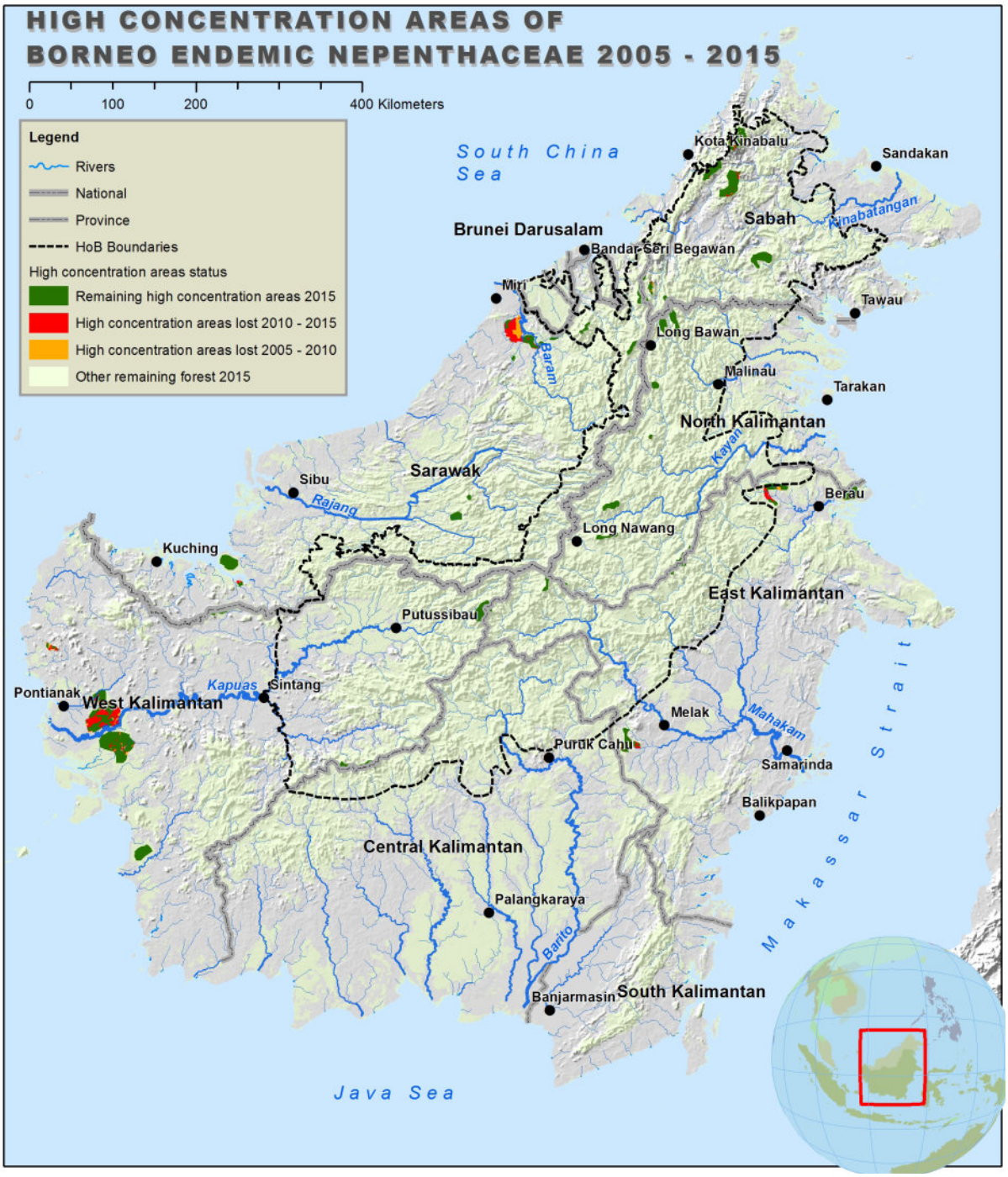
HIGH CONCENTRATION AREAS OF
BORNEO ENDEMIC NEPENTHACEAE 2005 - 2015
0
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400 Kilometers
Legend
Rivers
National
Province
HoB Boundaries
High concentration areas status
Remaining high concentration areas 2015
High concentration areas lost 2010 - 2015
High concentration areas lost 2005 - 2010
Other remaining forest 2015
South China Sea
Kota Kinabalu
Sandakan
Brunei Darusalam
Bandar Seri Begawan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
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Malinau
Tarakan
North Kalimantan
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Sarawak
Sibu
Rajang
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Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
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Mahakam
Putuk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

1.18 River ecosystem - percentage forested for each watershed (2005-2010-2015)

Snapshot

- Watersheds are a vital part of the overall ecosystem of Borneo, acting as living sponges, providing a myriad of ecosystem services to Borneo's entire population.
- In the past, many watershed ecosystem services were unknown and thus taken for granted, but increasingly the very real economic cost of the loss of these 'watershed services' is becoming apparent.
- In the reference maps featured in this section, calculation of forest cover is for the entire watershed - from the montane or upland headwaters, to the coastal lowlands.
- In the 10 years between 2005 and 2015, many large watersheds have been severely reduced in forest cover, to the extent that by 2015, only the Kayan and Sesayap in North Kalimantan still had more than 80% forest cover.
- Indicative of the situation is the drainage area of the Kinabatangan - the largest watershed of Sabah. Development has been ongoing since the 1980s with only one-third of the Kinabatangan area still covered with forest in 2015. This is due largely to oil palm plantations - despite this area being an important and recognized elephant habit.

Forest watersheds are a vital part of the overall ecosystem of Borneo, acting as living sponges and providing a myriad of services including water flow regulation, flood control, water purification, erosion control and the provision of fish habitat to the island's citizens, communities and businesses. In the past, many watershed ecosystem services were unknown and thus taken for granted, but increasingly the very real economic cost of the loss of these 'watershed services' is becoming apparent.

In the reference maps featured in this section, calculation of forest cover is for the entire watershed - from the montane or upland headwaters, to the coastal lowlands. Smaller coastal watersheds with only small headwater areas show relatively little forest cover as much of these areas had been deforested many years before our 2005 analysis.

In the 10 years between 2005 and 2015, many large watersheds have been severely reduced in forest cover. For example in 2005, there were a number of very large watersheds that could boast more than 80% forest cover. These included the Rajang and Baram watershed in Sarawak, the Sembakung that flows from Sabah into North Kalimantan, the Kayan, Sebuku and Sesayap in North Kalimantan and the Berau watershed in East Kalimantan. Dramatically, by 2015, only the Kayan and Sesayap still had more than 80% forest cover.

Description by region

Sabah: The drainage area of the Kinabatangan is the largest watershed of Sabah. Development has been on-going since the 1980s with now just over one-third of the Kinabatangan area still covered with forest in 2015. This level of forest cover is mainly in the interior highlands as the middle and lower sections appear to be very suitable for oil palm and pulpwood plantations. Several sections of the Kinabatangan provide a habitat for

high densities of elephants.

Brunei: The rate of forest loss in the Brunei watersheds is much lower than anywhere else in Borneo, with all watersheds in the country currently having at least 50% forest cover.

Sarawak: The drainage area of the Rajang River is the largest watershed in Sarawak. Up until 2005, much of this area was densely forested with the only development or deforestation occurring in the lowlands. From 2005 to 2015, forest cover decreased from 82% to 65% in 2015. The Baram watershed is another very large watershed of Borneo and is the second largest of Sarawak. Extensive deforestation occurred in the upper sections with a reduction of 20% forest cover over the 2005 to 2015 period.

West Kalimantan: The Kapuas watershed of West Kalimantan, the largest drainage area of Borneo, appears to have stable forest cover (40-60%), though extensive deforestation of the lowland western section occurred before 2005. The highland, eastern section, remains largely under forest cover.

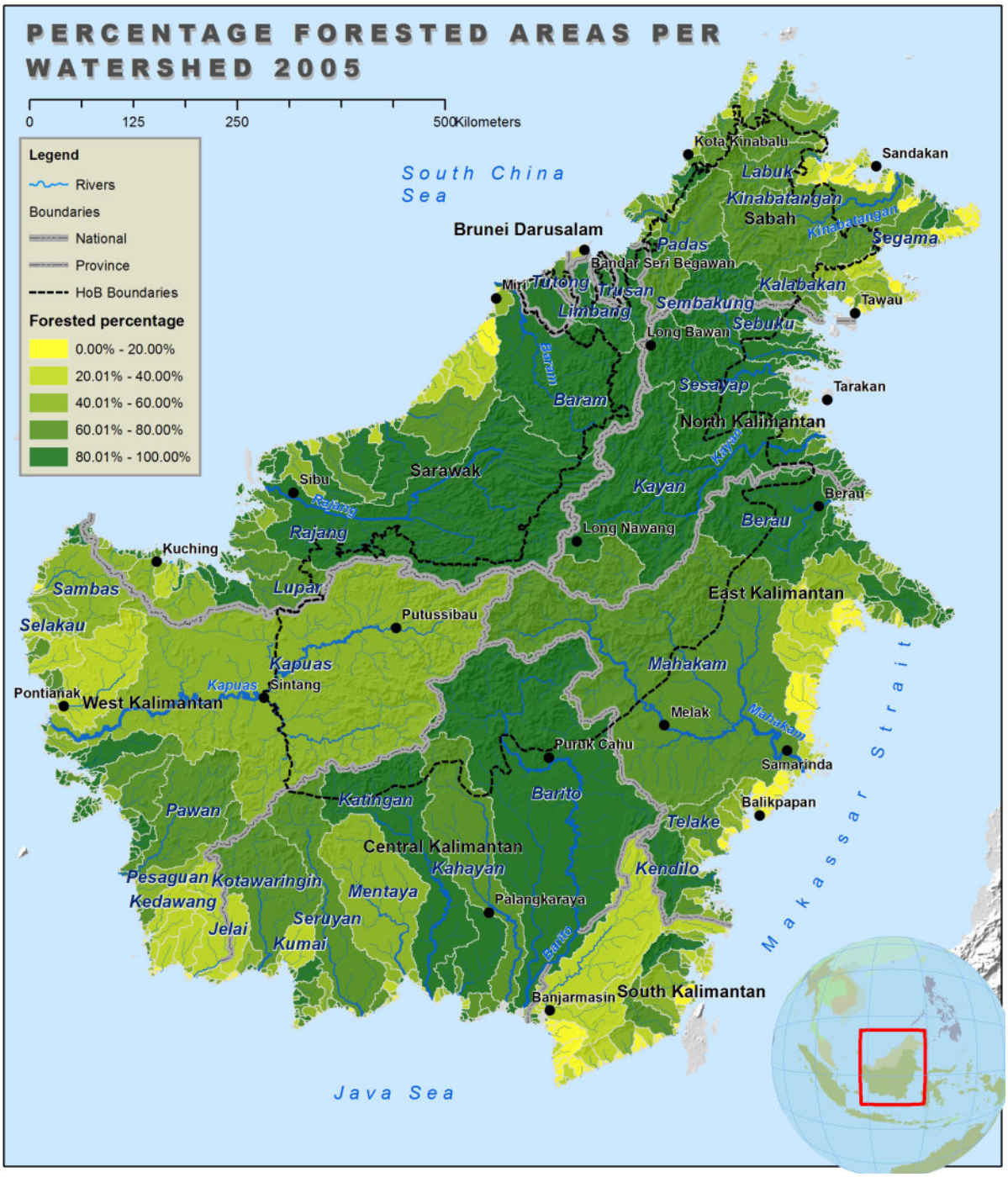
Central Kalimantan: The Barito watershed is the third largest drainage area of Borneo and the forest cover of this watershed is still relatively high, but has suffered a gradual (10%) decrease between 2005 and 2015, largely due to forest fire. The 2 million hectare Katingan watershed stretches from Sebangau National Park to the mountains. Continuous deforestation and development in the middle section of the watershed threaten to cut connectivity between mountain uplands and lowland peat swamps.

South Kalimantan: The largest river of South Kalimantan is the Sungai Negara, a tributary of the Barito river. The forest cover of the sub-watershed of this river is less than 15% and it is one of the densest populated areas of Kalimantan. The only watershed in South Kalimantan with a forest cover of more than 50% is the Sampanahan watershed, which is largely located in the Meratus mountains.

East Kalimantan: The Mahakam watershed is almost as large as the Kapuas watershed. Rapid deforestation in the middle and downstream sections of the watershed continued until 2010, after which deforestation slowed. The Berau watershed still has around 60% forest cover, but it lost 16% of its forest cover between 2007 and 2012. Half of the remaining forest is fragmented. At 87%, the Sesayap watershed has very good forest cover.

North Kalimantan: The Sebuku watershed, home of the only elephant population of Kalimantan, lost more than 20% of its forest cover between 2007 and 2012. Most of the lowlands are now deforested or fragmented; the uppermost section of this watershed is within the political boundaries of Sabah and here the satellite imagery indicates that some tracts of deforestation have occurred. The Kayan watershed is the greenest watershed of Borneo; even in 2015, 93% was under forest cover; indeed, when you take the longboat ride upstream, not far from the starting point of Tanjung Selor, you are already surrounded by forest. The 4% deforestation between 2005 and 2015 was caused by agricultural and infrastructure developments in downstream and middle sections of the watershed. The Kayan is a very large, 3 million hectare watershed, but population density is very low, with only one large town. A large part of the middle section of the Kayan and its tributary the Bahau is uninhabited, while further upstream many small settlements were established along the rivers since pre-historical times.

Other large (>1 million hectares) watersheds throughout Borneo with high deforestation rates are: Kotawaringin, Sembakung, Kahayan, Mentaya, Pawan, Berau, and Seruyan.


PERCENTAGE FORESTED AREAS PER WATERSHED 2005
0
125
250
500 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Forested percentage
0.00% - 20.00%
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40.01% - 60.00%
60.01% - 80.00%
80.01% - 100.00%
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Labuk
Kinabatangan
Sabah
Segama
Padas
Bandar Seri Begawan
Miri
Tutong
Trusan
Limbang
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North Kalimantan
Sarawak
Kayan
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Long Nawang
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Sambas
Lupar
East Kalimantan
Selakau
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Mahakam
Pontianak
West Kalimantan
Sintang
Melak
Puruk Cahu
Samarinda
Balikpapan
Pawan
Katingan
Barito
Telake
Central Kalimantan
Kahayan
Kendilo
Pesaguan
Kotawaringin
Mentaya
Palangkaraya
Kedawang
Seruyan
Jelai
Kumai
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea


PERCENTAGE FORESTED AREAS PER WATERSHED 2010
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Forested percentage
0.00% - 20.00%
20.01% - 40.00%
40.01% - 60.00%
60.01% - 80.00%
80.01% - 100.00%
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Labuk
Sabah
Kinabatangan
Segama
Padas
Bandar Seri Begawan
Miri
Tutong
Trusan
Limbang
Sembakung
Kalabakan
Tawau
Sebuku
Long Bawan
Baram
Sesayap
Tarakan
North Kalimantan
Kayan
Sarawak
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Rajang
Berau
Long Nawang
Kuching
Sambas
Lupar
Selakau
Putussibau
East Kalimantan
Kapuas
Mahakam
Pontianak
Sintang
West Kalimantan
Melak
Purukcahu
Samarinda
Barito
Katingan
Balikpapan
Pawan
Telake
Central Kalimantan
Kahayan
Kendilo
Pesaguan
Kotawaringin
Mentaya
Palangkaraya
Kedawang
Seruyan
Jelai
Kumai
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea


PERCENTAGE FORESTED AREAS PER WATERSHED 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Forested percentage
0.00% - 20.00%
20.01% - 40.00%
40.01% - 60.00%
60.01% - 80.00%
80.01% - 100.00%
South China Sea
Java Sea
Makassar Strait
Brunei Darusalam
Kota Kinabalu
Sandakan
Labuk
Sabah
Kinabatangan
Segama
Padas
Bandar Seri Begawan
Miri
Tutong
Trusan
Limbang
Sembakung
Kalabakan
Tawau
Sebuku
Long Bawan
Baram
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Central Kalimantan
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Kotawaringin
Mentaya
Palangkaraya
Kedawang
Seruyan
Jelai
Kumai
Barito
Banjarmasin
South Kalimantan

CHAPTER 2

Development Status

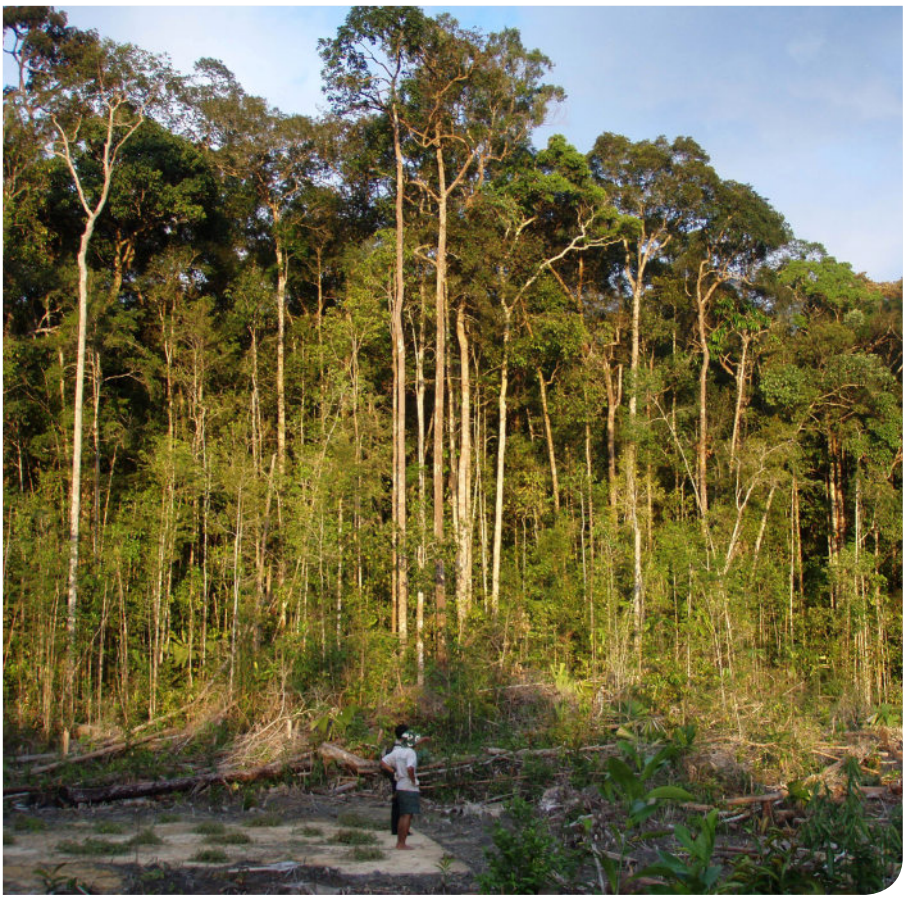
Ongoing developments have strongly affected the ecosystems and species habitats of Borneo.

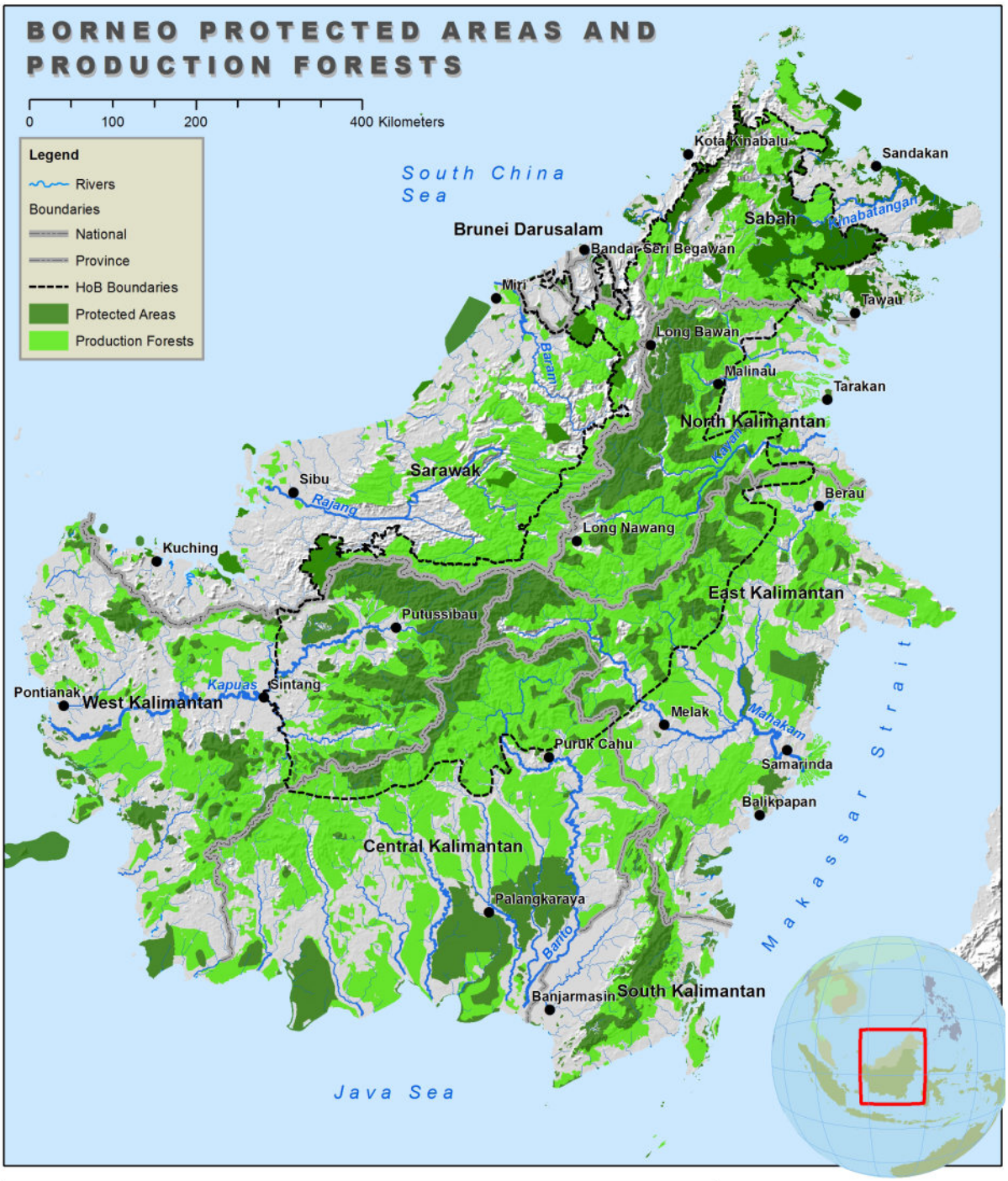
The Governments of Indonesia and Malaysia have produced spatial planning maps which determined the forest to be retained as production and protected forest in 2015. Following this, an assessment was made of the remaining natural forest that are not yet allocated as such. Areas of this natural forest might be allocated for conversion, depending on further designation of land use planning by the governments.

In Sarawak, some of these areas are actually inside gazetted water catchments, which have some form of protection in terms of restriction for other land uses, although this remains to be seen as being properly regulated.

The major land use with the largest impact in Borneo is the establishment of oil palm plantations, followed by pulpwood plantations. Mining activities are more localized, but exploration concessions cover large areas and can affect several ecosystem.

Forest fires have had a devastating impact on the ecology of Borneo and 2015 was another year when many hotspots occurred. The potential impacts of climate change were studied by external institutions and a summary of the findings is provided in this chapter as well.





Protected Areas
Kalimantan : National Park, Nature Reserve, Wildlife Sanctuary, Great Forest Park, Nature Tourism Park, Protection Forest
Brunei Darussalam: National Park, Nature Reserve, Wildlife Sanctuary, Forest Reserve
Sabah : Park, Wildlife Conservation Area/Wildlife Sanctuary, Protection Forest, Virgin Jungle, Wildlife Reserve, Class V: Mangrove Forest
Sarawak : National Park, Nature Reserve, Wildlife Sanctuary

Production Forest
Kalimantan : Limited Production Forest, Production Forest
Sabah : Class II: Commercial Forest, Class III: Domestic Forest, Class IV: Amenity Forest
Sarawak : Permanent Forest Estate

Indonesia

In Indonesia, the Ministry of Environment and Forestry is the authority that allocates forest into protection, production and other use classes. Categories of protected areas are mainly National Parks *(Taman Nasional)*, Nature Reserves *(Cagar Alam)*, Protection Forest *(Hutan Lindung)* and Wildlife Sanctuary *(Suaka Margasatwa)*. As for permanent production forest, there are the Production Forest *(Hutan Produksi)* and Limited Production Forest *(Hutan Produksi Terbatas)*. A third category would be areas allocated for both current and future conversion, Other Land Use Areas *(Areal Penggunaan Lain)* and Production Conversion Forest *(Hutan Produksi Konversi)*. It is necessary to note that the spatial planning allocation is not static for the plans can be revised accordingly as needed.

Sarawak

In Sarawak, there are two main categories of forest: Totally Protected Areas (TPA) and Permanent Forest Estates (PFE). Under the TPA, there are the National Parks, Nature Reserves and Wildlife Sanctuaries. The state's policy is to designate 1 million ha as TPA. As of 2015, 611,657 ha of terrestrial areas has been legally established (gazetted) as TPA. As for the second category, the PFE comprises Forest Reserves, Protected Forest and Communal Forest Reserves. The PFE is land designated to remain under forest in perpetuity and to be managed for the purpose of sustainable timber production. Another forest category is License Planted Forest (LPF) designated for forest plantation. The LPF is included into the PFE, in which the state's policy is to have 6 million ha established.

Sabah

Land use in Sabah falls under two main categories: stateland and forest reserves. Land under stateland is mainly for agriculture development while forest reserves are for forestry uses. Forest reserves are classified into seven classes under the provision of the Forest Enactment 1968. Four classes are regarded as protected areas: Class I Protection, Class V Mangroves, Class VI Virgin Jungle Reserves and Class VII Wildlife Reserve. The remaining classes i.e. II Commercial, III Domestic and IV Amenity can be exploited with Class II being the largest of all Forest Reserves.

Protected Areas
Kalimantan : National Park, Nature Reserve, Wildlife Sanctuary, Great Forest Park, Nature Tourism Park, Protection Forest
Brunei Darussalam: National Park, Nature Reserve, Wildlife Sanctuary, Forest Reserve
Sabah : Park, Wildlife Conservation Area/Wildlife Sanctuary, Protection Forest, Virgin Jungle, Wildlife Reserve, Class V: Mangrove Forest
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Production Forest
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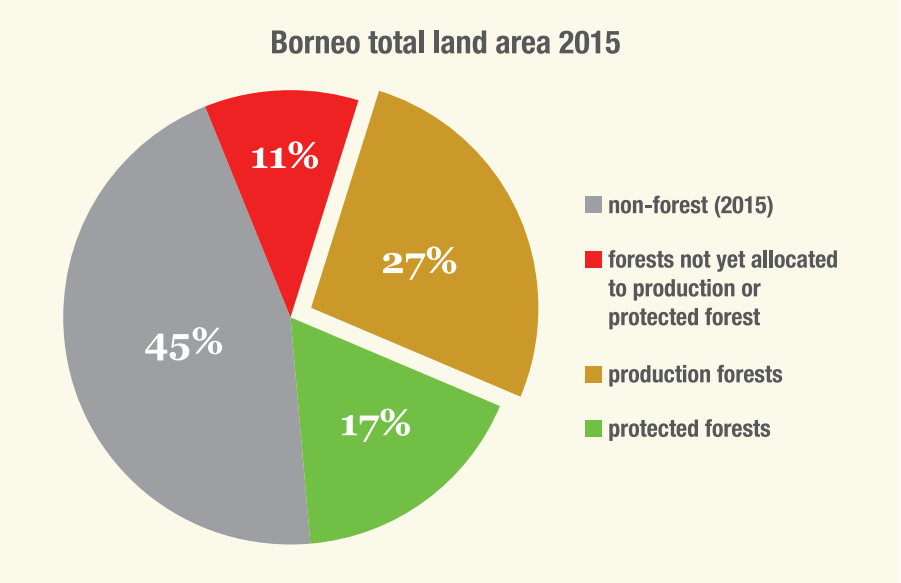
Sarawak : Permanent Forest Estate

2.1 Ecosystems inside protected and production forest concessions



The general category for Protected Forest as defined here in Borneo is strictly for conservation. Extraction of natural resources is prohibited with the exception of rights accorded to Indigenous Peoples for activities that do not impact the environment. The legal status of protected forest could only be changed through the process of degazettement by legislation. It is virtually unheard of for a protected forest to be de-gazetted.

In contrast, the status of production forest can be amended through administrative procedure, and there have been cases of such occurrences. Production forest is essentially meant for sustainable forest management, (SFM) in which management and production systems are carefully applied to balance the timber harvest levels and regeneration requirements. In this way, healthy forest is left standing after logging for future harvest rotations.

While SFM is the premise for regulating production forest, there are areas that have been allocated and licensed out for conversion into planting of pulpwood or other fast growing tree species. In Kalimantan, sections of natural forest in logging concessions can even be clear cut and then replanted, not with quality-timber trees that are natural to the climax stage of these forest, but with fast-growing pulpwood trees instead. Naturally, such practice of converting intact forest into forest plantations should not be defined as sustainable forest management. In Sarawak, although planted forest is supposedly to be undertaken only in degraded areas, much intact forest has been cleared and converted for planting of the fast growing species. In Sabah, with government approval, areas of commercial forest reserves can be cleared and replanted with pulpwood species.

Overall, Protected Forest stands at 12.6

million ha or 17% of the entire total land mass in Borneo. Production Forest is at 19.5 million ha amounting to 27% of the land mass. Combined, these two categories constitute 80% of the still intact forest in Borneo. 8 million ha or 11% of the land mass is still intact forest but has not yet been allocated into either protected or production forest.

The section that follows provides some details regarding forest categories in accordance to ecosystems.

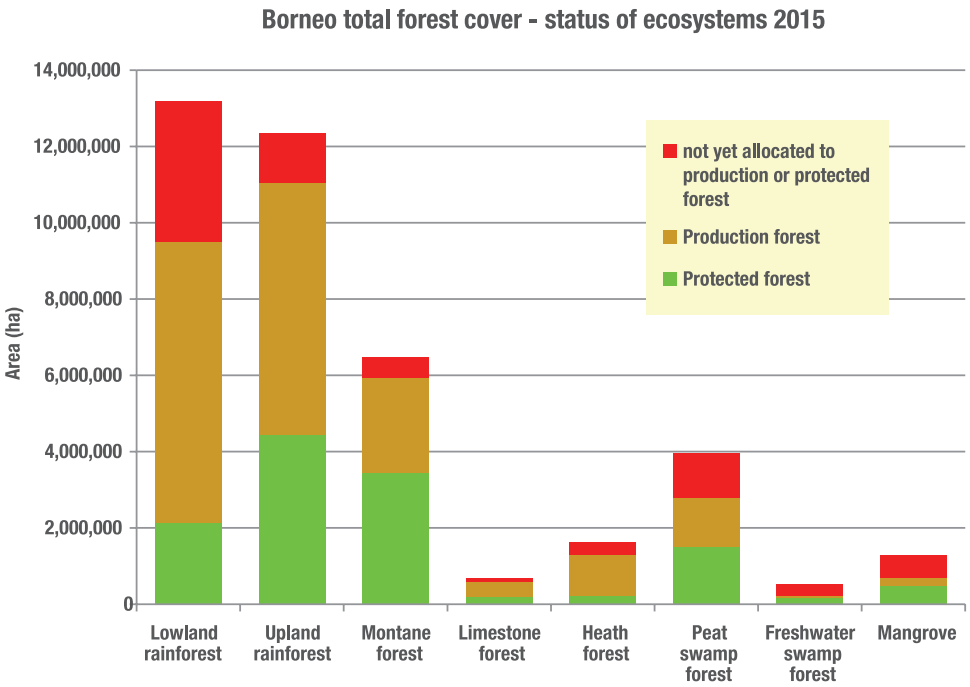


Table 20: Distribution of forest types within protected, production and neither type (2015)

Ecosystems	Forest cover 2015		
	Protected forest	Production forest	Not allocated to protected or production forest
Lowland rainforest	2,133,103	7,370,082	3,695,504
Upland rainforest	4,450,563	6,599,249	1,298,148
Montane forest	3,443,491	2,478,993	539,411
Limestone forest	192,361	384,109	98,677
Heath forest	228,044	1,071,945	324,729
Peat swamp forest	1,521,934	1,258,706	1,170,511
Freshwater swamp forest	162,068	71,884	300,613
Mangrove	484,772	216,616	578,026
Grand Total	**12,616,335**	**19,451,584**	**8,005,620**

Note: The figures in the graph and table are the actual forest covers (measured through GIS analysis), which were checked with the government allocation status data.

2.1.1 Lowland rainforest in protected and production forest

Snapshot

- Lowland rainforest is one of the most important ecosystems on the planet, but relatively little in Borneo is protected or located inside protected areas. Home to thousands of unique animal and plant species, the consequences of its loss are dire in terms of species extinction.
- Most of the protected lowland rainforest in the Indonesian part of Borneo is inside *Hutan Lindung* (Protection Forest) areas which do not have a management body or plan in place.
- The total extent of lowland rainforest within allocated production forest is 7.3 million ha in 2015.
- Logging companies are increasingly committed to sustainable forest management so the chances are improving that this forest can be preserved for the future as production forest while still maintaining significant biodiversity.
- Although most species might be able to survive in logged-over forest, the delicate vegetation structure of primary lowland rainforest will be lost.

Lowland rainforest is one of the most important ecosystems on the planet. Home to thousands of unique animal and plant species, the consequences of its loss are dire in terms of species extinction.

A situation made all the more precarious by the fact that relatively little lowland rainforest in Borneo (around 2.1 million ha) is protected or located inside protected areas. Indeed, of the lowland rainforest remaining, 57% or 7.3 million ha is inside production forest, while a staggering 3.7 million ha is not yet allocated to be retained as production or protected forest, and could be allocated to other land uses.

Most lowland rainforest is on relatively flat terrain, facilitating good infrastructure development and erosion control, and many conservationists agree that with carefully planned logging, much of the biodiversity and wildlife can be preserved.

While it is true that most of the protected lowland rainforest in the Indonesian part of Borneo is inside *Hutan Lindung* (Protection Forest) areas, these, unlike national parks, generally do not have a management body or plan in place. In addition, large areas of lowland rainforest are inside logging concessions.

Fortunately, these days, many logging companies are committed to sustainable forest management so the chances are improving that these forest can be preserved for the future as production forest, with reduced impact logging while still maintaining significant biodiversity.

Selective logging through sustainable forest management should retain forest that can recover and remain productive for the future. Although most species might be able to survive in logged-over forest, the delicate vegetation structure of primary lowland rainforest will be lost.

Description by region

Sabah: Around 600,000 hectares remain in central Sabah within forest reserves, such as Danum Valley and Gunung Rara.

Brunei: Significant protected lowland rainforest exists inside Ulu Temburong National Park.

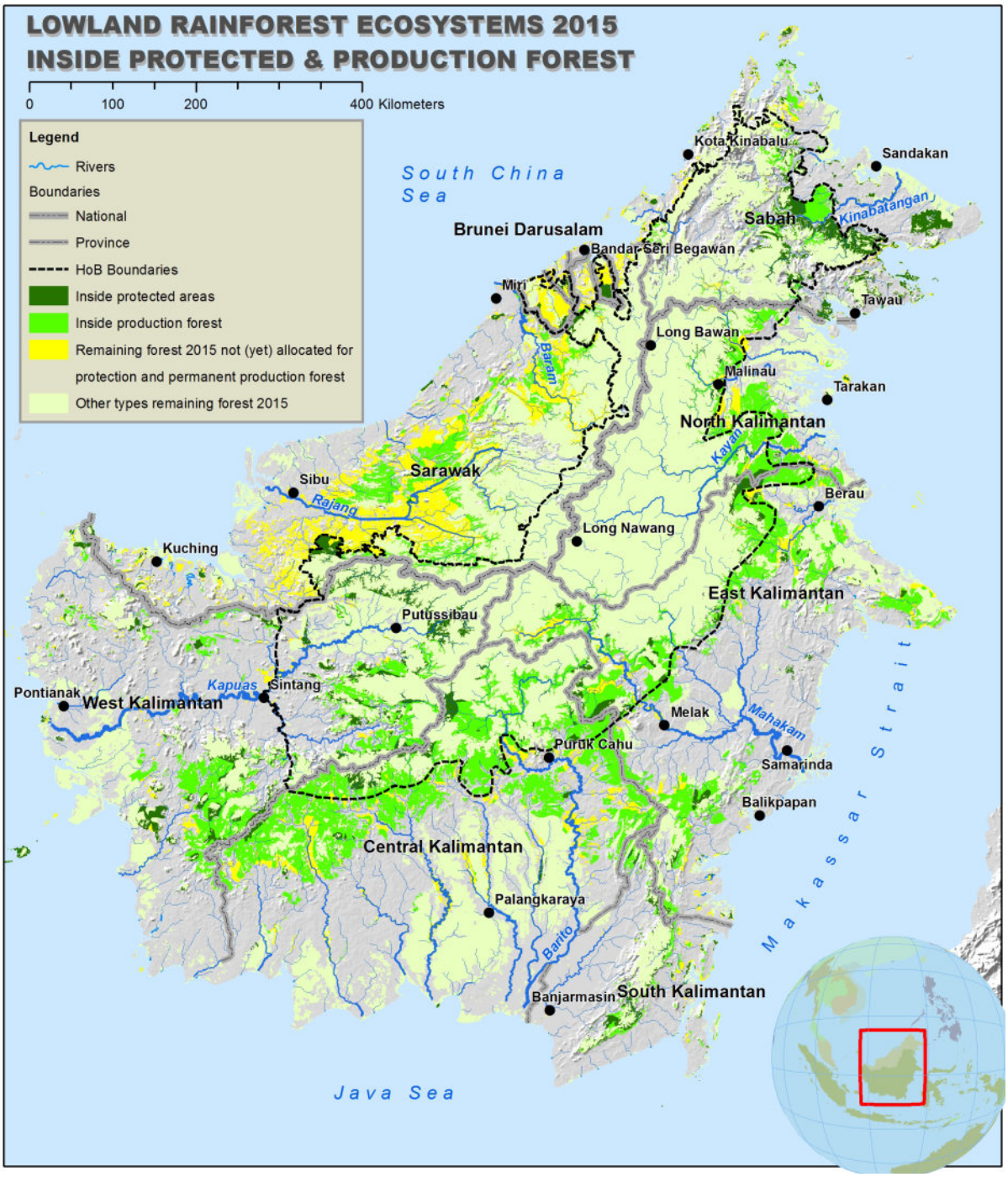
Sarawak: The largest remaining area of protected lowland rainforest is in the Lanjak Entimau Wildlife Sanctuary and is relatively undisturbed.

West Kalimantan: The second largest area of lowland forest (around 300,000 ha) in a protected area in Borneo is in the Betung Kerihun National Park in West Kalimantan. Other than that, the only patches now remaining which could be preserved as sustainable production forest are in the Arabela landscape and in the valleys of mountain foot slopes. Around 900,000 ha of the remaining lowland rainforest of West Kalimantan is in logging concessions.

Central Kalimantan: The dryland lowlands of this province still hold opportunity for preserving lowland forest, though there is heavy pressure for conversion in all the easily accessible locations.

South Kalimantan: The lowland rainforest left in South Kalimantan is found mainly at the foot slopes of the Meratus mountains, and half of the area is protected while the other half is production forest. The only lowland rainforest outside of the Meratus area is allocated for conversion.

North and East Kalimantan: Much of these provinces comprise uplands and mountains, but large stretches of good quality lowland rainforest could still be preserved as sustainable production forest in the eastern lowlands of North and East Kalimantan. Some areas of lowland forest in a protected area of Borneo is in Kayan Mentarang National Park in North Kalimantan, though with the exception of a few river valleys, most of the area is above 300 m asl.


LOWLAND RAINFOREST ECOSYSTEMS 2015
INSIDE PROTECTED & PRODUCTION FOREST
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Inside protected areas
Inside production forest
Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
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Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
West Kalimantan
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Mahakam
Puruk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.1.2 Upland rainforest inside protected and production areas

Snapshot

- With most of the lowland forest of Borneo now logged, logging companies operate in the upland forest as their second best option.
- The total area of upland rainforest inside protected areas is large at 4.5 million ha, but whether this will be sufficient for conservation of the ecosystem and its species is as yet unknown and subject to doubt by many ecologists.
- More than half of the remaining upland rainforest (53%) at 6.6 million ha is inside production forest.
- The logging impacts in upland rainforest are often smaller than in lowland rainforest, as the number of commercially valuable trees that can be harvested per hectare is generally lower.

Protected forest

The total upland rainforest inside protected areas is 4.5 million ha. The largest blocks of upland rainforest that remain forest covered and protected are those in the Lanjak-Entimau Wildlife Sanctuary in Sarawak, the Betung-Kerihun National Park in West Kalimantan, and the Bukit Baka Bukit Raya National Park straddling West and Central Kalimantan. The other blocks are in the Kayan-Mentarang National Park in North Kalimantan and the Danum Valley in Sabah. On the Muller Mountain Range straddling West and East Kalimantan, large blocks of upland rainforest are also protected. In South Kalimantan, the Gunung Meratus Mountain still contains intact forest.

Elsewhere remain pockets of upland rainforest, the sizes of which are inadequate for conservation of biodiversity and protection of ecosystem services. It is therefore vital to identify steep slopes in certain regions of Borneo that need to be preserved for conservation as well as to function as erosion and hydrological protection.

Production forest

More than half of the remaining upland rainforest (6.6 million ha) is inside production forest. The distribution of commercial timber species in the highland areas is uneven. From 300 to 800 m above sea level, there is a wide variation of species over the different elevation ranges. At foot slopes of the lower elevations, a higher number of bigger sized trees of the Dipterocarpaceae species could be found. As timber in the lowland forest becomes depleted, forest at the lower elevations have now become the focus of logging. Overtime, as these forest too become extensively logged, the higher elevations would not be spared from harvesting operations, even though the volumes of timber species are lower.

As logging operations get higher and higher into terrains that are susceptible to erosion and degradation, the impact on the environment becomes increasingly severe. While improved forest management systems have reduced the impact on the environment and helped to preserve ecological functions of the upland rainforest of Borneo, harvesting operations should not take place nor logging roads be constructed in areas of steep terrain. In Sarawak, steep terrain with more than 35 degree or 70% slope is prohibited from conventional logging, while in Sabah, vast areas of commercial Class II Forest Reserve have been reclassified as Class I Forest Reserve where logging is now prohibited, though the area has been previously logged.

Description by Region

Sabah: The upland forest of the Crocker Range is all protected, so are Danum Valley, Imbak Canyon and Maliau Basin. The central part of Sabah is largely production forest which may be subject to conversion into industrial tree plantations.

Brunei: All Brunei upland forest is protected.

Sarawak: The wide upland forest of Lanjak Entimau and Batang Ai in Sarawak is inside these protected areas, but otherwise hardly any uplands in Sarawak are strictly protected. This situation is remarkable given the fact that most of these uplands of the interior mountain ridges are characterized by steep slopes and serve very important hydrological functions for the productive lowlands of Sarawak. However, the Sarawak government is pursuing some pro-active measures for forest management certification, targeting all production forest within the HoB to be certified by mid-2017.

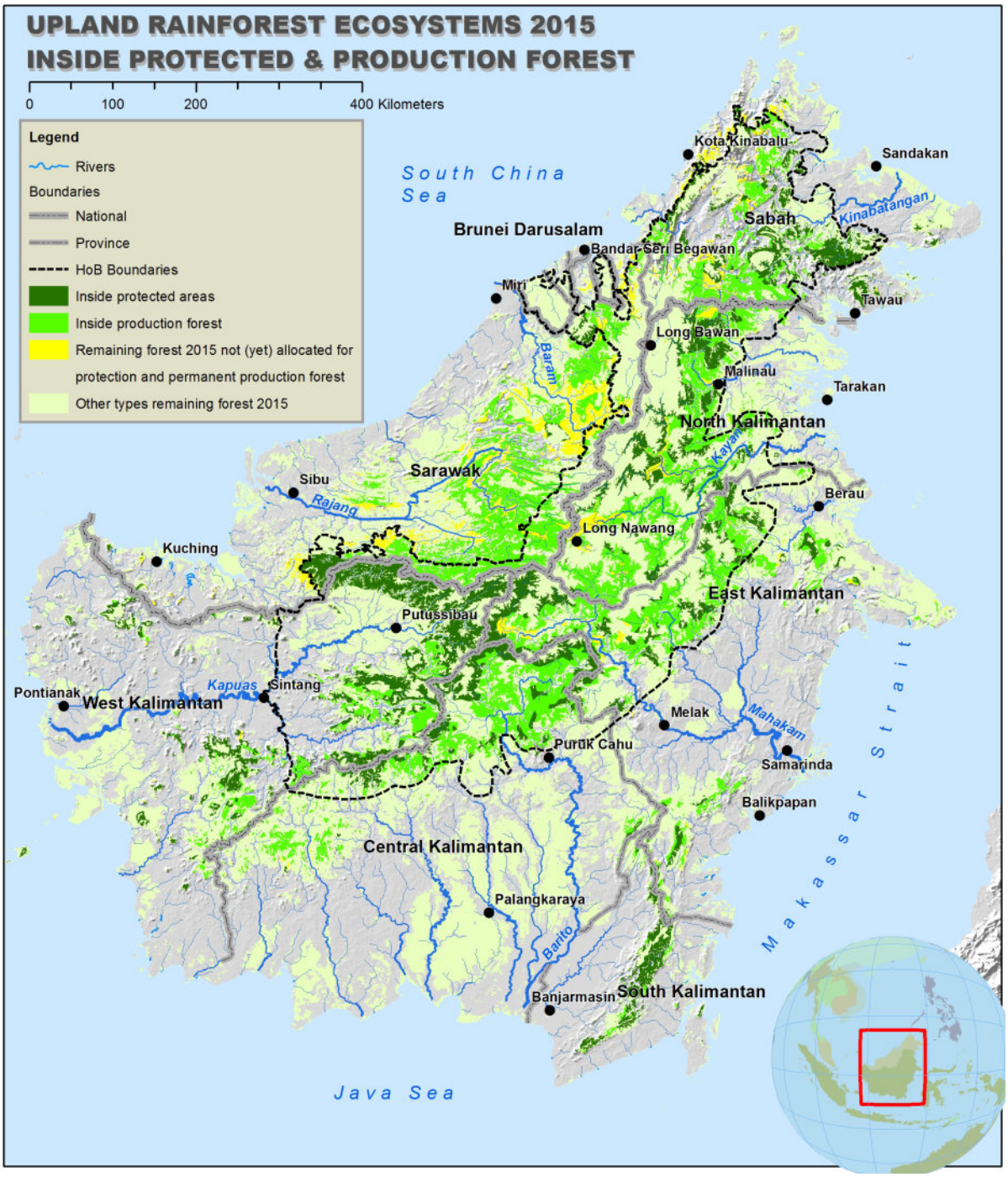
West Kalimantan: Most land of Betung Kerihun is upland forest and encompasses the largest stretch of this ecosystem in West Kalimantan. The northern slopes of Bukit Baka Bukit Raya are also covered by large areas of upland forest. Otherwise, none of the upland forest of West Kalimantan is strictly protected, though several areas will probably be retained as "Protection Forest" (*hutan lindung*). Relatively few logging companies are currently active within the HoB in this province because the remaining upland forest is all in remote locations with limited accessibility, making it difficult and expensive to transport logs to coastal areas.

Central Kalimantan: Upland rainforest is the largest ecosystem of the HoB part of Central Kalimantan. The area that is strictly protected will increase once the Muller-Schwaner conservation initiative is implemented. In Central Kalimantan, wide rivers make it possible to transport logs from the uplands. Several roads also provide access to the remote interior. Many active logging concessions reach all the way to the foot slopes of the highest mountain complexes of the province.

South Kalimantan: Most of the remaining upland forest is in the Meratus Mountains.

East Kalimantan: Nearly all the land between the highest mountain ridges in the west and the lowlands in the east of the province is covered by upland forest. Logging concessions have been operating along the Mahakam river and its tributaries for several decades. Now that all lowland rainforest in these areas has been logged, concessions have expanded to the uplands, most of which is being harvested.

North Kalimantan: Most upland rainforest now exists east of Kayan Mentarang National Park.


UPLAND RAINFOREST ECOSYSTEMS 2015
INSIDE PROTECTED & PRODUCTION FOREST
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400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Inside protected areas
Inside production forest
Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
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Samarinda
Purūk Cahu
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.1.3 Montane forest ecosystems in protected and production areas

Snapshot

- Montane forest has more area in protected forest (3.4 million ha) than production forest (2.5 million ha).
- The large majority of the montane forest of Borneo will be retained under forest cover as protected or production forest.
- The volume of commercial timber species of montane forest is more limited than in the lowlands.
- Logging of the montane forest at the highest elevations of their concessions is often not the highest priority of the timber companies since volumes of commercial timber are much lower.

Protected forest

Montane forest has significantly more area in protected forest (3.4 million ha) than production forest (2.5 million ha). The large majority of the montane forest of Borneo will be retained under forest cover as protected or production forest.

Production forest

A very large portion, 38% of montane forest is inside production forest. Montane forest in a logging concession is usually part of a bigger area that encompasses large sections of upland rainforest. With higher costs of extraction, montane forest is a lesser priority for logging companies. However, in certain areas, logging companies will harvest high commercial value species such as Agathis and *Palaquium spp*. up to 1800 m if they are allowed.

Description by Region

Sabah: Nearly the entire Crocker Range and Mt. Kinabalu is protected forest. Maliau Basin is the largest protected montane forest in the interior of Sabah, and encompasses unique mixture of montane forest types including montane heath forest.

Brunei: Only has montane forest at the upper reaches of Ulu Temburong.

Sarawak: Has more montane forest allocated as production forest in the central upper watersheds than allocated as protected forest in the Gunung Buda, Pulong Tau and Usun Apau National Parks.

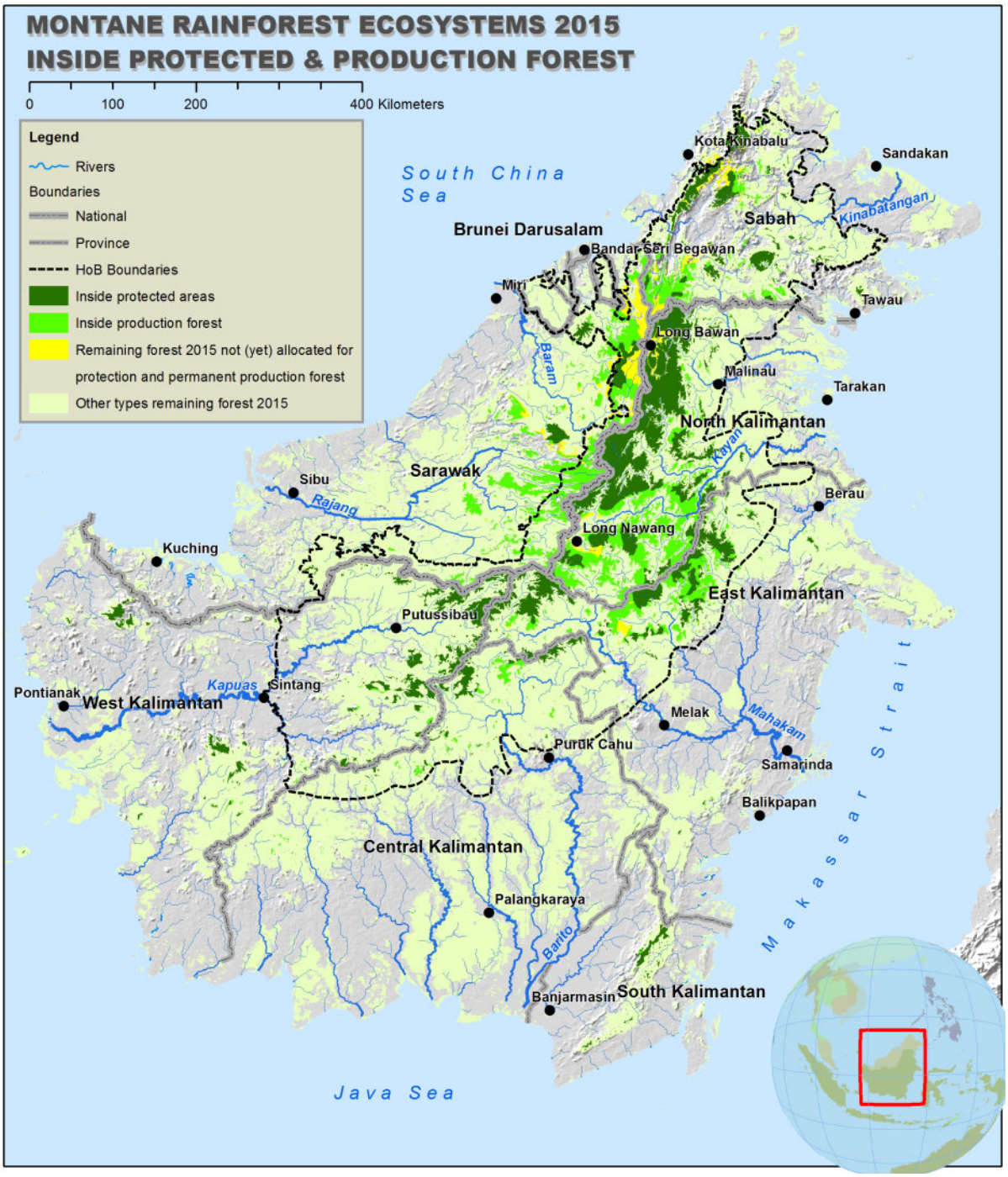
West Kalimantan: The westernmost montane forest of Borneo, Gunung Niut Penrissen Nature Reserve in West Kalimantan, consisting of Mount Niut, Mount Serang and Mount Penrissen which have several peaks above 1500 meters above sea level. Other large montane forest in this province is found in the northern part bordering with Sarawak, in the upper Kapuas and protected areas inside Betung Kerihun National Park and as protection forest (*Hutan Lindung*) in the south.

Central Kalimantan: All montane forest in this province is in the northern mountain ranges, most of this is protected as Nature Reserve (*Cagar Alam*) or Protection Forest (*Hutan Lindung*).

South Kalimantan: All montane forest in South Kalimantan is in the Meratus Mountains and all is protected.

East Kalimantan: The highest upper sections of the Mahakam river and its tributaries are protected.

North Kalimantan: North Kalimantan is the province with the largest extent of montane forest in Borneo. Wide uninterrupted montane forest is in Kayan Mentarang National Park. Mountain complexes in the south of the Kayan river are protected as well. However, there is 800,000 hectares of montane forest in the upper Kayan watershed which is allocated for production forest.


MONTANE RAINFOREST ECOSYSTEMS 2015
INSIDE PROTECTED & PRODUCTION FOREST
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200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Inside protected areas
Inside production forest
Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.1.4 Peat swamp forest in protected and production areas

Snapshot

- The total extent of peat swamp forest inside protected areas (1.52 million ha, 39% remaining) is larger than the total extent of peat swamp forest inside production forest (1.29 million ha, 32% remaining).
- Though a number of valuable tree species are present, removal of timber is time consuming and costly, so the sustainability of forestry in this area is questionable.
- Critics may speculate that the real goal of pursuing a logging concession in interior peat swamp forest is to eventually convert the area to oil palm plantations.

Protection forest

By far the largest areas of peat swamp forest inside protected areas are in Central Kalimantan; other protected peat swamp forest is in West Kalimantan and Sarawak. The total extent of peat swamp forest inside protected areas (1.52 million ha) is larger than the total extent of peat swamp forest inside production forest (1.29 million ha).

Production forest

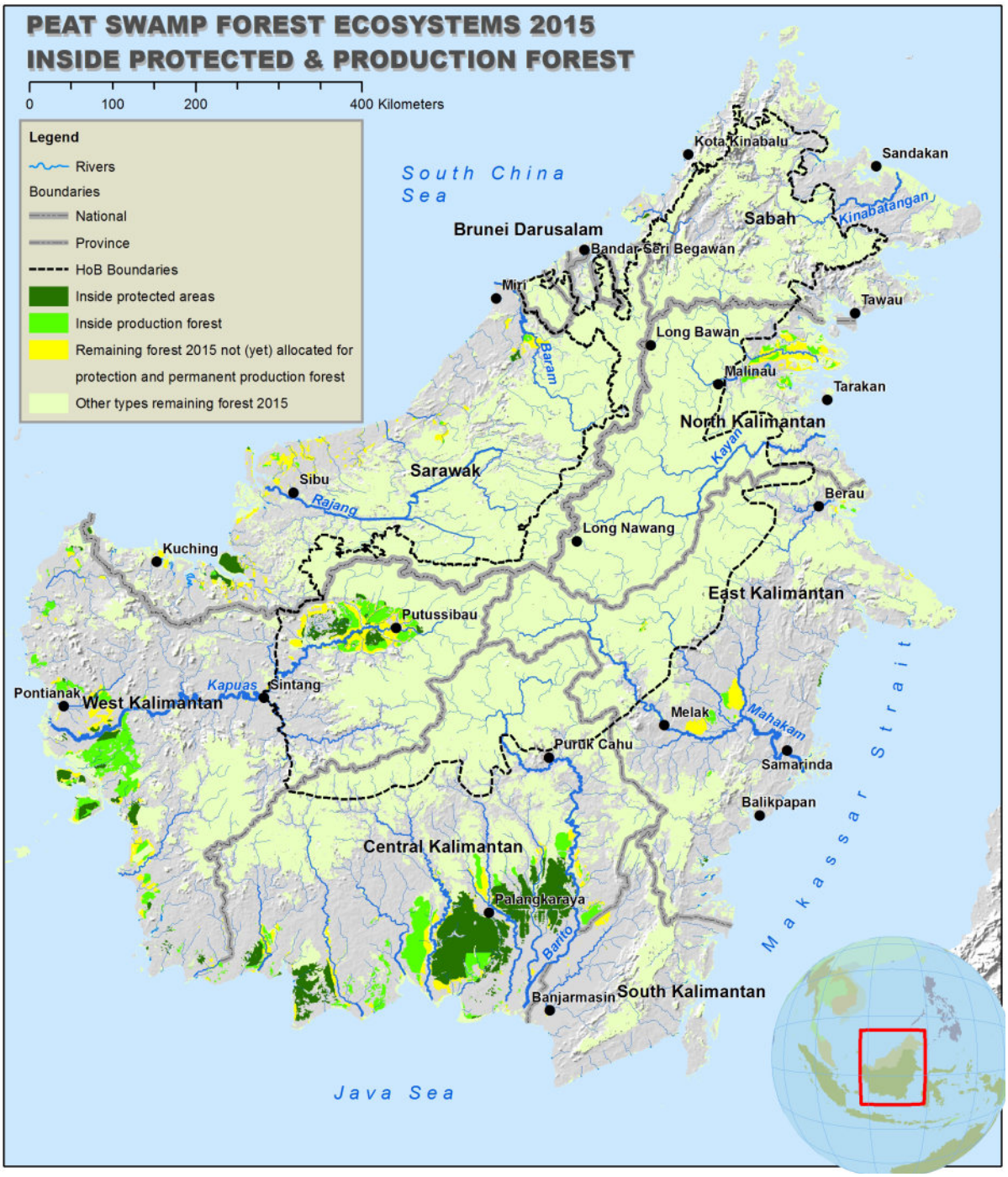
About one-third (32%) of the remaining peat swamp forest is inside production forest. Logging of peat swamp forest requires the construction of extensive infrastructure, which has undeniable environmental impacts. Development plans have extended deep into the peat forest of the region with large areas currently inside logging concessions. Of the peat swamp forest of West Kalimantan not currently inside concessions, large areas are allocated as 'other land use areas', which implies that this forest type can be converted.

Peat swamp forest in Borneo's interior provides much lower volumes of commercial timber than lowland rainforest. Though a number of valuable tree species are present, removal of timber is time consuming and costly, so the sustainability of forestry in this area is questionable. Critics may speculate that the real goal of pursuing a logging concession in interior peat swamp forest is to eventually convert the area to oil palm plantations.

In Sarawak as an example, there is no logging concession inside peat swamp forest, but that does not eliminate the threat of conversion to other land uses. Also, timber production has stopped because there is limited stock available, as these forests are the first areas to be harvested for commercial timber.

Much peat swamp forest is already inside oil palm plantation concessions and the planting of the oil palm can only begin once the terrain is fully prepared, which includes the modification of the natural hydrology via the digging of drainage canals and associated destruction of conservation values. Once this is done, then oil palm plantations can be easily established, though requiring large amounts of fertilizer to be productive.

In places where this occurs, some of the peat swamps on terrains with deep peat and long inundation periods might be preserved by the companies as green belts or high conservation value areas. At the moment these decisions are at the discretion of company managers and HCV assessors as more and more areas are getting certified for Roundtable on Sustainable Palm Oil (RSPO).


PEAT SWAMP FOREST ECOSYSTEMS 2015
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Inside protected areas
Inside production forest
Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
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Purūk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.1.5 Freshwater swamp forest inside protected and production areas

Snapshot

- Around 30% of Borneo's total freshwater swamp forest is inside protected areas, while around 13% is inside production forest.
- The largest freshwater swamp forest area still remains in Brunei. Although not inside protected areas, there appears to be no current government planning to convert or log any of these areas.
- In Indonesian Borneo, the only remaining large stretches of freshwater swamp forest are along the main rivers, none of which is protected or inside concessions.
- Timber extraction costs in swamp forest are much higher than in dryland forest since drainage or canal digging is required to transport the logs.
- Accessible freshwater swamp forest is highly sought after for agriculture since the soil is generally very fertile which makes it more profitable to convert.

Protected areas

In Indonesian Borneo, the only remaining large stretches of freshwater swamp forest are along the main rivers, none of which is protected or inside concessions. These then remain vulnerable to conversion. In Sabah, most of the remaining freshwater swamp forest is protected. Around 30% of freshwater swamp forest is inside protected areas. These include the more remote swamps with the highest water levels. The largest areas of freshwater swamp forest (106,000 ha) still remain in Brunei; although not inside protected areas. For the moment, they appear safe as there is no current government planning to convert or log any of these areas.

Production forest areas

A relatively small part (13%) of Borneo's total freshwater swamp forest is inside production forest.

Timber extraction costs in swamp forest are much higher than in dryland forest since drainage or canal digging is required to transport the logs. Accessible freshwater swamp forest is highly sought after for agriculture since the soils are generally very fertile which makes it less financially viable to retain as production forest.


FRESHWATER SWAMP FOREST ECOSYSTEMS 2015
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Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
South China Sea
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Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.1.6 Heath forest inside protected and production areas

Snapshot

- The heath forest of Borneo is only protected in three main national parks in Borneo: Danau Sentarum in West Kalimantan, northernmost Sebangau and northern Tanjung Puting, both in Central Kalimantan.
- The vast majority (66%) of the remaining heath forest is inside production forest, but the volume of commercial value timber that can be extracted from heath forest is limited
- Conservation of parts of this unique ecosystem in Borneo is still possible as most of the areas that are currently not productive are allocated as limited production forest and protection forest.
- Monitoring of the land use status will be crucial as this fragile ecosystem can be degraded rapidly.

Protected areas

The heath forest of Borneo is only protected in three main national parks in Borneo: Danau Sentarum in West Kalimantan, northernmost Sebangau and northern Tanjung Puting, both in Central Kalimantan.

Production areas

The vast majority (66%) of the remaining heath forest is inside production forest. Some sections of heath forest are inside logging concessions that operate mainly in the surrounding lowland rainforest. The volume of commercial value timber that can be extracted from heath forest is limited.

Regeneration of large trees in logged-over forest on these extremely poor soils is naturally very slow. The core heath forest areas grow on extremely nutrient-poor white sands and timber productivity is therefore lower than in lowland and upland rainforest. Nevertheless, a very popular timber species, Agathis, is particularly common in most heath forest and can reach large diameters here. Ensuring the presence of sufficient standing timber for a second and further harvest rotations requires careful forest management.

Large stretches of heath forest, particularly in Central Kalimantan, are allocated for conversion; the soils of these heath forest areas are actually too poor for production of cash crops. However, with high price of palm oil, it is often still economically viable to establish palm plantations and apply large amounts of artificial fertilizer.

Conservation of remaining parts of this unique ecosystem in Borneo is still possible as most of the areas that are currently not productive are allocated as limited production forest and protection forest. Monitoring of the land use status will be crucial as this fragile ecosystem can be degraded rapidly.


HEATH FOREST ECOSYSTEMS 2015
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Inside protected areas
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Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
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Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

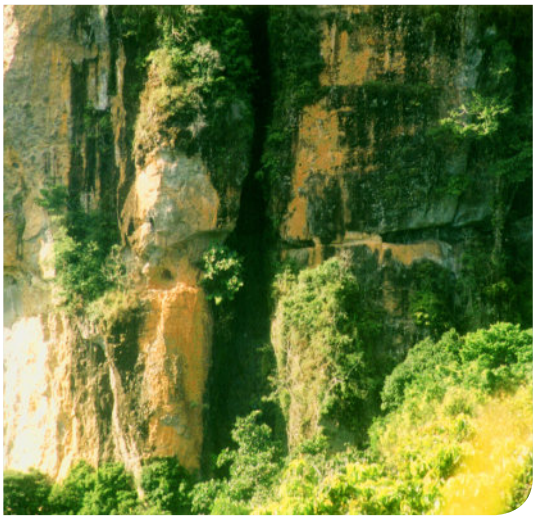
2.1.7 Limestone forest in protected and production areas

Snapshot

- Many large limestone forest ecosystems are not in protected areas in Borneo.
- More than half (57%) of the limestone forest in Borneo is inside production forest.
- A number of limestone forest areas are allocated for conversion as limestone for the cement industry is a major source of income.
- Disturbance of limestone forest ridges often results in community unrest due to cultural significance or due to the presence of bird nest caves.

Protected areas

Many large limestone forest ecosystems are not in protected areas in Borneo. The exception is in Sarawak where these sites (with their caves and rock formations) are all protected and are major tourism destinations, such as inside the Gunung Mulu National Park.



On the Indonesian side of Borneo, sites with steep slopes (a characteristic of limestone forest terrains) are automatically gazetted as Protection Forest. This is indeed the case with most of the limestone ridges and cliffs along many of the major rivers of Kalimantan. However, in Sangkulirang in East Kalimantan, less than 40%, of limestone forest is protected.

Production forest

More than half (57%) of the limestone forest in Borneo is inside production forest. Much of the limestone forest inside logging concessions is part of greater concessions of lowland or upland rainforest with sections of limestone areas. However, in the Sangkulirang peninsula in eastern Kalimantan, logging concessions exist that encompass solely limestone forest.

Large limestone outcrops can also be found inside logging concessions. Timber productivity within limestone forest is generally much lower than in lowland rainforest. The number of commercial species is lower and sizes are smaller due to the limiting soil conditions with limestone base rock not far below the surface.

Given the characteristics of limestone areas where many steep cliffs and unusual shaped outcrops occur, part of these concessions appear to be almost impossible to log without great extraction costs.

A number of limestone forest areas are allocated for conversion, as limestone for the cement industry is a major source of income. Disturbance of limestone forest ridges often results in community unrest due to cultural significance, or the presence of bird nest caves.


LIMESTONE RAINFOREST ECOSYSTEMS 2015
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Inside protected areas
Inside production forest
Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
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Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.1.8 Mangrove ecosystems inside protected and production areas

Snapshot

- More than one third (38%) of the remaining mangroves is inside protected forest, while 17% is inside production forest.
- A complete mangrove ecosystem includes both frontal as well as rear mangroves with the highest biodiversity usually found in the rear mangroves.
- Rear mangroves have been subjected to small-scale conversion throughout Borneo for decades, due to easy access and low visibility by boat.
- The proboscis monkey is a key indicator species in these areas for measuring the impacts of sustainable management.

A complete mangrove ecosystem includes both frontal as well as rear mangroves. The highest biodiversity of a mangrove ecosystem is usually found in the rear mangroves, with the highest number of plant species and the highest number of mammal species

Rear mangroves have been subjected to small-scale conversion throughout Borneo for decades; access from the dryland rear is possible and drainage is less complicated; this conversion is often not directly visible to the public, who mainly pass by mangroves by boat and thus only see the frontal mangroves.

© WWF-Indonesia/Stephan Wulffraat

Protected areas

More than one-third (38%) of the remaining mangroves are inside protected forest. There is also a RAMSAR site in Sarawak where the Kuching Wetlands National Park is a mangrove area.

Production forest

Around 17% of mangrove ecosystems is inside production forest. These areas are managed by specialized logging concessions who are experienced in extraction methods of mangrove trees from the semi-inundated terrains and serve a separate market for the mangrove species.

Some of the largest mangrove areas inside logging concessions are in West Kalimantan; the largest of these is at Kubu Raya, where the companies are committed to sustainable production incorporating wildlife protection. The proboscis monkey is a key indicator species in these areas for measuring the impacts of sustainable management.

Much mangrove forest (particularly in the north-eastern part of Borneo) is allocated for conversion, mainly for aquaculture with fish ponds and prawn ponds. Government regulations state that a strip of natural vegetation should be retained along the coastline and the major river banks.

The Rajang Delta in Sarawak still has extensive coverage of mangroves which are protected as Rajang Mangroves National Park, but large areas remained to be accorded any form of protection, which the government should give urgent attention to before they are lost to other land uses.


MANGROVE ECOSYSTEMS 2015
INSIDE PROTECTED & PRODUCTION FOREST
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HoB Boundaries
Inside protected areas
Inside production forest
Remaining forest 2015 not (yet) allocated for protection and permanent production forest
Other types remaining forest 2015
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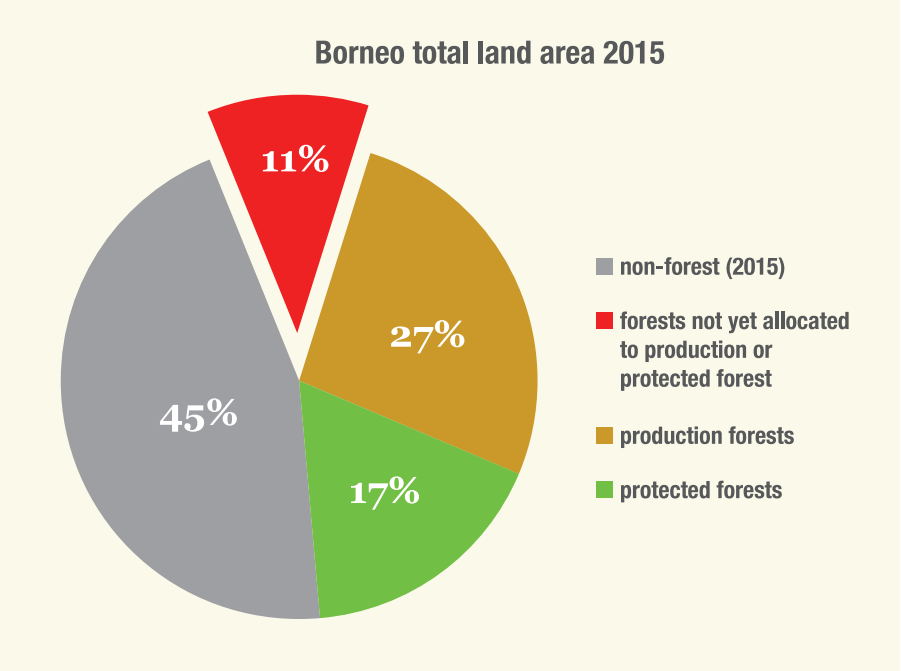
Makassar Strait
Java Sea

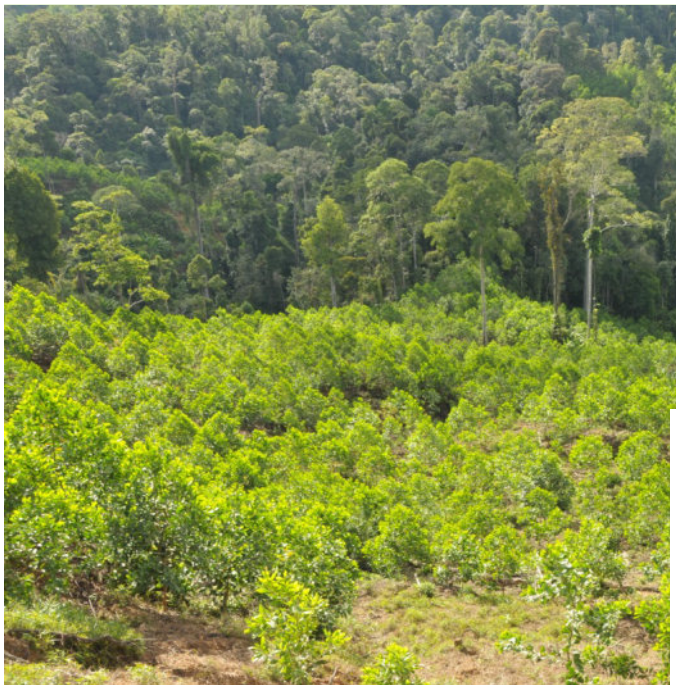
2.2 Forest allocated to other land use



Forest allocated or designated for other uses refers to areas that are still forest covered, but are located outside protected areas or production forest as in map (page 97). Without legal protection, or additional land use planning, this forest could be allocated for conversion, or illegally felled and then converted.

At this point, there are steps taken by the respective forestry authorities to legally establish more areas into protected areas or production forest. As of 2015, the total forest area that could potentially be allocated for other land uses is 8.0 million ha.

Forest allocated for conversion into pulpwood plantation (photo: © WWF-Malaysia/Henry Chan)



Forests not yet allocated for protection and permanent production forest are not yet secured from allocation for conversion such as shown in the photos. The page-size map indicating these areas is displayed on page 97.

Forest allocated for conversion into oil palm plantation (photo: © WWF-Malaysia/Henry Chan)

2.3 Forest allocated for other land uses by ecosystem type

Lowland rainforest

More than 3.7 million ha (or 28%) of the remaining lowland rainforest of Borneo is not yet allocated to be retained as production or protected forest. Part of this forest type could be allocated for conversion. Information on the final destinations of these land allocations is not available.

Previous conversions tell us that the major conversions are for:

1) Oil palm plantations

2) Pulpwood plantations

3) Community agriculture

4) Hydropower, infrastructure and other land developments.

Upland rainforest

More than 1 million ha (1,298,000) of the remaining upland rainforest in Borneo is not yet allocated to be retained as production or protected forest, representing 10% of the total extent. Most of these areas throughout Borneo is on the lower slopes in more accessible locations.

Montane forest

Almost half a million ha (539,000) of montane forest is not yet allocated to be retained as production or protected forest. These areas are mainly in Sabah and Sarawak.

Peat swamp forest

More than one-quarter (30%) or 1.17 million ha of the remaining peat swamp forest is not yet allocated to be retained as production or protected forest. Parts of this forest type are allocated for conversion. These areas are considered as good opportunities for plantation establishment by developers.

Freshwater swamp forest

The majority (56%) or 300,000 ha of the remaining freshwater swamp forest is not yet allocated to be retained as production or protected forest. Freshwater swamp forest along the major rivers is attractive to agriculture because of its fertile soil, easy access, and not-too-complicated drainage possibilities.

Heath forest

A large area of 325,000 ha of heath forest is not yet allocated to be retained as production or protected forest. Part of this forest type is allocated for conversion. The extremely low soil fertility of these areas will be a challenge for developers.

Limestone forest

The 11% (98,000 ha) of the total extent of limestone forest allocated for conversions is mainly in the Sangkulirang peninsula in East Kalimantan.

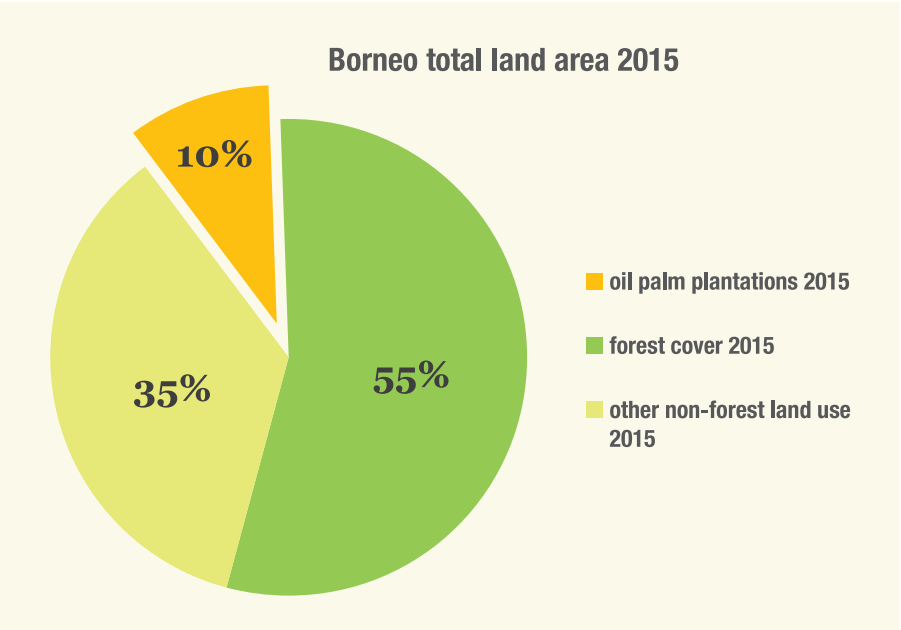
Mangrove

Almost half (45%) or 578,000 ha of the remaining mangroves of Borneo is not yet allocated to be retained as production or protected forest. Parts of this forest type are allocated for conversion. Previous mangrove conversions were mainly done for the development of aquaculture.

2.4 Oil palm plantations

Snapshot

- The rapid growth of oil palm plantation development is one of the biggest drivers of deforestation in Borneo, in response to a global demand, making it the most important tropical vegetable oil in the world.
- Throughout its rapid growth over the past 20 years, various states and provinces embraced industrial style production at different times, with the largest growth in Borneo's history occurring between 2005 and 2010.
- The international market for palm oil is still growing and the profits from the industry are higher than any other agricultural produce in Borneo.
- The strong effect of oil palm plantation development on native forest is apparent throughout Borneo.
- Palm oil industry expansion is inevitable; whether this occurs at the further expense of Borneo's spectacular rainforest ecosystems will be a true test of industry stewardship and government foresight and regulation.



One of the biggest drivers of deforestation is the rapid growth of plantation development for oil palm (*Elaeis guineensis*). This has been in response to a global demand for palm oil which has made it the most important tropical vegetable oil in the world. Oil palm plantations, as at 2015, stand at more than 7 million ha or 10% of the Borneo land area.

Throughout its rapid growth over the past 20 years, various states and provinces embraced industrial style production at different times. In Sabah, for example, most of the large oil palm plantations were already established by 2005, with less rapid expansion since then. Before 2005, lowland areas with good accessibility were developed into oil palm plantations. After 2005, many upland areas were also developed, with the initial plantation development providing access roads and the further development of new plantations.

The largest expansion of oil palm in Borneo's history occurred between 2005 and 2010. From 2010-2015, expansion was smaller, with a few large blocks appearing, but largely just additions to the edges of existing plantations. By 2015, palm oil plantations that form entire landscapes in some parts of Sabah have likewise become a feature of northern Sarawak, as well as West and Central Kalimantan.

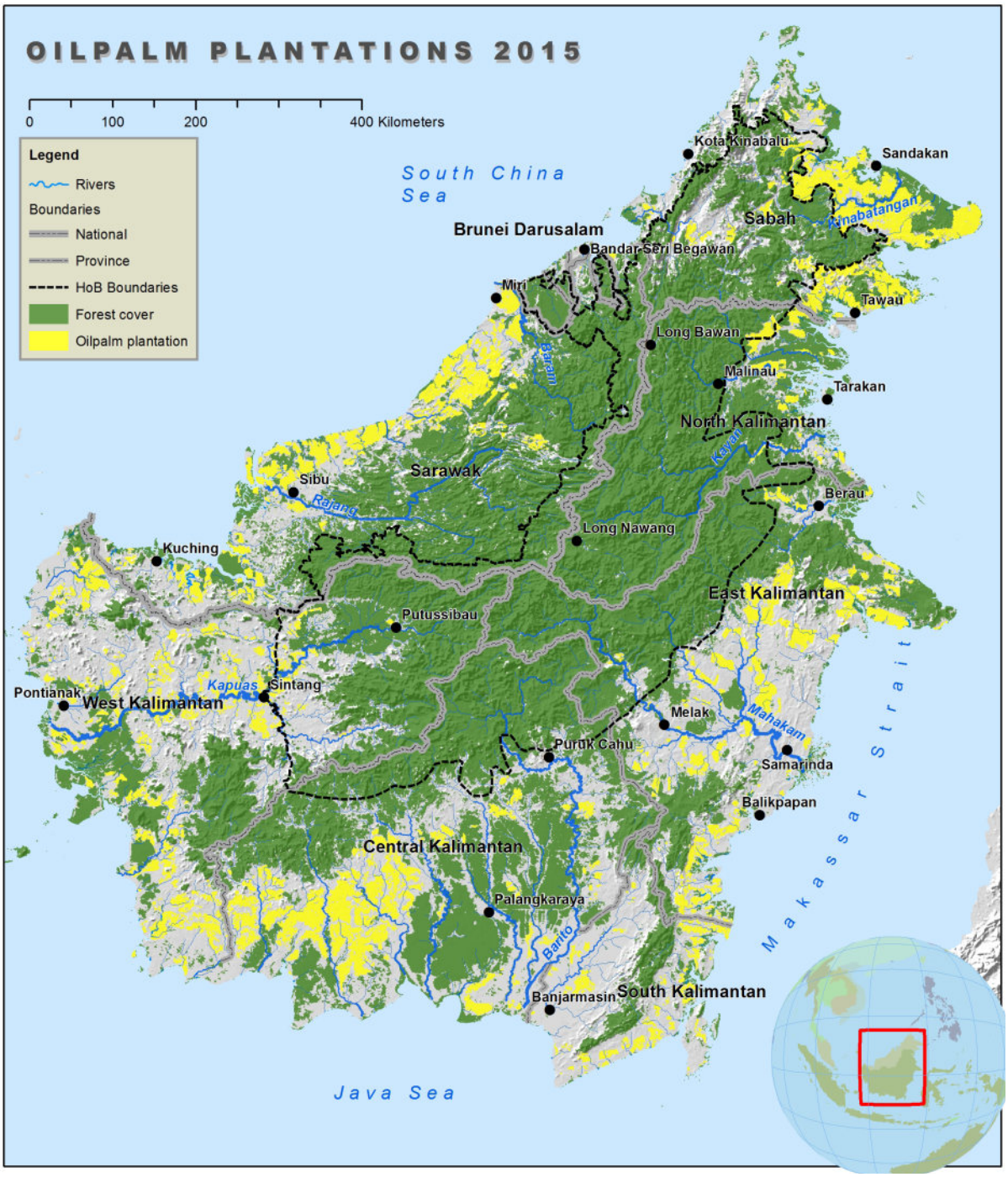
In Malaysian Borneo, Sarawak is regarded as the final frontier for oil palm plantation development, due to the exhaustion of land banks for other states in Malaysia. Intensification began in 2000 and this has resulted in the opening up of many peat swamp forest and peatlands for palm oil production.

The greatest impact from land conversion in Sarawak is oil palm plantation development, accelerated by the exhaustion of land banks in Peninsular Malaysia. Malaysia has been a top palm oil producing country since the 1970s, and together with Indonesia, account for more than 85% of the world's production (FAO, 2014).

Under the Malaysian Third National Agriculture Policy (1998-2010), more land in Sarawak was designated for planting oil palm (MOA, 1998) and since then, Sarawak has recorded the highest expansion in planted areas for all states in Malaysia.

The devastating effect of oil palm plantation development on native forest is apparent throughout Borneo. The international market for palm oil is still growing and the profits from the industry are higher than any other agricultural produce in Borneo. Palm oil industry expansion is inevitable; whether this occurs at the further expense of Borneo's spectacular rainforest ecosystems will be a true test of industry stewardship and government foresight and regulation.

***Note**: Spatial data on oil palm plantations in Borneo is often not available, but their development can be easily detected from publicly available satellite images. Oil palm plantations were mapped from satellite images – this assessment can be done from freely available images by anyone with basic GIS skills, and does not require government-issued plantation concession maps. In contrast, the mapping is not possible for pulpwood plantations (since spectral characteristics of older pulpwood stands cannot be faultlessly distinguished from certain forest types).*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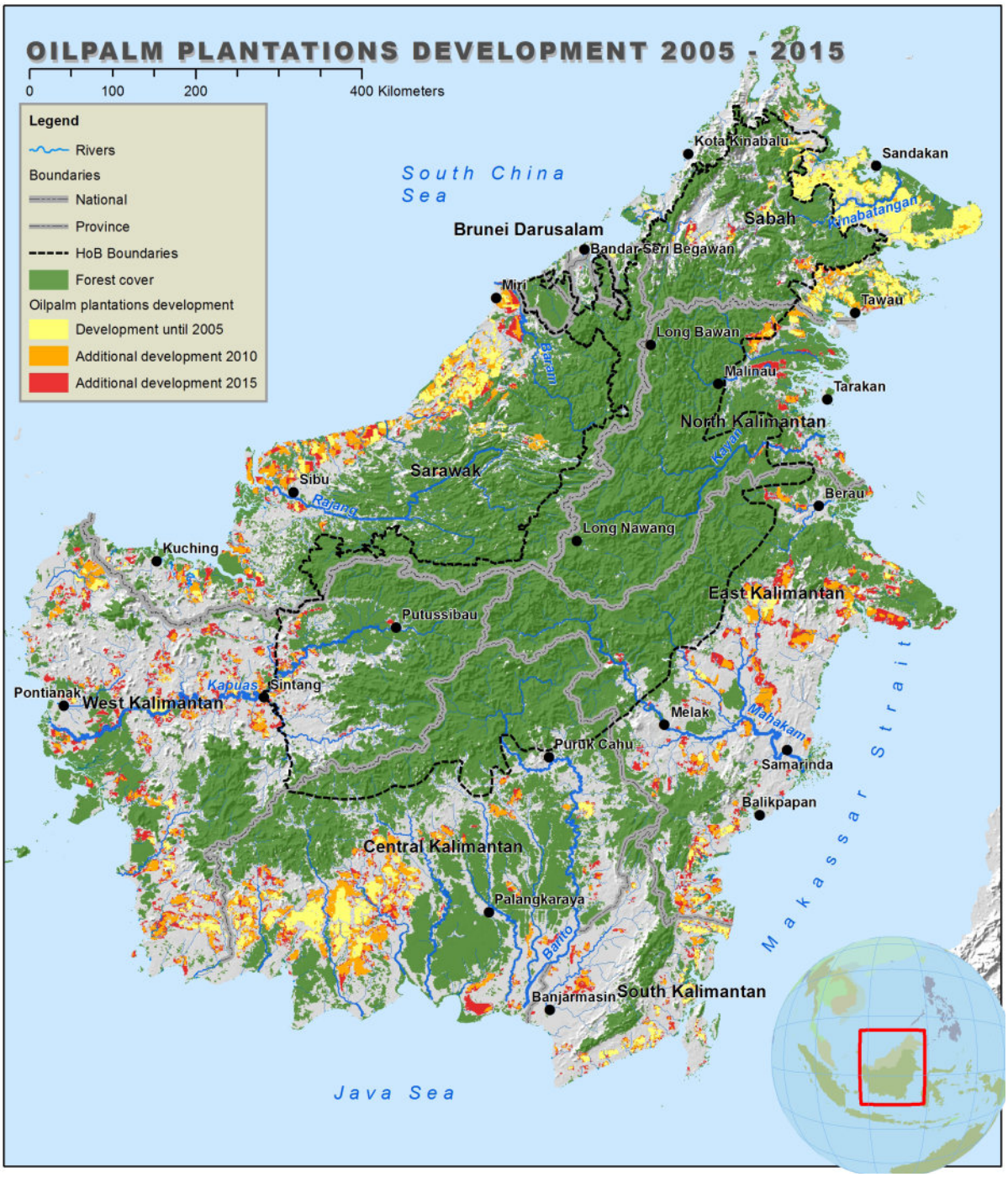
OILPALM PLANTATIONS DEVELOPMENT 2005 - 2015
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Makassar Strait
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Kayan
Sinabatangan

2.5 Oil palm expansion 2005-2015

Snapshot

- Expansion of oil palm plantations has been rapid between 2005 and 2015.
- In 2005 the total area was 2.4 million ha; in 2010, this had more than doubled to 4.9 million ha; by 2015, this figure was more than 7.0 million ha.
- Palm oil expansion has occurred almost exclusively in land below 500 m asl, with the best locations being areas of (former) lowland rainforest.
- Peat swamp forest is also often converted due to easy availability and fewer land use and ownership issues.

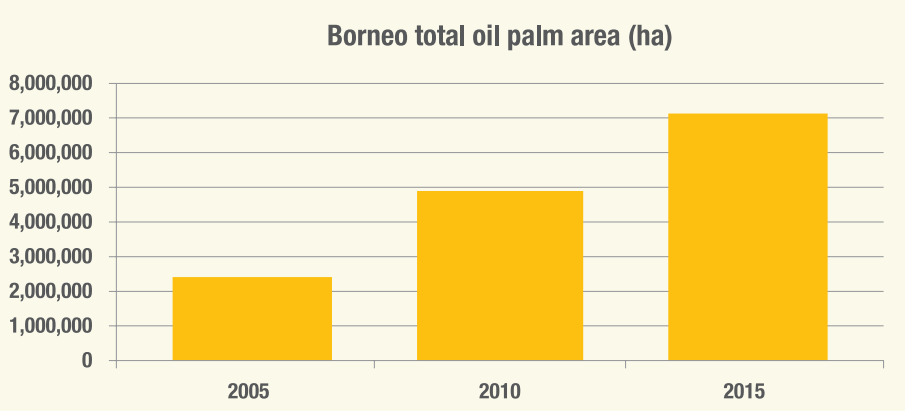


Table 21: Expansion of oil palm cover across Borneo 2005 - 2015

	Oil Palm Cover (Ha)		
	2005	2010	2015
Sabah	1,091,264	1,340,551	1,413,195
Brunei	787	874	1,093
Sarawak	360,046	856,426	1,203,006
West Kalimantan	171,636	613,758	1,270,548
Central Kalimantan	484,382	1,120,622	1,493,666
South Kalimantan	134,018	233,593	356,150
East Kalimantan	136,544	608,008	1,152,479
North Kalimantan	27,757	115,734	239,729

Oil palm expansion rates have differed over the 2005-2015 period between provinces. The highest rates were in West, East and North Kalimantan, with growth rates of more than 20% each. Growth rates in Sabah were relatively low (2.6%) but this reflects the fact that by 2005, many more oil palm plantations had already been established than in any other provinces or states.

Forest allocated for conversion into palm oil plantation

2.6 Pulpwood plantations

Snapshot

- Pulpwood plantations are plantations of fast-growing trees used for the pulp industry.
- No pulpwood maps were available for Sabah and Sarawak.
- The biodiversity of pulpwood plantations is generally higher than in oil palm plantations.
- The overall biodiversity of pulpwood plantations is incomparably lower than in natural forest.
- The total area of pulpwood plantations is enormous: 5.9 million ha in Kalimantan alone.

Pulpwood plantations are plantations of fast-growing trees used for the pulp industry. The major tree species planted is *Acacia mangium*, which is a species not native to Borneo. Another species planted is *Albizia chinensis*, which naturally grows in Java and many other places, but not in Borneo. The other species largely planted in Sarawak is *Paraserianthes falcataria*.

The biodiversity of pulpwood plantations is generally higher than in oil palm plantations. Nevertheless, the overall biodiversity of pulpwood plantations is incomparably lower than in natural forest.

As pulpwood plantations are treated just a few times before final harvest of the trees, undergrowth does develop providing vegetation for animals to forage.

Unlike oil palm plantations, pulpwood plantations cannot be faultlessly mapped from satellite images. The extent of the pulpwood plantations needs to be provided by the responsible agencies and this information up to 2014 is available only for Indonesian Borneo. In Sabah, pulpwood plantations are generally not mapped separately but are included in production forest (Forest Reserves Class II).

The total area of pulpwood plantations is enormous: 5.9 million ha, (not even including the Malaysian part of Borneo) which is 11% of the total land area of Indonesian Borneo (Kalimantan).

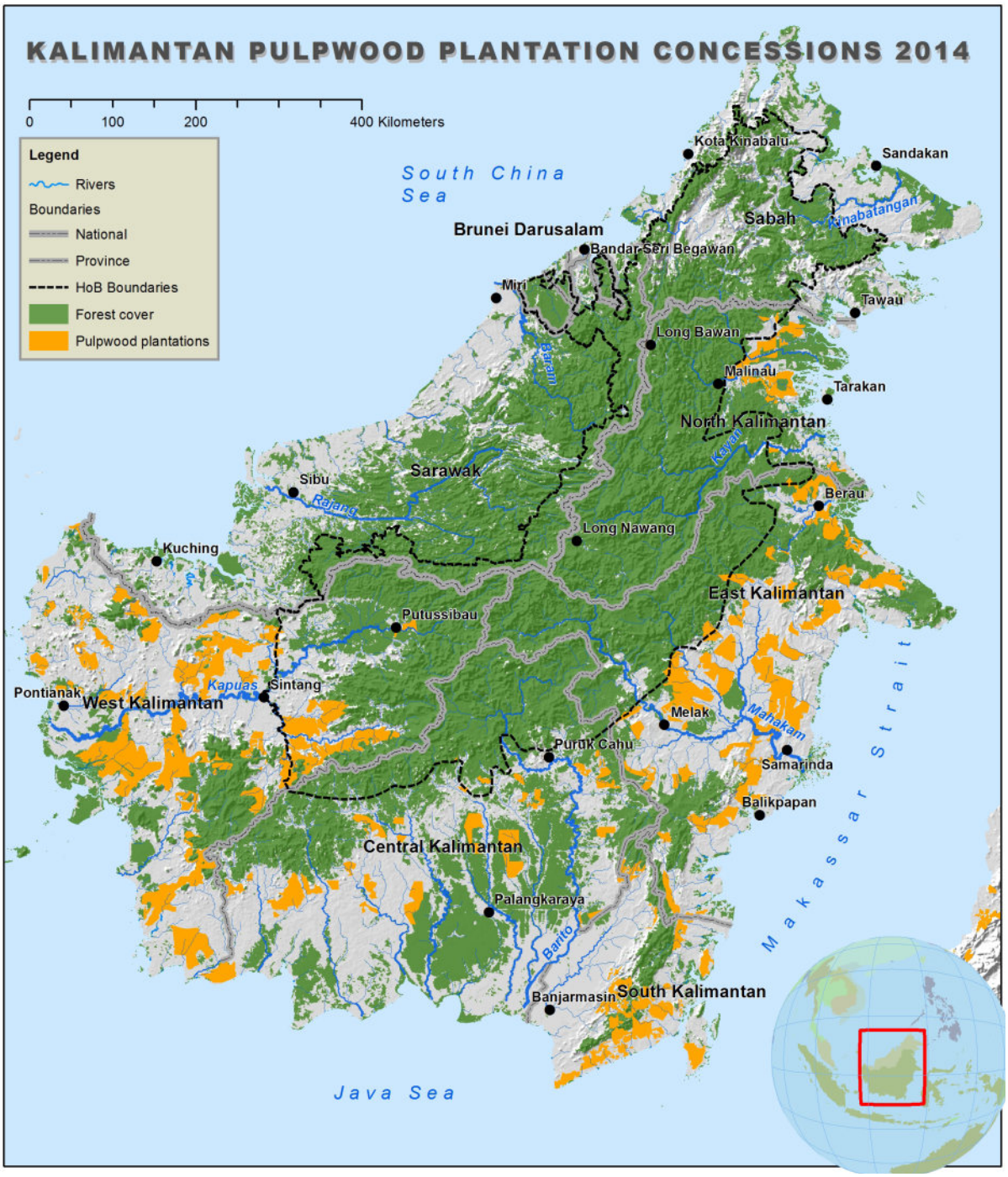
The provinces of West Kalimantan and East Kalimantan have by far the largest areas of pulpwood plantations.

Indonesian provinces

Pulpwood plantations were established mainly in areas formerly covered by lowland rainforest. Further developments are moving into upland areas.

Table 22: Pulpwood plantations in Indonesia 2014

Pulpwood plantations in 2014 (Ha)	
West Kalimantan	2,476,965
Central Kalimantan	740,574
South Kalimantan	596,480
East Kalimantan	1,857,194
North Kalimantan	262,903
Grand Total	**5,934,116**



Note: It it is not possible to map the pulpwood plantations in Sabah and Sarawak as these data are not available.

2.7 Ecosystems and mining concessions – 2015

Snapshot

- The most important mining products in terrestrial Borneo are coal, limestone and diamonds.
- No mining data is available for Malaysia and Brunei.
- Mining concessions can overlap with other land use allocations and can take precedence in land use determination conflicts.
- Mining sites in Borneo, though small in area, still often have large environmental impacts through the infrastructure development, the influx of people and growth in illegal logging, hunting and forest encroachment.
- The large mining companies may aim to conduct responsible mining with a minimal environmental impact, but smaller mining companies and fortune seekers are far less committed to the environment.

The map on page 131 shows all mining concessions (both exploitation as well as exploration) as of 2015, for the Indonesian part of Borneo. No mining data is available for Malaysia and Brunei.

Exploration concessions refer to areas where a company is permitted to conduct surveys and sampling for commercially valuable geological deposits - often very large areas. Once a mining company has found a location with commercially feasible amounts of deposits, further permits and reports, including an environmental impact assessment study, are required, in order to apply for an exploitation concession.

Mining concessions can overlap with other land use allocations including areas allocated for production forest, plantations, and protection forest. If for instance a mining exploration reveals a particularly rich deposit area in a logging concession, then this section might be excluded from the concession holder and sold to a mining company for exploitation.

In developing an exploitation concession, the preparation of infrastructure is essential and the larger mining companies usually develop an excellent road network, which is generally much better developed than for logging concessions. The mined area, mainly through open pit mining, is relatively small, often less than 5000 ha, but the environmental impacts of the infrastructure to otherwise remote and inaccessible locations should not be underestimated.

Mining sites in Borneo, though small in area, still often have large environmental impacts through the influx of people and growth in illegal logging, hunting and forest encroachment.

The largest mining companies endeavour to conduct responsible mining with a minimal environmental impact (for example PT KEM Restoration program). However, the smaller mining companies and fortune seekers are often far less committed to the environment (UNITAR 2016).

By far the most important mining products from terrestrial Borneo are coal, followed by gold and limestone in East Kalimantan and diamonds in South Kalimantan. Oil and gas is mainly found offshore, but a number of terrestrial oil fields are still operational.

Around the regions

Sabah: Gold mining is being proposed in a 948 ha area, some 30 km northwest of Tawau town in eastern Sabah. The site straddles the Mt. Wullersdorf and Ulu Kalumpang Forest Reserves known to be inhabited by orangutans, Malay civets and other wildlife.

Brunei: No mining data available and exploration concessions are not visible.

Sarawak: Little mining data available and exploration concessions are not visible, but mines do exist for example, coal mines, used for power generation.

West Kalimantan: Mining concessions are often found in peat swamp forest and in the heath forest of the interior. Many concessions are also to be found in the last of the lowland rainforest, whilst comparatively few are found in upland rainforest. In the more central and elevated parts of West Kalimantan, mining is concentrated along the edges of the uplands and the Kapuas basin.

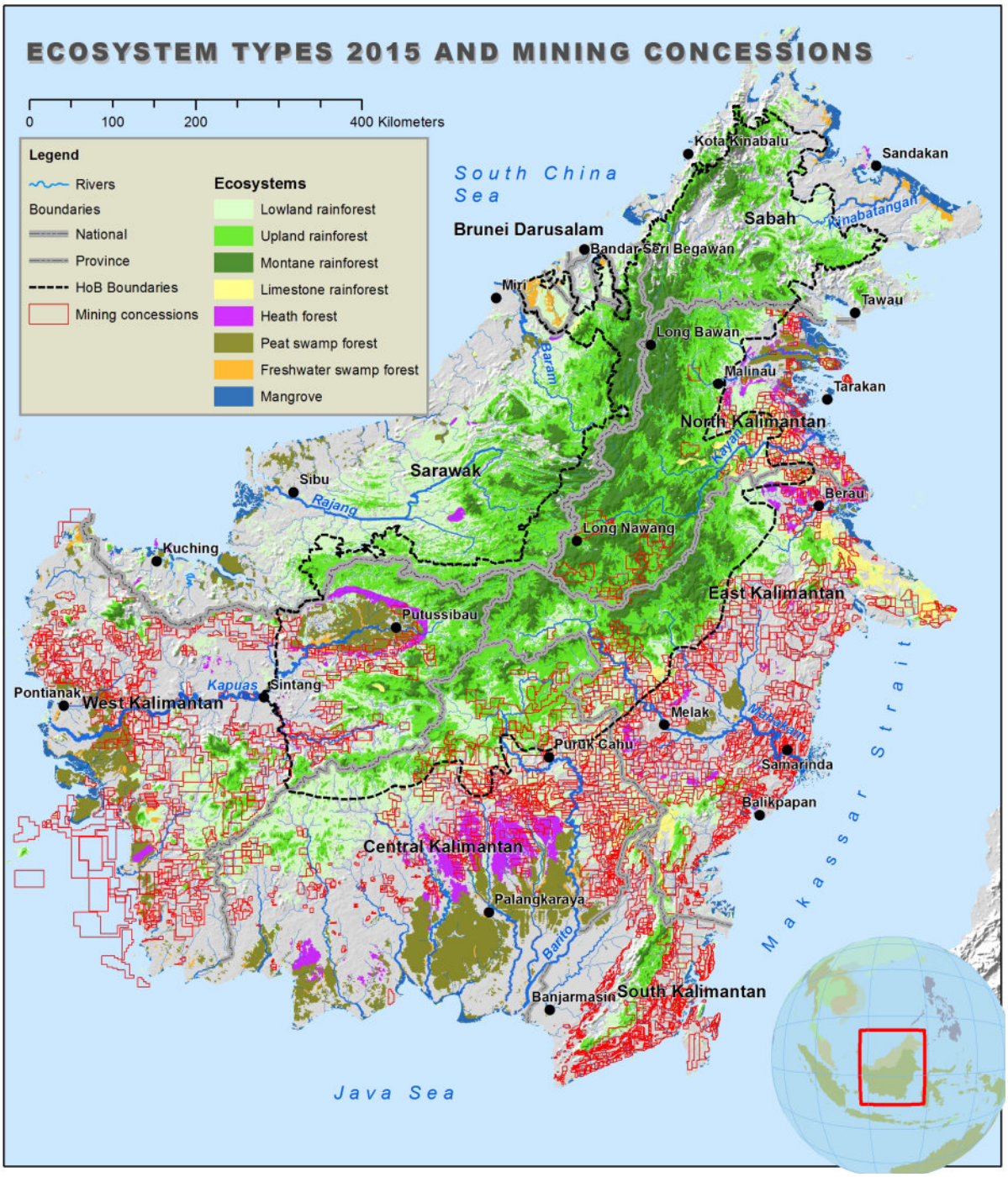
East Kalimantan: The Berau coal mine is a major exploitation concession in Borneo, expanding into heath forest. Coal mining is also apparent upstream of the major rivers, in lowland and upland rainforest of the interior of the province.

Central Kalimantan: Central Kalimantan has exploitation concessions in many areas of upper Barito, as well as in its last remaining lowland rainforest. Gold mining occurs in many of its rivers, as well as zircon mining by smallholders, always in heath forest.

North Kalimantan: North Kalimantan has large mining concession areas in lowland and heath forest, though most are not yet operational. There are also large exploration concessions in the remote interior of the province.

South Kalimantan: South Kalimantan has many small concessions most prominently for diamond mining.

Gold Mining in West Kalimantan

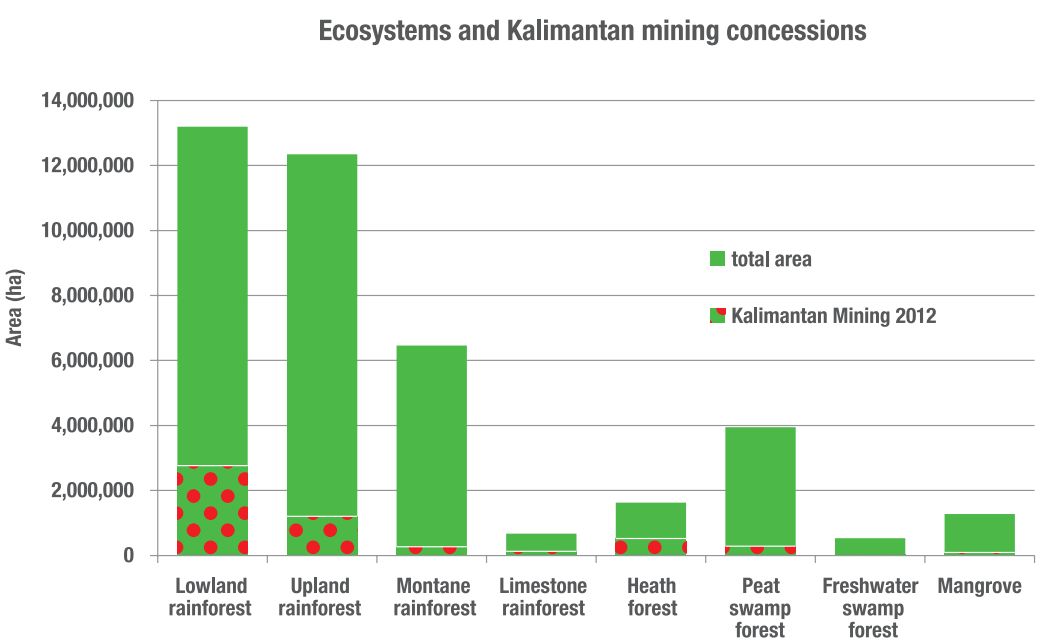


Note: it is not possible to map the mining concessions in Sabah and Sarawak as these data are not available.

Checking the mining concessions with the ecosystem types gives us the following table with the extent of each ecosystem type inside mining concessions:

Table 23: Mining concessions in Kalimantan 2015

Ecosystem types	Kalimantan mining concessions (ha)
Lowland rainforest	2,762,317
Upland rainforest	1,210,210
Montane rainforest	269,185
Limestone rainforest	126,160
Heath forest	518,955
Peat swamp forest	283,615
Freshwater swamp	32,668
Mangrove	72,445
Grand Total	**5,275,555**



Lowland rainforest comprises more than half (52%) of all ecosystems inside mining concessions; furthermore, more than one-fifth (21%) of the remaining lowland rainforest is inside mining concessions. Heath forest is the other ecosystem with a disproportionally high percentage inside mining concessions, comprising almost 10%. More than 32% of the remaining heath forest is inside mining concessions. This is correlated to the fact that the sandstone plateaus, where heath forest soils occur, are often the locations of mineral deposits.

2.8 Forest fires

Snapshot

- The term 'forest fire' is not entirely appropriate, since many of these fires actually occur in shrubland and highly degraded forest.
- Peat swamp forest has the disproportionally highest number of hotspots (28,461), representing 55% of all the forest hotspots, though this forest type is only 10% of all the natural forest.
- Once started, peat swamp forest can burn for days.
- The number of hotspots in lowland rainforest is also very high, more than 10,000 or 21% of the total.
- Fire damage in heath forest and limestone forest (524 hotspots or 1%) is often irreversible.
- Forest hotspots are very high in protected areas. They are also high in production areas, indicating concession holders in these areas have trouble implementing sustainable management practices.

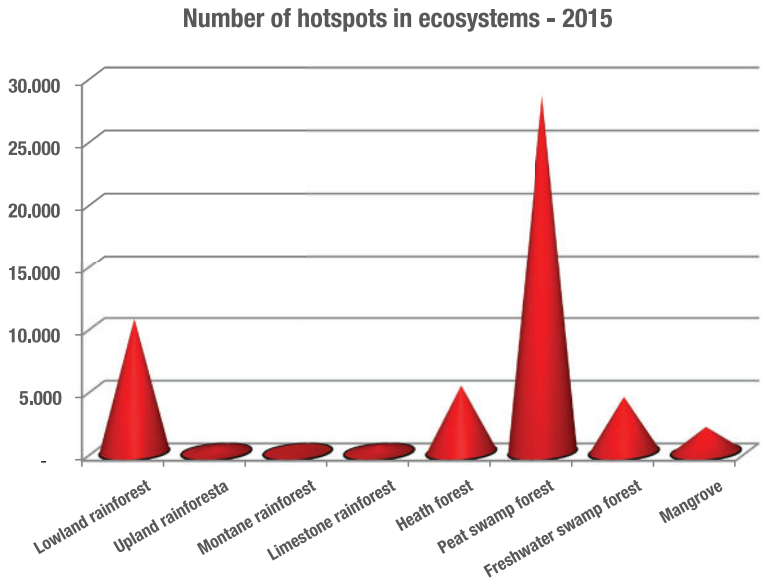
The term 'forest fire' is not entirely appropriate, since many of these fires actually occur in shrubland and highly degraded forest.

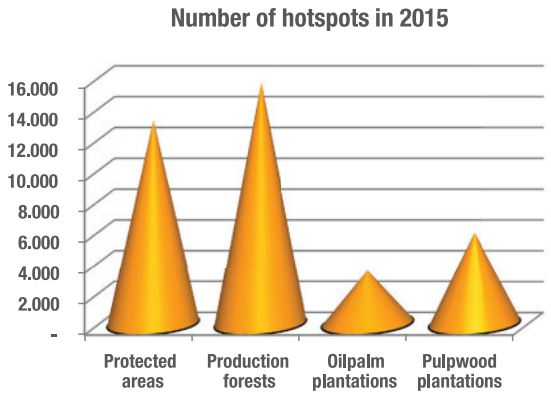
Borneo was again affected by forest fires in 2015. Fires can be detected and mapped by applying the hotspot information from satellite images. The size of these hotspots depends on the resolution of the satellite type; the Modis satellite can only detect larger fire spots. The number of hotspots tells us also about the duration of fires in locations: if a fire continues then the hotspot will be counted again the next day.

By far the highest number of hotspots in forest (28,461) was detected in peat swamp forest. This is disproportionally high since it is 55% of all the forest hotspots, while peat swamp forest comprises only 10% of all the natural forest. Fire in peat swamp forest occurred mainly in the province of Central Kalimantan and can continue for many days. The number of hotspots in lowland rainforest was also very high, more than 10,000 or 21% of the total. The extent of remaining lowland rainforest is much larger and these fires occurred throughout the provinces.

Relatively few hotspots were detected in upland rainforest and montane forest. The number of hotspots in heath forest was disproportionately high (5,307), which is more than 10% of all the hotspots in natural forest. Fire damage in heath forest and limestone forest (524 hotspots) is often irreversible.

The number of hotspots in freshwater swamp forest and mangroves (4,403 and 2,008) is remarkably high given that these ecosystems are at least partly inundated most of the time.





The number of hotspots in protected areas was very high at 13,227. These fires occurred particularly in protected areas of Central and South Kalimantan, and to a lesser extent in East Kalimantan. Detailed analysis needs to be done as to the high occurrence of forest fire in the protected areas.

The very high number of hotspots in production forest indicates that concession holders in these areas have difficulties in applying sustainable forest management. Rainforest with a closed canopy is not susceptible to internal forest fires. Hotspots in production forest were detected in all of the provinces, with the vast majority in Central and South Kalimantan.

The 3,446 hotspots in oil palm plantations occurred often in locations where the oil palms had not yet been planted and mainly at the edges of the plantations.

Almost 6,000 hotspots were detected in pulpwood plantations in Kalimantan. Young planted stands were also reported to have been burnt.

Most of the area had become scrubland in 2015; part is developed as oil palm or pulpwood plantation.

2.8.1 Ecosystem types and forest fires

Snapshot

- During El Nino drought years, large scale forest fires are major events and have the most pronounced effect on lowland rainforest, peat swamp and heath forest.
- Once heath forest is burnt, it is almost impossible for it to completely recover and the remaining vegetation becomes more akin to shrubland.
- Previous disturbance, coupled with fire, leads in many cases to a gradual conversion to agricultural production.
- Many of the lowland areas in the HoB which have been burnt have been in locations where 'land use plans for development' have been in place, leading to speculation as to the actual cause of the fires.

During the dry season, forest fires in Borneo are an annual event. They are much more prevalent in land less than 300 m above sea level and particularly severe during El Nino years with its prolonged dry seasons. Fire hotspots are detected in real-time by satellites and 'hotspot points' are freely available for download from European Space Agency and other websites.

Forest fires have the most pronounced effect on lowland rainforest, peat swamp and heath forest, but the detection of single hotspots in forest does not mean the entire forest is burnt. Previous disturbance, coupled with fire, leads in many cases to a gradual conversion to agricultural production.

Rainforest in good natural condition will not easily burn, as the closed canopy, multi-strata vegetation keeps the humidity very high, even after extended periods without rainfall. Disturbance however, causes opening of the canopy, allowing sunlight to reach the undergrowth and the forest loses its high humidity.

Lowland rainforest

Of all the lowland rainforest areas strongly affected by forest fire, the majority has already been 'logged-over' or become secondary forest or worse. Primary lowland forest remains relatively unaffected. Many of the lowland areas which have been burnt have been in locations where 'land use plans for development,' have been in place, leading to speculation as to the actual cause of the fires.

Swamp forest

Peat swamp forest is severely affected by fire. Once peat starts burning, these glowing fires can continue for weeks; often burning under the surface making them very hard to detect.

Most peat swamps in natural conditions will never become fully dry, even during periods of limited rainfall. However, disturbance of the ecosystem, particularly by draining the terrain and construction of canals, makes the peat soils even drier during the dry season, thus making them vulnerable to fire.

Heath forest

Heath forest is generally more sensitive to burning than Dipterocarp forest, because many tree and shrub species have somewhat drier leathery leaves and there is usually a thick layer of dead organic material on the forest floor. The sandy soils are very poor and most of the nutrients are in the vegetation. Heath forest burns mainly from the edges, with the interior, especially of large stretches remaining unaffected. This is most likely due to the fact that the interior remains

undisturbed. Once heath forest is burnt, it is almost impossible for it to completely recover and the remaining vegetation becomes more akin to shrubland.

Upland and montane forest were, in most places, rarely affected by large forest fires, only along major rivers and other easily accessible locations.

Description by region

Sabah: Most of the interior lowland forest in the Kinabatangan and Kalabakan areas of the state have experienced forest fires, however, these fires have been rapidly brought under control and so done less damage than in other parts of the state.

Brunei: Coastal edge areas have been affected by forest fires but most of the sites will be retained as forest.

Sarawak: A number of fires occurred in Lanjak Entimau Wildlife Sanctuary, but these spots were not followed by conversion and are expected to gradually grow back. Many fires occur annually from shifting agriculture practices, when local people clear land for planting. These areas get detected by satellite, but most of them are small scale and temporary. The major concern is the increase of forest fires resulting from local communities opening up land for plantations (smallholders oil palm), which in some cases, can occur over a much larger area than shifting agriculture

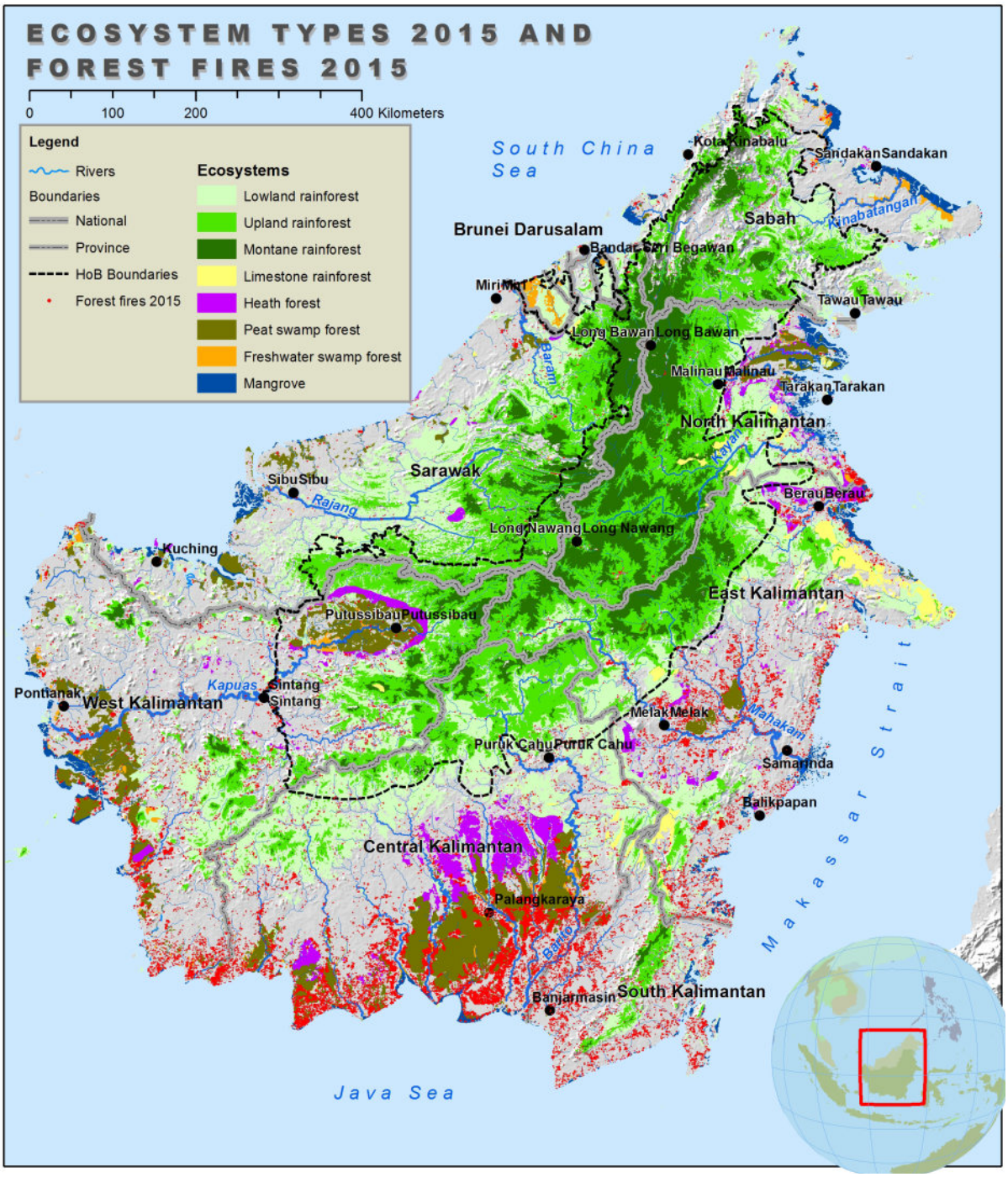
West Kalimantan: Forest fires have been particularly devastating in this province where nearly all the lowland forest has been affected, with the exception of the humid and undisturbed river valleys. For example, hotspots were detected around nearly all the freshwater swamps of Danau Sentarum National Park, but those at the edges of the park are less likely to fully recover than those in the core area, where humidity remains high even during very dry periods.

Central Kalimantan: Most of the edges and some of the interior of lowland forest along the major rivers have had forest fires.

East Kalimantan: Forest fires have been particularly severe along the Mahakam and Kelai rivers and in several of these areas, 'plantations' have followed the fire.

North Kalimantan: The heath forest of the Nunukan district has been strongly affected by forest fires and there is little heath forest left in decent condition here.

The map below shows all fire hotspots of 2015, with the ecosystems extent of 2015. Another map (appendix 3) shows all the hotspots from 2001 to 2015. This demonstrates the vast impact of forest fires on the ecosystems in the last decade.


ECOSYSTEM TYPES 2015 AND FOREST FIRES 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Forest fires 2015
Ecosystems
Lowland rainforest
Upland rainforest
Montane rainforest
Limestone rainforest
Heath forest
Peat swamp forest
Freshwater swamp forest
Mangrove
South China Sea
Kota Kinabalu
Sandakan
Sabah
Tawau
Brunei Darusalam
Bandar Seri Begawan
Miri
Long Bawan
Malinau
Tarakan
North Kalimantan
Sarawak
Sibu
Rajang
Kuching
Long Nawang
Berau
East Kalimantan
Putussibau
Kapuas
Sintang
Pontianak
West Kalimantan
Melak
Mahakam
Samarinda
Balikpapan
Puruk Cahu
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.8.2 Forest fires in oil palm plantation concessions

Snapshot

- Fire is a tool used by many around the world to clear vegetation to prepare land prior to planting crops and oil palm saplings. Borneo has been no exception to this.
- The majority of hotspots now detected are located at the edges of existing oil palm plantation areas. These burnt forest areas are then frequently converted to oil palm plantations.

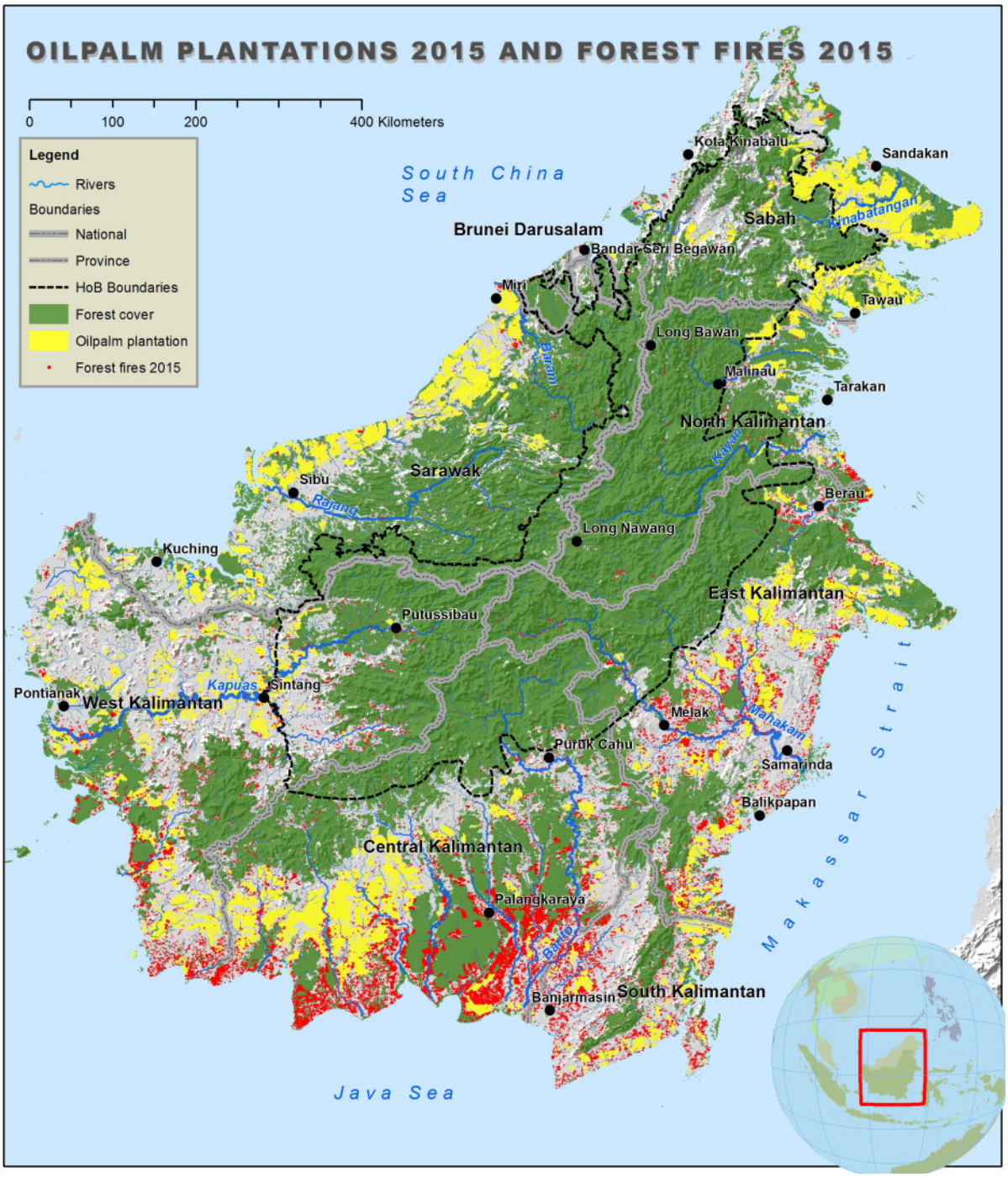
Fire is a tool used by many around the world to clear vegetation to prepare land prior to planting crops and oil palm saplings. Borneo has been no exception to this. The majority of hotspots in 2015 were located at the edges of existing oil palm plantation areas. These burnt forest areas are then frequently converted into oil palm plantations.

In Sarawak, a burning permit is required from the authorities before any clearing of biomass, though controlled burning is allowed. During bad weather especially during the seasonal dry period, the issuance of permits is halted.

Most economic development has occurred in the more accessible lowland areas of Borneo leading to more disturbance of the forest in these areas. Disturbed forest burns easier than forest in good condition and so inevitably the lowland areas of West, Central, East and North Kalimantan have been particularly affected by fire. Sabah and Sarawak have been relatively undisturbed by forest fire in 2015.

Note to map on page 139

The areas and locations of oil palm plantations on the map have been derived from MODIS and Landsat 2015 satellite images which are accessible to anybody. On top of this map were plotted the fire hotspots of 2015, from the MODIS satellite, presented at the ESA websites. These images are also freely available.


OILPALM PLANTATIONS 2015 AND FOREST FIRES 2015
0
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Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Forest cover
Oilpalm plantation
Forest fires 2015
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Kapuas
Sintang
Pontianak
West Kalimantan
Melak
Mahakam
Puruk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

2.9 Climate change

Snapshot

- A 2016 Naturalis Biodiversity Center* study concluded that even if global warming was kept below the 2.0°C level, no area of Borneo would be left unaffected.
- Orangutans appear to be vulnerable to climate change due the nature of their habitat being affected by decreasing rainfall under both the 2.0°C and 4.0°C scenarios.
- Global warming above 4.0°C is likely to result in the disappearance of orangutan across vast areas of the island.
- Climate change analysis should be taken into account in the spatial planning process and establishment of wildlife corridors.

A 2016 study conducted by the Naturalis Biodiversity Center* based in the Netherlands, investigated the possible impacts of climate change on Borneo. Whilst its focus was on three major species: proboscis monkey, rhinoceros hornbill and orangutan, it concluded that even if global warming was kept below the 2.0°C level, no area of Borneo would be left unaffected. If the worst case scenario of 4.0°C was reached, then there would be widespread effect with the whole island severely affected.

In particular, orangutan appear to be vulnerable to climate change due to the nature of their habitat being affected by decreasing rainfall under both the 2.0°C and 4.0°C scenarios. It is predicted that orangutan range would be significantly reduced, and they would need to move to other areas as their present habitats may no longer be optimal, even assuming a level of adaptation among the populations. Moreover, the 4.0°C scenario is likely to result in the disappearance of orangutan across vast areas of the island.

The report concluded that impending climate change, whether kept below 2.0°C or rising above 4.0°C will have a serious effect on the ecosystems of Borneo and made the following mitigation recommendations.

- Deforestation should be halted and disturbed natural forest should be given the chance to recover and be rehabilitated where possible:
- Forest fires should be stopped through strict law enforcement and awareness campaigns to avoid the burning of natural vegetation for land clearing.
- Fast action should be enabled in case of fire e.g. training fire-fighting squads and providing adequate equipment.
- Climate resilience landscape connectivity and contiguous forest corridors should be maintained or developed to link existing species habitats: e.g. a very high priority is the connectivity of habitats at lower elevations to final species refugia at cooler elevations.
- Climate change analysis should be taken into account in spatial planning processes.

* Ref: Borneo chapter, Climate Change Impacts Study. Naturalis Biodiversity Center (www.naturalis.nl/en/)

Upper Tutoh, Sarawak

CHAPTER 3

Conservation Management Status

3.1 Certified versus non-certified concessions 2015

Snapshot

- Forest certification - where the quality of forest management is assessed against a series of agreed standards - is an important system for forest monitoring, tracing and labeling timber.
- Many international organisations consider Forest Stewardship Council (FSC) certification to be the best certification system to ensure environmentally responsible, socially beneficial and economically viable management of forest.
- In some provinces, logging concessions are held by only a handful of companies thus making it crucial to get these companies committed to internationally recognized certification in order to conserve biodiversity.

Forest certification - where the quality of forest management is assessed against a series of agreed standards - is an important system for forest monitoring, tracing and labeling timber.

Credible forest certification covers much more than just logging practices, it also accounts for the social and economic well-being of workers and local communities, transparency and inclusiveness in decision making.

There are a number of forest certification schemes around. Many international organisations consider Forest Stewardship Council (FSC) certification to be the best certification system to ensure environmentally responsible, socially beneficial and economically viable management of forest.

SVLK (*Sistem Verifikasi Legalitas Kayu*) is an Indonesian certification that gives assurance that wood is legally harvested. SVLK certification is made obligatory by the Indonesian government for companies who want to export their timber. Malaysia also has its own certification system called the Malaysian Timber Certification Scheme (MTCS) which aims to ensure sustainable management of the forest of Malaysia.

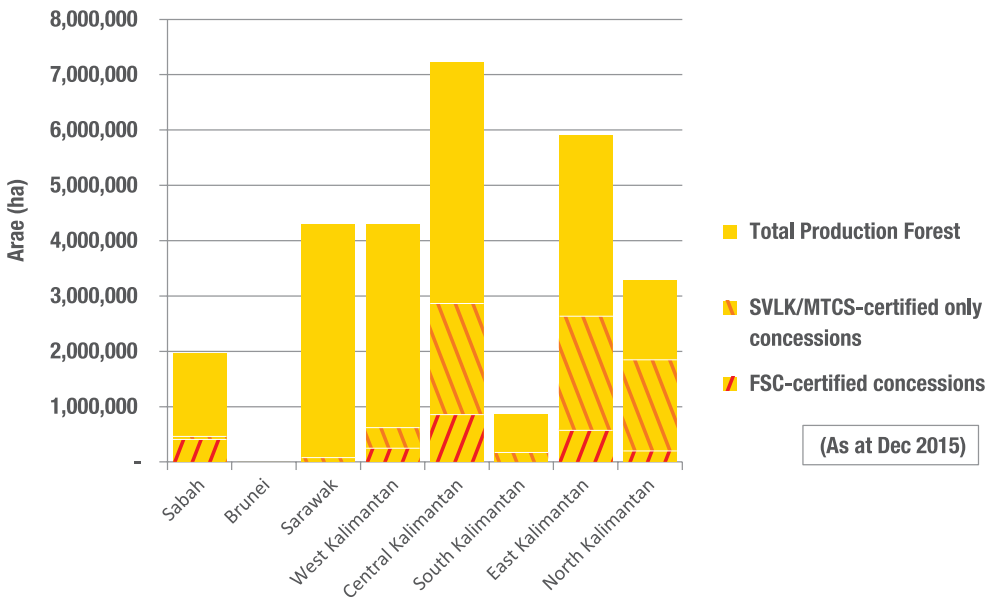
FSC certification is more difficult to comply with than SVLK or MTCS certification; all Indonesian FSC-certified concessions on the map have also SVLK certification. Many logging concessions in North, East and Central Kalimantan are now certified, and some are in the process of getting FSC-certified.

The FSC administration maintains a post 1994 Conversion rule, which makes it difficult for many Forest Management Units (FMUs) to be certified in Sarawak as many FMU holders also own licenses to forest plantations that were converted or established after the year 2000.

Table 24: Production forest vs SVLK/MTCS and FSC certified forest in Borneo 2015 (as of December 2015)

	Total Production Forest (ha)	SVLK/MTCS-certified only concessions (ha)	FSC-certified concessions (ha)
Sabah	2,046,345	57,956	488,505
Brunei	497	-	-
Sarawak	4,297,949	83,535	-
West Kalimantan	4,301,264	372,737	250,776
Central Kalimantan	7,236,273	2,007,723	856,929
South Kalimantan	871,594	176,065	-
East Kalimantan	5,913,556	2,062,871	571,330
North Kalimantan	3,284,231	1,647,345	199,376

Note: the table refers to natural forests, industrial tree plantations are not included.



Description by region

Sabah: A number of the concessions in Sabah are certified; several others are in the process of being certified. Several of these concessions collaborate with research institutions working on long-term production of timber from natural forest.

Brunei: No certified logging concessions in Brunei.

Sarawak: There is one Forest Management Unit certified under Natural Forest Management and two others certified under the Forest Plantation of the MTCS. Sarawak government is targeting that all production forest within the HoB be certified by mid-2017.

West Kalimantan: There are two certified logging concessions in the HoB part of the province. Both are located along the northern edges of Bukit Baka Bukit Raya National Park and thus provide

a continuation of the forest areas to the lowland foot slopes. These concessions at the edges of deforested areas serve to prevent further conversion of forest land and assist the orangutan population of this area to survive.

Central Kalimantan: There are two large logging concessions in the interior upland forest of the province, both managed by one company in the upper Barito area. This area is also home to a small population of orangutan, adding to the high biodiversity, but also connecting the mountain range to the lowlands in the south. There are a number of certified logging concessions along the southern foot slopes of Bukit Baka Bukit Raya.

- **Arabela landscape** – companies managing the uncertified logging concessions in the Arabela landscape are currently being approached for certification. The company which certified the first concession in this landscape has received favourable publicity for orangutan conservation in its concession which may prove to be an incentive for others to follow.
- **Seruyan area** - none of the logging concessions of the upper Seruyan is currently certified. This area was identified as one of the areas with a high level of forest conversion and fragmentation. Engagement and certification of logging concessions here could be crucial for the preservation of the remaining forest.

North Kalimantan: One company holds a large concession which almost connects directly to the Tubu area of Kayan Mentarang National Park that hardly has any lowland forest in it. A large part of North Kalimantan's remaining lowlands are inside the certified logging concessions belonging to two companies. Along the border with Sabah in the northernmost part of the province, one company holds a significant logging concession which contains Kalimantan's only elephant population and two very important trans-boundary corridors.

East Kalimantan: The largest logging concessions in the province are controlled by two companies. It will become crucial to keep these core areas covered by forest to conserve biodiversity and thus it is vital that these companies pursue certification. In the Berau area, there are five certified logging concessions on the lowland edges of the HoB with important orangutan habitats. In the middle Mahakam area, there are two companies with four concessions. These areas can ensure the connectivity of lowland and upland rainforest from the upper to the lower Mahakam basin and might ensure the survival of the orangutan population, whose decreasing habitats are surrounded by many oil palm plantations. In the upper Mahakam, below the mountain ranges, there are four large certified logging concessions held by two companies.

Further to the south are the two large certified concessions held by one company. These form a very large area that connects to the mountains of East and Central Kalimantan.

3.2 Certification of concessions

All FSC-certified logging concessions in Indonesia are also SVLK-certified. The FSC-certified logging concessions in Malaysia adhere also to the MTCS certification standards.

Description by region

Sabah: Has the highest percentage (18%) of its production forest FSC-certified. Another 2.6% is MTCS-certified and might adhere to FSC standards as well.

Brunei: Less the 500 hectares of production forest, none certified.

Sarawak: As at 2015, 2% of the logging concessions of Sarawak are certified.

West Kalimantan: Almost 6% of the production forest of West Kalimantan is FSC-certified.

Central Kalimantan: Has the largest certified production forest area, 12% of which is FSC-certified.

East Kalimantan: Has the second largest production forest area and almost 10% of these are FSC-certified.

South Kalimantan: One-fifth of the production forest of South Kalimantan is SVLK-certified, none is FSC-certified yet.

North Kalimantan: More than half (56%) of the production forest of North Kalimantan is certified; 50% is SVLK-certified, while 6% is FSC-certified.

3.3 Protected area representation

Table 25: Percentage of Borneo's ecosystem protected

Ecosystem	% of extent protected	% of Borneo land area
Lowland rainforest	16.2	2.9
Upland rainforest	36.0	6.0
Montane forest	53.3	4.6
Limestone forest	28.5	0.3
Heath forest	14.0	0.3
Peat swamp forest	38.5	2.0
Freshwater swamp forest	30.3	0.2
Mangrove	37.9	0.7
Grand Total		**17.0**

Lowland rainforest is the most species-rich terrestrial ecosystem on earth. 16% of the remaining lowland rainforest of Borneo is protected. This is 2.9% of the total land area of Borneo.

Large stretches of protected lowland rainforest are present in Sabah: middle Kinabatangan, Danum valley; Brunei: upper Temburong; Sarawak: Batang Ai and Lanjak Entimau; West Kalimantan:

the valleys of Betung Kerihun and Gunung Palung; Central Kalimantan: Bukit Batikap and the foot slopes of Bukit Baka Bukit Raya; South Kalimantan: lower sections of Gunung Meratus; East Kalimantan: upstream section of the Ratah watershed and foot slopes of the Gunung Lumut area; North Kalimantan: upstream sections of the Kelai and Segah watersheds.

The protected lowland rainforest appears to be scattered on the 'lowland rainforest ecosystems inside protected and production forest' map, but is in fact mostly connected to additional protected upland rainforest.

Upland rainforest is more strongly represented in the protected areas, with 36% of the remaining upland rainforest protected. This is 6.0% of the total land area of Borneo.

Large stretches of protected upland rainforest are situated in the remote interior of Borneo and are well-connected, often through several provinces and states. The more accessible areas of upland rainforest are generally not protected. Several of these are also part of the habitats of endangered species such as orangutans.

Montane forest is the ecosystem with the highest rate of protection: more than half (53%) of the remaining montane forest is inside protected areas. Most of the montane areas of the central mountain spine of Borneo are protected and are connected.

A large part, 39%, of the remaining peat swamp forest is protected. The largest stretches are in Tanjung Puting National Park, Sebangau National Park and in the middle Barito area. Other remaining large stretches are allocated for conversion.

More than one-quarter of the remaining freshwater swamp forest in Borneo is protected. The largest stretches are in Sabah, while all other locations comprise small areas of the deepest swamps that are less attractive for agricultural development. The total extent is 0.2% of the land area of Borneo.

Heath forest has the lowest representation of protected areas in Borneo, with 14.0% of the remaining heath forest protected. The largest stretches are in Danau Sentarum and north of Tanjung Puting.

Less than one-third (28.5%) of the remaining limestone forest is protected. The only large limestone forest stretch inside a national park is in Mulu in Sarawak, while all the other large stretches are classified Protection Forest (*Hutan Lindung*) and are relatively unknown as well as rarely visited.

Landscapes

A number of priority landscapes have been identified on which WWF HoB initiative will concentrate its conservation efforts. These landscapes emphasize ecological connectivity and habitats of key species, while taking into account all remaining opportunities for conservation and sustainable land use.

The **transboundary elephant landscape** ranges from northern Kalimantan, to the south of Sabah and focusses on the conservation of the elephant population as well as the large areas of lowland and upland rainforest in their habitats.

The **Crocker Range - Central Sabah** landscape connects the high mountain massive of western Sabah to the valleys and uplands in the center of the state. It encompasses ecological gradients from the summits of upper montane forests to undulating lowland rainforests.

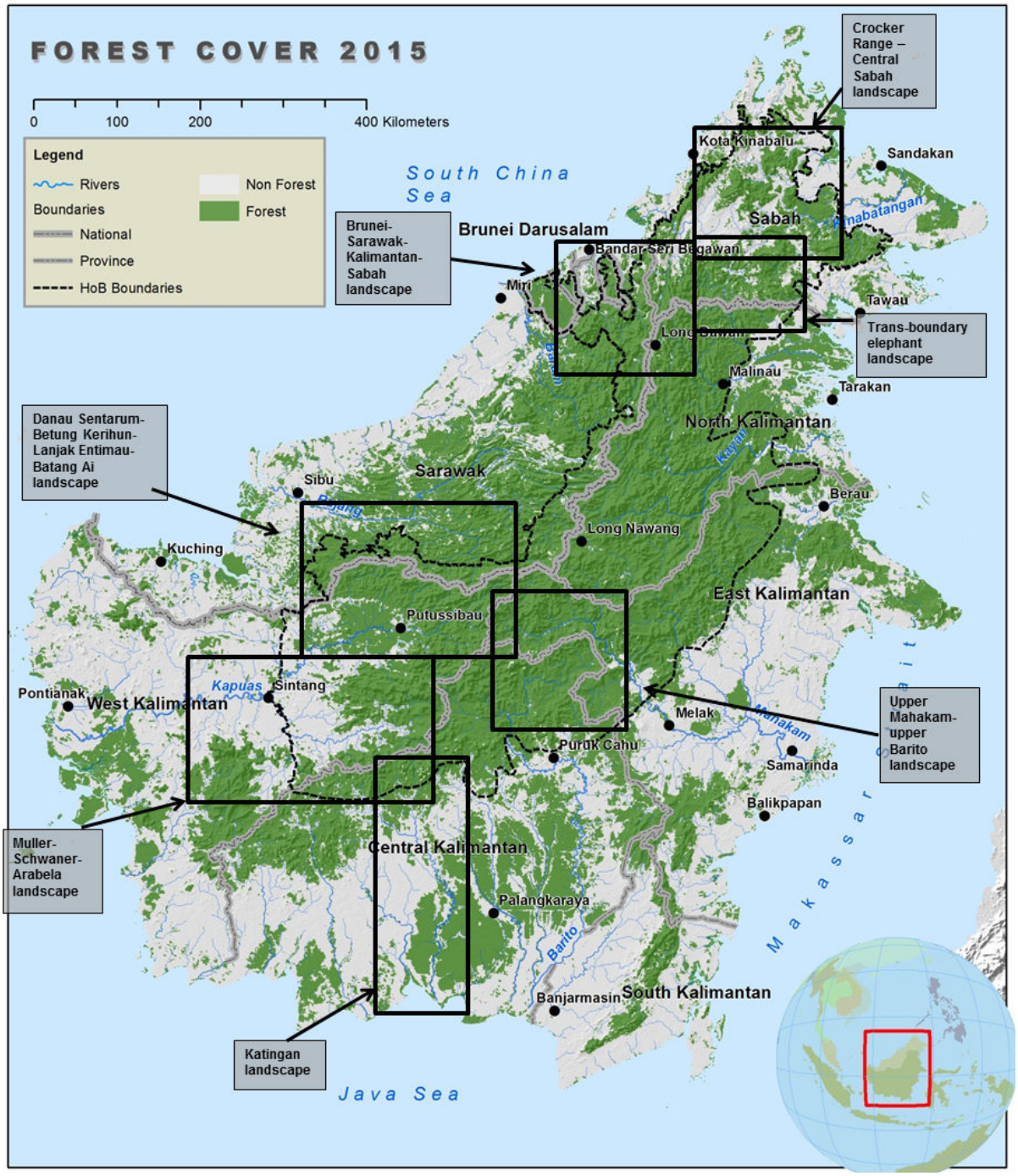
The **Brunei-Sarawak-Kalimantan-Sabah transboundary landscape** connects the upper section of Brunei through the limestone and upland forest of Sarawak to the montane forest of North Kalimantan and western Sabah. The entire area is known for its extremely high biodiversity, and connectivity will be preserved by developing sustainable land use.

The **Sarawak-West Kalimantan** transboundary landscape connects protected areas of Batang Ai-Lanjak Entimau-Betung Kerihun-Danau Sentarum. The southern section encompasses peat swamp forest and heath forest, while the northern section encompasses lowland rainforest, upland rainforest and montane forest.

The **Muller-Schwaner-Arabela landscape** encompasses most of the remaining lowland rainforest of West and Central Kalimantan, connected by vast areas of uplands and mountains. This landscape harbours one of the largest populations of orangutans in the world and most of this forest will be retained, albeit as production forest.

The **Katingan landscape** connects orangutan habitats of Sebangau National Park to the uplands in the north through a mosaic landscape of peat swamp forest, lowland rainforest, heath forest and some of the last remaining freshwater swamp forest.

The **wide landscape of the upper Mahakam and upper Barito watersheds** focusses on the preservation of the habitats of the individual rhinos found in the area. The lowland and upland rainforest of this landscape can be retained as sustainable production forest.


FOREST COVER 2015
0
100
200
400 Kilometers
Legend
Rivers
Non Forest
Boundaries
Forest
National
Province
HoB Boundaries
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Tawau
Miri
Malinau
Tarakan
North Kalimantan
Sarawak
Sibu
Kuching
Berau
Long Nawang
East Kalimantan
Putussibau
Pontianak
West Kalimantan
Kapuas
Sintang
Melak
Mahakam
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Java Sea
Makassar Strait
Crocker Range – Central Sabah landscape
Brunei-Sarawak-Kalimantan-Sabah landscape
Trans-boundary elephant landscape
Danau Sentarum-Betung Kerihun-Lanjak Entimau-Batang Ai landscape
Upper Mahakam-upper Barito landscape
Muller-Schwaner-Arabela landscape
Katingan landscape

3.4 Protected area intactness

Snapshot

- Intactness of protected areas is measured by looking at their fragmentation.
- Fragmentation of large protected areas in the remote interior is mainly restricted to valleys at the edges of the areas.
- Fragmentation in the more accessible protected areas is higher.
- The protected areas in Kalimantan with a Protection Forest (*Hutan Lindung*) status generally show higher levels of fragmentation than protected areas with a National Park or Nature Reserve status.

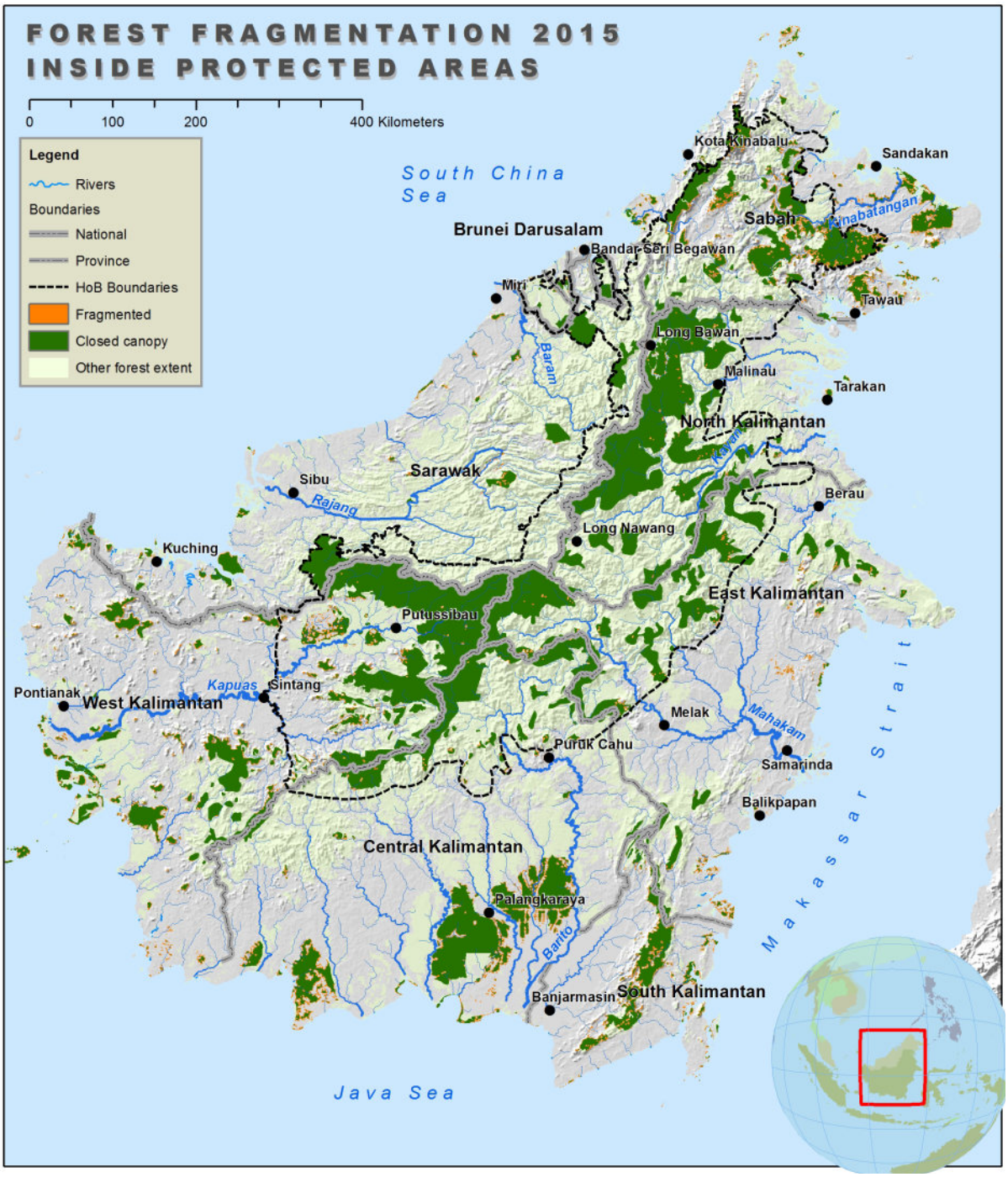
Intactness of protected areas is measured by looking at their fragmentation. Forest in protected areas are supposed to naturally have closed canopies and be connected rather tightly. Gaps generally occur but these are never very wide.

Somewhat larger open spots can occur naturally in places of landslides or strong storms. Otherwise, fragmentation should only be visible in the vicinity of large rivers, lakes and swamps, if the area is in good natural condition.

Fragmentation of large protected areas in the remote interior is mainly restricted to valleys at the edges of the areas. In protected areas such as Mulu, Betung Kerihun and the southern section of Kayan Mentarang, less than 6% of the total area is fragmented.

Fragmentation in the more accessible protected areas is higher. Fragmentation of the Kinabatangan forest is more than 20% and is almost 30% in Tanjung Puting and Danau Sentarum.

The protected areas in Kalimantan with a Protection Forest (*Hutan Lindung*) status generally show higher levels of fragmentation than protected areas with a National Park or Nature Reserve status.


FOREST FRAGMENTATION 2015
INSIDE PROTECTED AREAS
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Fragmented
Closed canopy
Other forest extent
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
Kapuas
Sintang
West Kalimantan
Melak
Mahakam
Puruk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea

3.5 Forest fragmentation 2005-2010-2015

Snapshot

- The 10 year period from 2005 to 2015 has seen a dramatic fragmentation of the Bornean interior forest.
- By 2015, Borneo's lowland rainforest had become particularly fragmented, whilst most of the montane forest of Borneo was still unfragmented.
- Analysis of the 2005, 2010 and 2015 time series data indicates that fragmentation is frequently followed by deforestation.
- Fragmentation is common along major interior rivers, mainly due to shifting agriculture and development of transportation sites.

2005: Large parts of the interior forest blocks of Borneo were still unfragmented in 2005; the interior in particular, had large areas of continuous forest. Along large interior rivers however, fragmentation was common, mainly due to shifting agricultural cultivation and development of transportation sites for companies. The most fragmented ecosystem at this time was lowland rainforest. Upland rainforest was generally intact in most areas and montane forest was generally unfragmented, except for parts of the Crocker Range and the upper Padas area in Sabah.

2010: By 2010, many of the forest areas of Borneo's interior had begun to become fragmented, while further fragmentation occurred in most of Sabah and the edges of West and Central Kalimantan.

2015: Fragmentation was well entrenched by 2015, with vast swathes of the interior forest areas also becoming fragmented. The largest areas of unfragmented forest left in Sabah were mainly in the protected areas and parts of the eastern Crocker Range. Most of the upland forest of Sarawak underwent fragmentation between 2005 and 2015. Most of the lower forest areas of West Kalimantan were fragmented, though the mountain ranges were often still intact. Nearly all of the edges of the forest of Central Kalimantan were fragmented by 2015, and fragmentation was also high along the Barito river. Many edge areas of the forest of East Kalimantan became fragmented.

By 2015, Borneo's lowland rainforest had become particularly fragmented, whilst most of the montane forest of Borneo was still unfragmented in 2015. Analysis of the 2005, 2010 and 2015 time series indicate that fragmentation is frequently followed by deforestation.

Description by Region:

Sabah: By 2005, lowland forest had already experienced fragmentation, particularly in the interior forest areas. The upland rainforest of Sabah underwent fragmentation in between 2005 and 2015, with most of the forest fragmented by 2010. The largest areas of unfragmented forest left in Sabah were mainly in the protected areas and parts of the eastern Crocker Range. In collaboration with the state government, WWF-Malaysia has started to restore some of the connectivity through restoration in the Bukit Piton area of the Ulu Segama-Malua Forest Reserve.

Brunei: In Brunei, only parts of the forest are fragmented.

Sarawak: The western part of the state is particularly fragmented.

West Kalimantan: In West Kalimantan, most of the western lowland edges and the western part of the upland forest is fragmented by 2005.

Central Kalimantan: Most of the southern edges of the province were already strongly fragmented by 2010. Fragmentation of the upland forest of Central Kalimantan in the southern part of Arabela landscape and along the large rivers has been pronounced.

East Kalimantan: The upland forest of East Kalimantan remained mostly unfragmented. East Kalimantan remains mostly unfragmented except for parts along the middle Mahakam, Belayan, the Telen, the Senyur, Berau, lower Kayan and Sebuku rivers.

South Kalimantan: Most of the remaining forest of South Kalimantan is fragmented, with the exception of upper slopes of the Meratus mountains.

North Kalimantan: The vast upland and montane forest of North Kalimantan remained unfragmented except for locations with intensive shifting cultivations.

Note to maps:

*The forest fragmentation maps are based on the application of filters to the forest/ non-forest base maps. Each pixel of forest cover was checked for its neighboring pixels and if a certain number of these pixels was non-forest then the forest pixel would be classified as being fragmented. The size of the pixels (250*250 m) as well as the fact that forest with open canopies were still classified as forest have probably led to an underestimation of the fragmentation. We can say that the maps show areas with severe fragmentation. The automated choice for the number of pixels took into consideration landscape features such as water bodies and mountain ridges. Fragmentation maps provide an indication of the connectivity of forest blocks in the entire landscape. If a pixel on the satellite image of forest cover had many neighboring pixels of non-forest then the forest pixel would be classified as being fragmented.*


FOREST FRAGMENTATION 2005
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Fragmented
Closed canopy
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Putussibau
Pontianak
West Kalimantan
Kapuas
Sintang
Melak
Mahakam
Puruk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea


FOREST FRAGMENTATION 2010
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Fragmented
Closed canopy
South China Sea
Brunei Darusalam
Kota Kinabalu
Sandakan
Sabah
Kinabatangan
Bandar Seri Begawan
Miri
Tawau
Long Bawan
Baram
Malinau
Tarakan
North Kalimantan
Kayan
Sarawak
Sibu
Rajang
Berau
Long Nawang
Kuching
East Kalimantan
Pukussibau
Kapuas
Sintang
Pontianak
West Kalimantan
Melak
Mahakam
Putuk Cahu
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Barito
Banjarmasin
South Kalimantan
Makassar Strait
Java Sea


FOREST FRAGMENTATION 2015
0
100
200
400 Kilometers
Legend
Rivers
Boundaries
National
Province
HoB Boundaries
Fragmented
Closed canopy
South China Sea
Brunei Darusalam
Bandar Seri Begawan
Kota Kinabalu
Sandakan
Sabah
Tawau
Miri
Long Bawan
Malinau
Tarakan
North Kalimantan
Sarawak
Sibu
Kuching
Long Nawang
Berau
East Kalimantan
Putussibau
Pontianak
West Kalimantan
Sintang
Melak
Samarinda
Balikpapan
Central Kalimantan
Palangkaraya
Banjarmasin
South Kalimantan
Java Sea
Makassar Strait
Kapuas
Barito
Mahakam

CHAPTER 4

Projections for 2020

This chapter relates to the projections of the 2020 extent of the eight major ecosystems in Borneo and is based on the linear extrapolation (business-as-usual scenario) of the forest cover trends of 2005-2015. The projections are compared to the goals for conservation as determined by a team of experts in 2007 (explained in the first Environmental status report for the HoB). The goals are based on the historical extent of forest coverage at the turn of the 20th century in which Borneo's entire land mass then was covered by 96% of forest. It is inevitable that the extent of forest coverage would since then decline, as forest were converted for development and other land uses, including logging and plantations, as well as increasing numbers of local people opening up forest land for agriculture. The question then was how much was the decline, and to what extent would the decline be over time? Taking the cue of the Heart of Borneo Declaration signed in 2007, WWF intensified the monitoring of the extent of forest coverage.

To visualize and prevent this rapid rate of decline, an international team of Borneo experts set the 2020 goals as a guide towards retaining the ecosystems for biodiversity conservation and protection of ecosystem services. Each major ecosystem had its own goal in relation to the historical extent.

As this 2016 status report now covers all of Borneo, new conservation goals that reflect the entire island need to be set. These goals are based on the best possible extents for well-functioning ecosystems while taking into accounts the requirements of land use for economic development.

The conservation goals are:

- **Lowland rainforest**: at least 45% of historical extent remains
- **Upland rainforest**: at least 80% of historical extent remains
- **Montane forest**: at least 90% of historical extent remains
- **Limestone forest**: at least 60% of historical extent remains
- **Heath forest**: at least 50% of historical extent remains
- **Freshwater swamp forest**: at least 40% of historical extent remains
- **Peat swamp forest**: at least 60% of historical extent remains
- **Mangrove**: at least 60% of historical extent remains

Based on the baseline year of 2015, the projected coverage by 2020 under BAU and with a concerted intervention approach, our conservation goals for each ecosystem in Borneo are set out in the table, and described in the chart below.

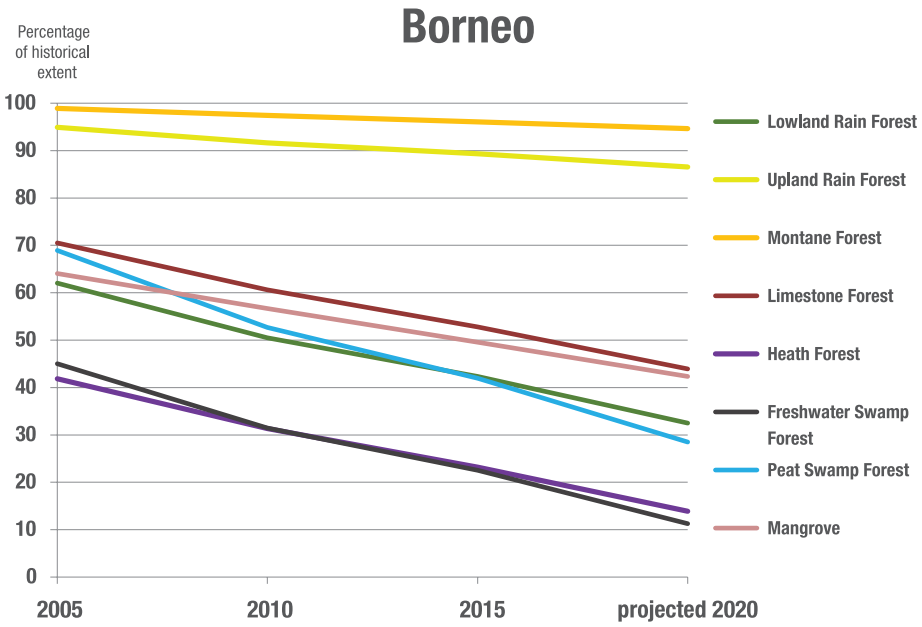
Based on projections, the conservation goals are hard to realise with the current business-as-usual (BAU) projections.

In fact the only goals that can still be reached for these projections are for upland rainforest, 89% in 2015, projected 87% in 2020 and montane forest, 96% in 2015, projected 94% in 2020.

- Lowland rainforest already passed the 45% mark between 2010-2015. Currently less than 43% remains and the projection for 2020 is 32% remaining.

- Limestone forest stands at 53% in 2015, but is projected at 44% in 2020.
- Heath forest falls far below the goal, with 23% remaining in 2015, and a projected decline to 14% in 2020.
- Freshwater swamp forest is also not doing well, with 23% remaining in 2015, and a continuing rapid decline projected to 11% in 2020.
- Peat swamp forest already passed the 60% mark between 2005-2010. Less than 42% remained in 2015 and a strong decline to 28% is projected in 2020.
- Mangroves had nearly 50% remaining in 2015, but projected to 42% in 2020.

Ecosystem	Historical Extent (ha)	% of Historical Extent in 2005	% of Historical Extent in 2015	% of Projected BAU coverage for 2020	Conservation Goal for 2020 (%)
Lowland rainforest	31,180,400	62.0	42.3	32	45
Upland rainforest	13,820,400	94.9	89.3	87	89
Montane forest	6,727,300	98.9	96.1	94	94
Limestone	1,279,200	70.5	52.8	44	60
Heath forest	7,004,200	41.8	23.2	14	50
Freshwater swamp	2,373,100	45.0	22.5	11	40
Peat swamp forest	9,417,900	68.9	42.0	28	60
Mangrove	2,580,600	64.1	49.6	42	60



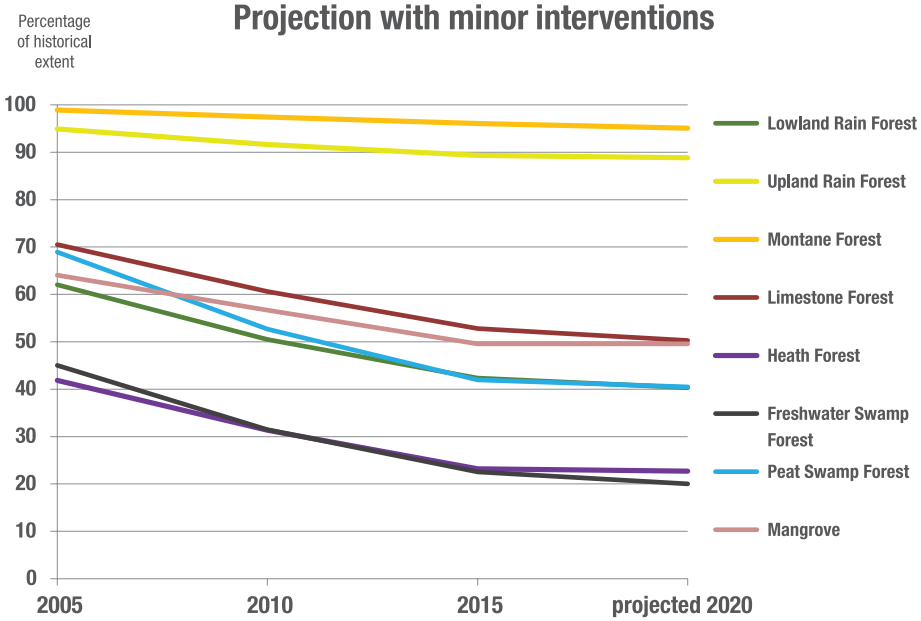
4.1 Projections with minor interventions: reduction of deforestation rates

The need for further development will result in opening of more forest land. However, to prevent BAU from leading to excessive forest loss, interventions on reducing deforestation rates must be implemented. This implies that for the following ecosystems, some loss would occur, but must be controlled in order to maintain our conservation goals by 2020:

- If deforestation of lowland rainforest can be reduced to 125,000 ha per year, then 40% of the historical extent will be preserved by 2020
- If deforestation of upland rainforest can be reduced to 14,000 ha per year, then 88% of the historical extent will be preserved by 2020
- If deforestation of montane forest can be reduced to 13,000 ha per year, then 95% of the historical extent will be preserved by 2020
- If deforestation of limestone forest can be reduced to 7,000 ha per year, then 50% of the historical extent will be preserved by 2020
- If deforestation of heath forest can be reduced to 7,000 ha per year, then 23% of the historical extent will be preserved by 2020
- If deforestation of freshwater swamp forest can be reduced to 12,000 ha per year, then 20% of the historical extent will be preserved by 2020
- If deforestation of peat swamp forest can be reduced to 28,000 ha per year, then 40% of the historical extent will be preserved by 2020
- If deforestation of mangrove can be reduced to zero, then 50% of the historical extent will be preserved by 2020

The map on page 119 shown forest not yet allocated for protection or production forest amounting to 8 million hectares, and indicates the general locations where deforestation must be controlled if not halted altogether.

Ecosystem	If Deforestation Reduced (Ha/ Year)	% of Historical Extent could be preserved by 2020
Lowland rainforest	125,000	40
Upland rainforest	14,000	88
Montane forest	13,000	95
Limestone	7,000	50
Heath forest	7,000	23
Freshwater swamp	12,000	20
Peat swamp forest	28,000	40
Mangrove	0	50



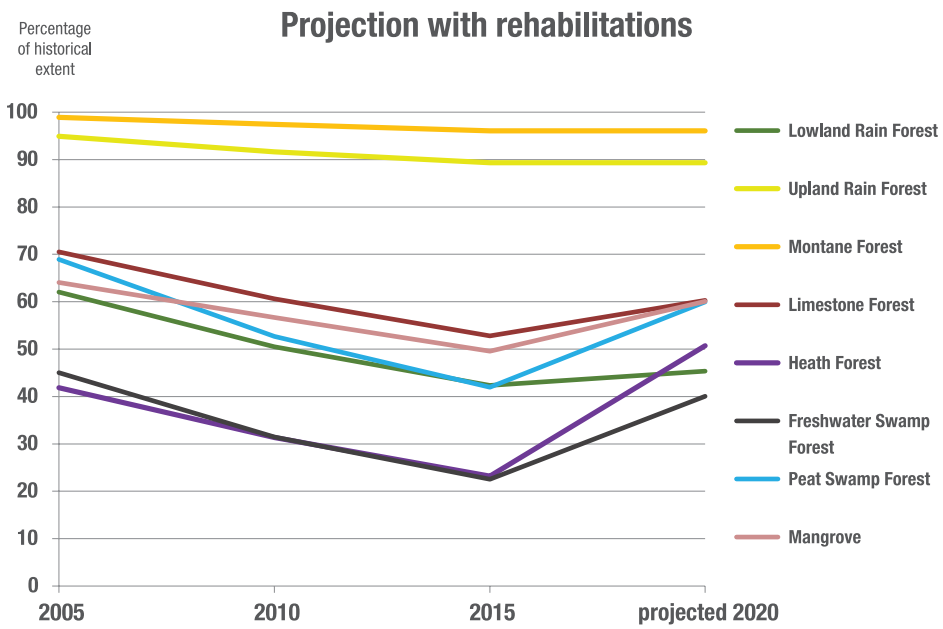
4.2 Projections with major interventions: rehabilitations

Reducing deforestation is not enough for most of the ecosystems, where the conservation goals can only be reached through increase of existing forest cover. This implies forest rehabilitation, either by recovery of degraded forest or by reforestation. The projections indicate that for some of the ecosystems, very large areas would have to be rehabilitated. The question is whether this is realistic for heath forest, where damage is often irreversible, and peat swamp forest which requires major restoration works for rehabilitation, as can be seen in Sebangau National Park.

Ecosystem	Restoration (Ha/Year)	% of Historical Extent could be preserved by 2020
Lowland rainforest	187,000	45
Upland rainforest	0	89
Montane forest	0	95
Limestone	19,000	60
Heath forest	380,000	50
Freshwater swamp	83,000	40
Peat swamp forest	339,000	60
Mangrove	54,000	60

- If 187,000 ha of lowland rainforest can be restored annually, then 45% of the historical extent will exist in 2020.
- Restoration of upland rainforest and montane forest is not required to reach the conservation goals, it is sufficient that deforestation is reduced to zero.
- If 19,000 ha of limestone forest can be restored annually, then 60% of the historical extent will exist in 2020.
- If 380,000 ha of heath forest can be restored annually, then 50% of the historical extent will exist in 2020.
- If 83,000 ha of freshwater swamp forest can be restored annually, then 40% of the historical extent will exist in 2020.
- If 339,000 ha of peat swamp forest can be restored annually, then 60% of the historical extent will exist in 2020.
- If 54,000 ha of mangrove can be restored annually, then 60% of the historical extent will exist in 2020.

The map on page 155 showing forest fragmentation indicates general locations where rehabilitation of degraded forest needs to take place to restore the integrity of the ecosystems and species habitat via larger interconnected forest landscapes.

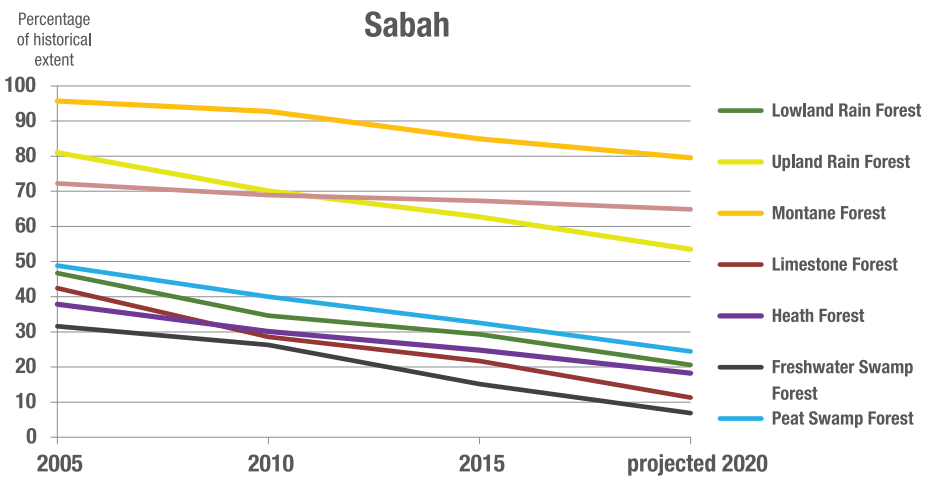


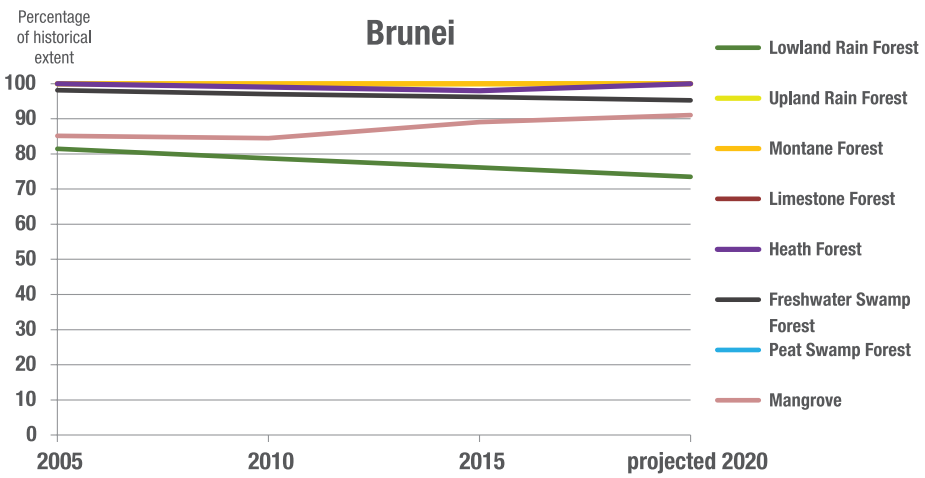
4.3 Projections for state and province

The charts that follow show percentage of historical extent for each ecosystem per province or state as projected for 2020, in a BAU scenario.

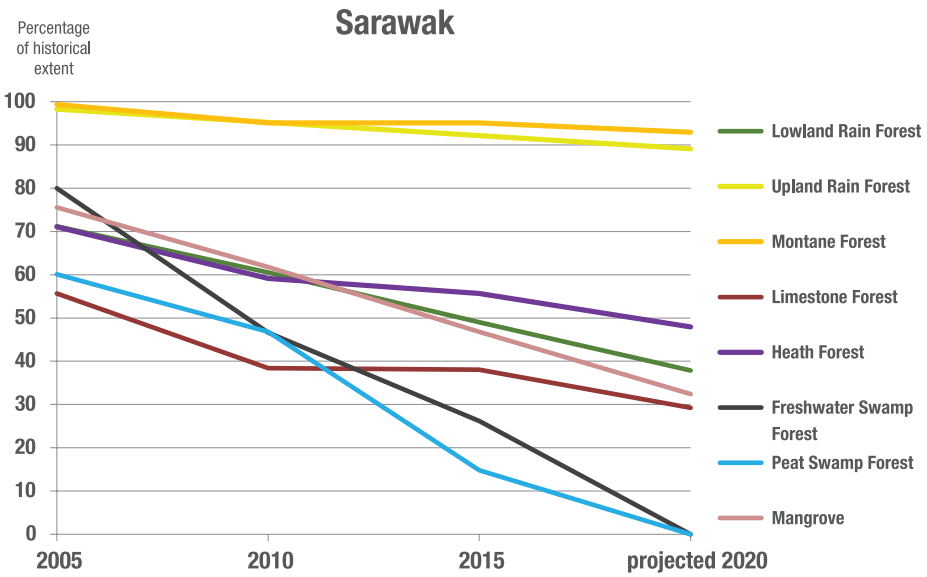
Sabah is the only state or province where the projected remaining coverage of montane forest is below the 90% of the historical extent. However, mangroves in Sabah are preserved high above the Borneo total. The other ecosystems including upland rainforest are declining, with freshwater swamp forest projected to be less than 10% of the historical extent.

Interventions are however proceeding and trends for montane, limestone and peat swamp forest can stabilize, meaning that actual decreases of extent will be lower than projected.

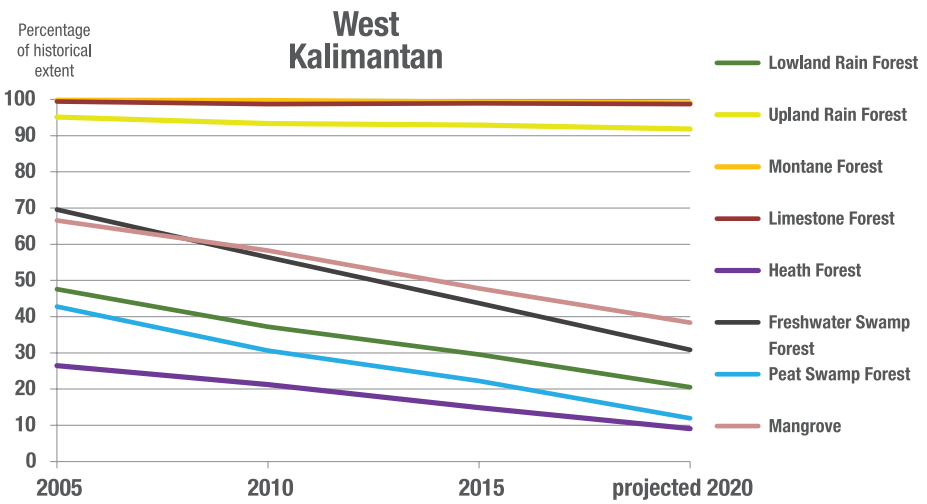




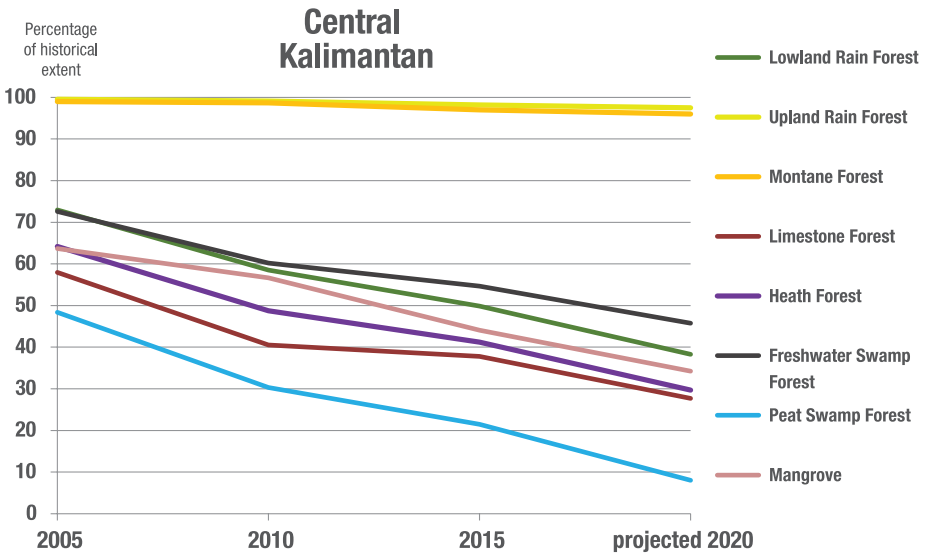
In Brunei all present ecosystems are faring well. Lowland rainforest shows a slow decline but is still projected to have more than 70% of its historical extent in 2020.



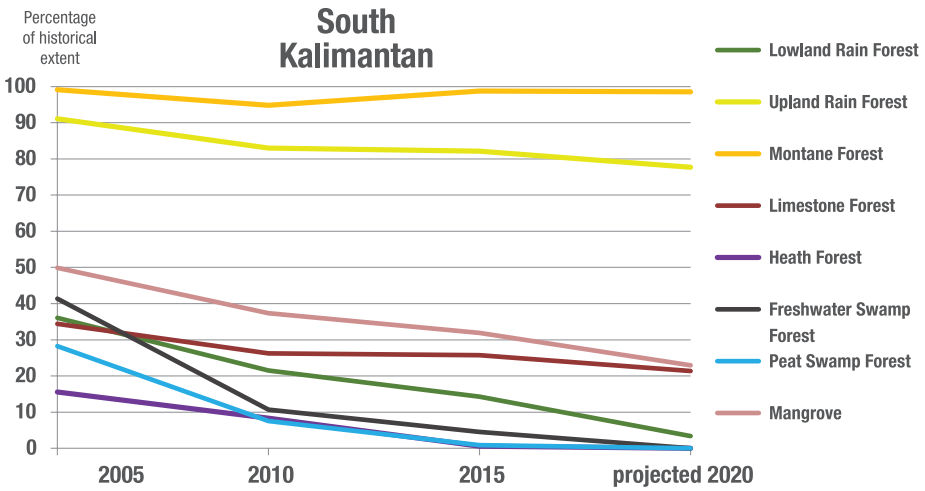
Upland rainforest and montane forest are well preserved in Sarawak with percentages more than 80% of the historical extent. Heath forest in Sarawak is doing better than in most other areas of Borneo. All other ecosystems are below 40% and are projected to decline further. Freshwater swamp forest is projected to be completely lost by 2020. With the exception of the few protected areas: Maludam, Sedilu, Sebuyau and Loagan Bunut National Parks, with a total area of 88,902 hectares, peat swamp forest is likewise projected to be all but lost in 2020.



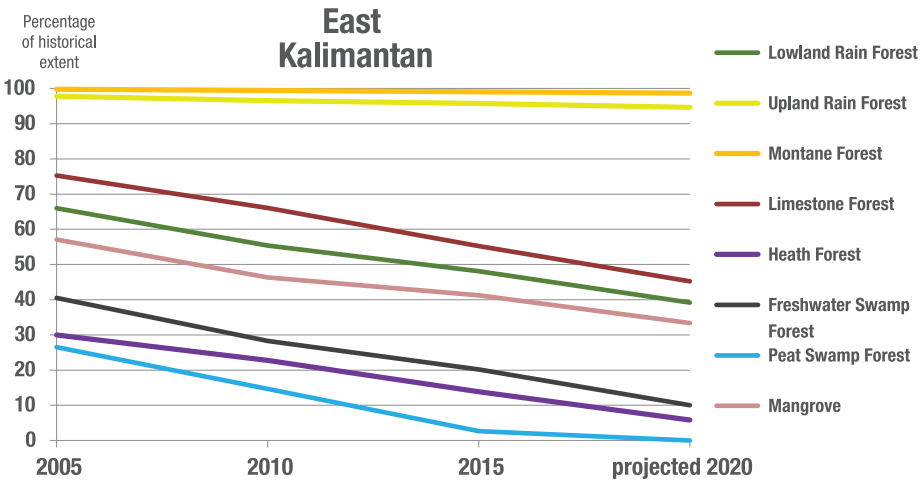
Montane, upland and limestone ecosystems are well preserved in West Kalimantan; lowland rainforest and peat swamp forest is disappearing rapidly.



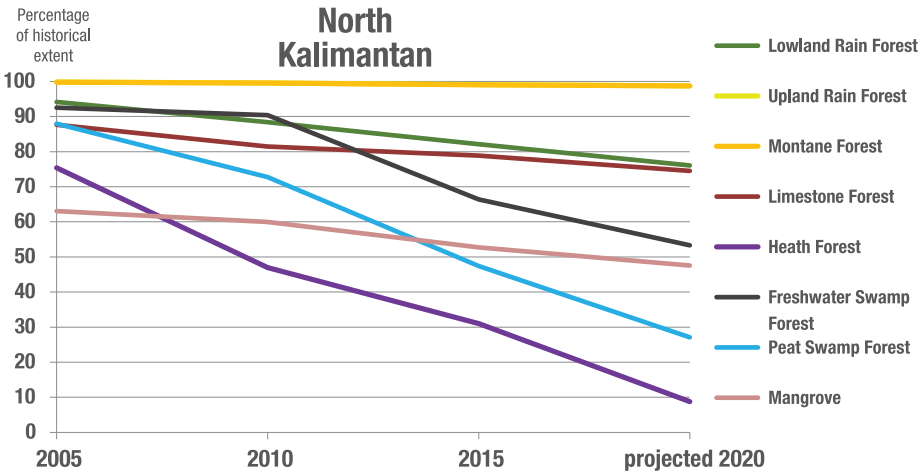
In Central Kalimantan, upland and montane ecosystems are very well preserved, but peat swamp forest in particular is declining rapidly to less than 10% of historical extent.



South Kalimantan managed to restore montane forest, but lowland rainforest, peat swamp forest and freshwater swamp forest are on the verge of extinction.



East Kalimantan has preserved the upland and montane ecosystems well. The other ecosystems are declining but the conservation goal of 50% for lowland rainforest can still be preserved with interventions. The other ecosystems are declining. Heath forest is projected to be less than 10% and peat swamp forest is on the verge of extinction.



North Kalimantan has done well in preserving most of its ecosystems until 2010, then decline set in. Mangrove and peat swamp are projected to lose more than half of their historical extent, with heath forest even worse, to less than 10% remaining. So the future for these forest ecosystems looks bleak. Upland rainforest and montane forest are nevertheless projected to be the best preserved ecosystems for all of Kalimantan. The biggest natonal park in all of Borneo, the Kayan Mentarang National Park at 1.4 million hectare is in North Kalimantan.

Forest in Kubaan-Puak, Sarawak, Malaysia

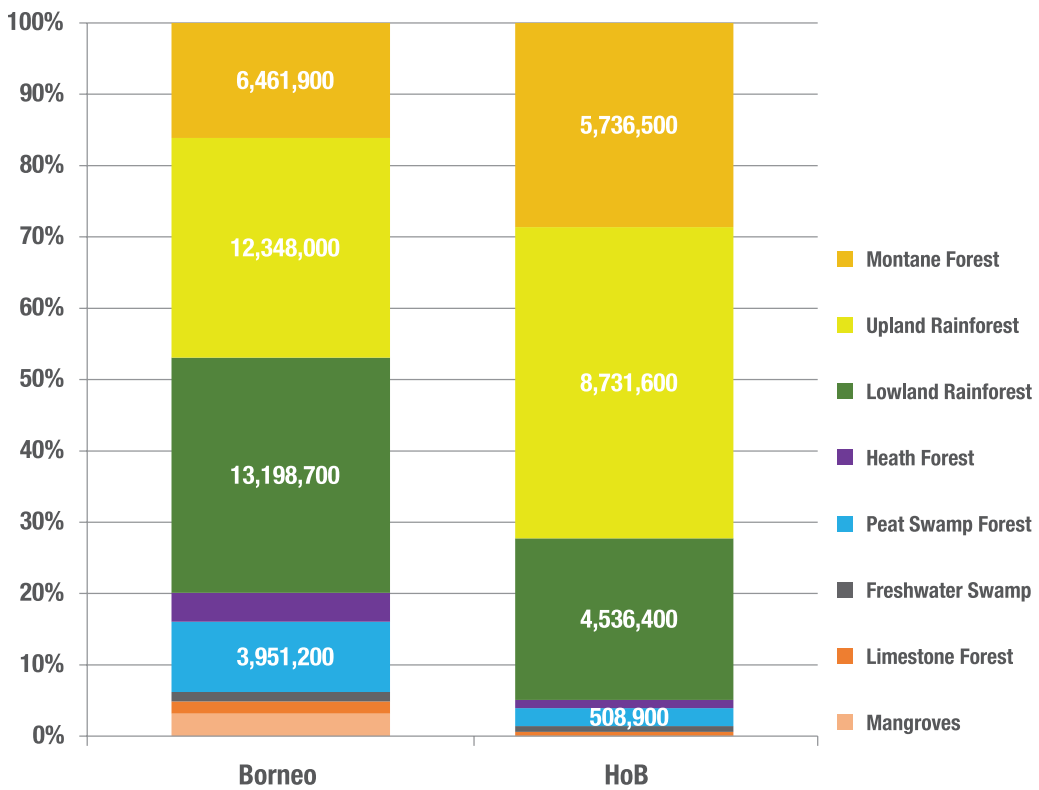
CHAPTER 5

Environmental status comparison between the HoB and the whole of Borneo

The Heart of Borneo (HoB) area covering 23 million ha, encompasses the headwaters of the major rivers of Borneo. The first delineation of the HoB boundaries roughly corresponded with the contour lines of the foot slopes of the interior mountain complexes of Borneo. In due course, more lowland areas were added to improve ecological connectivity and conservation opportunities.

The representation of the major ecosystems in the HoB is, however, still different from that of Borneo as a whole, as can be seen in the graphs below, based on the extent at 2015.

Comparison of ecosystem ratios - Borneo and HoB



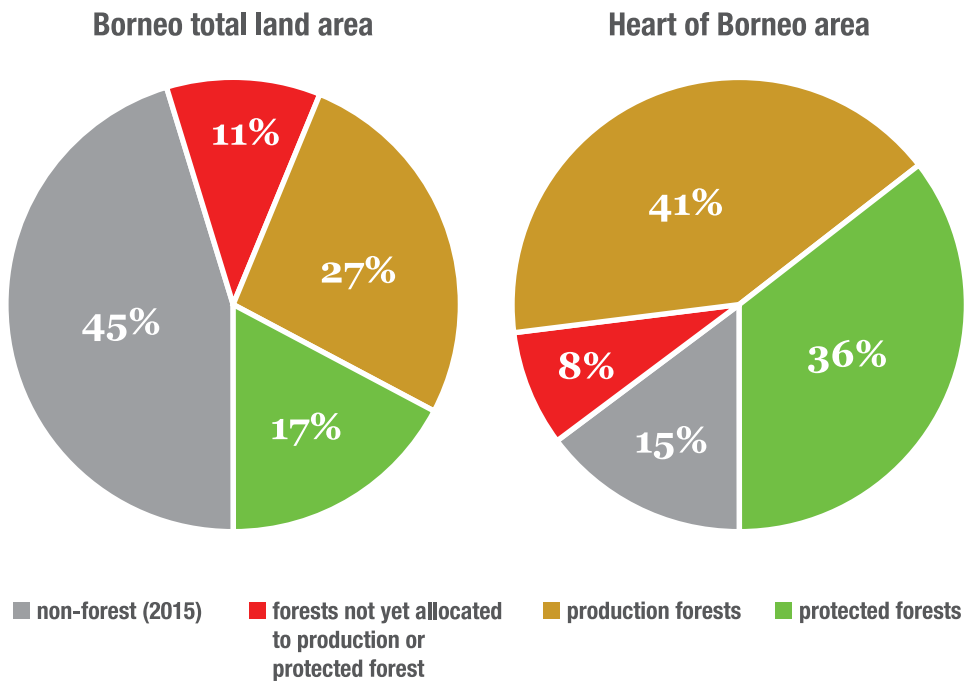
Most areas of the montane ecosystems are inside the HoB and these include almost 30% of the total area of the HoB, and 16% of the total Borneo land area. A majority of the upland rainforest ecosystem is also in the HoB. It is 44% of the HoB area, but only 31% of the whole of Borneo area.

Almost three-quarter (74%) of the HoB land is higher than 300 m above sea level; for the whole of Borneo, the area is about 50%.

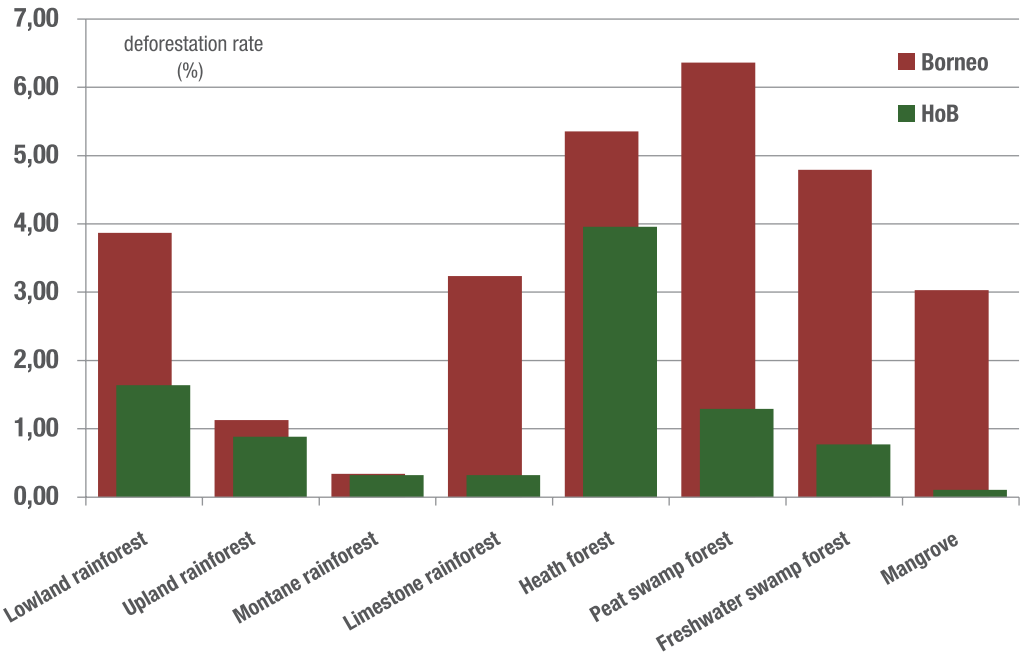
The area of lowland rainforest ecosystems in the HoB is much smaller than in the whole of Borneo (4.5 million ha versus 13.2 million ha) but still comprises 23% of the land area of the HoB.

Peat swamp forest is a very large ecosystem of Borneo, comprising 10% of the area. It is much smaller in the HoB, only 2.5%. Heath forest can also be considered under-represented with 289,000 ha inside the HoB, out of the total of 1.6 million ha in Borneo. Although many small limestone areas and the large Mulu National Park area are present inside the HoB, the largest limestone area of Borneo, the Sangkulirang area, is outside.

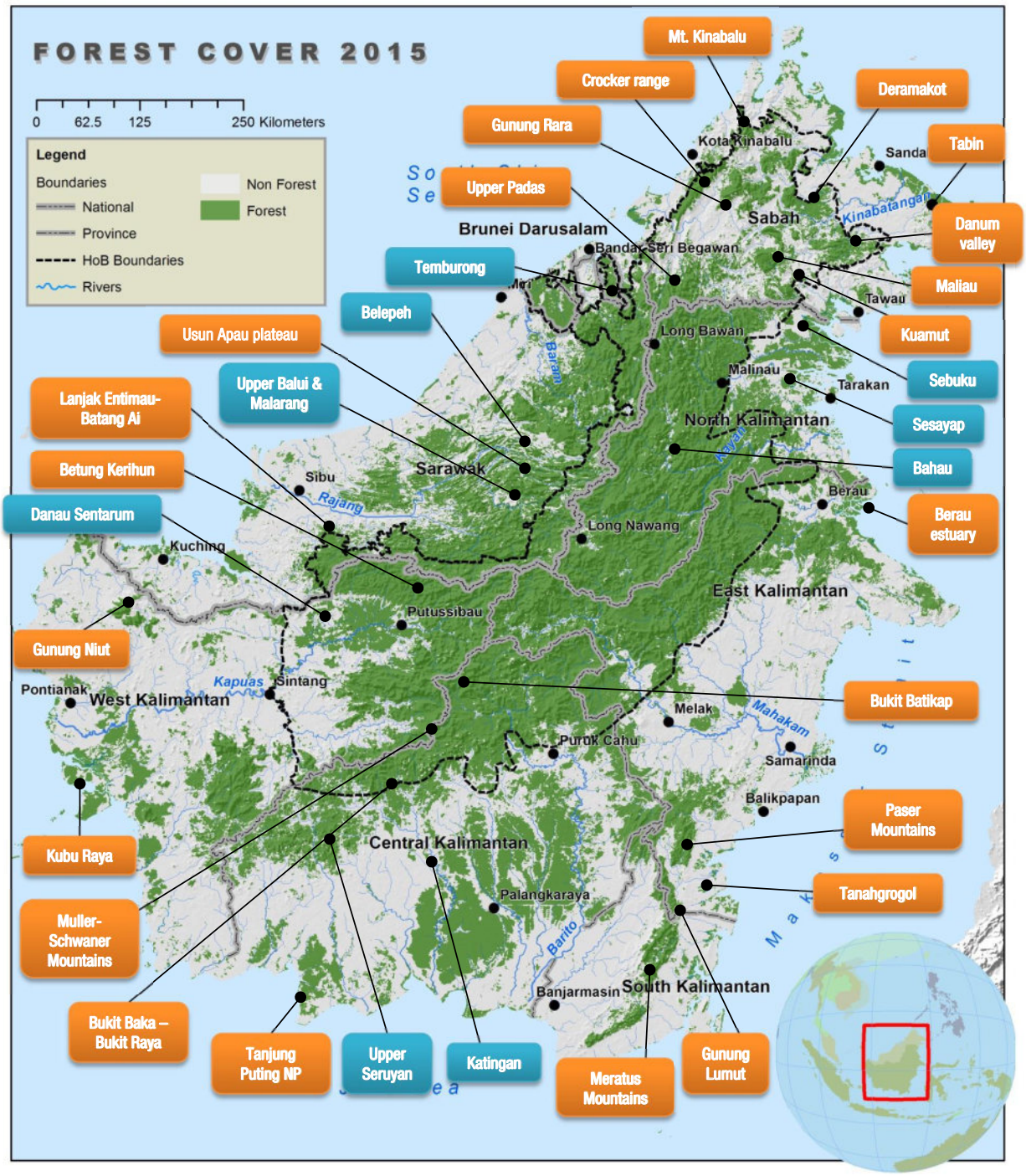
The forest cover and land use status is very different between the HoB and Borneo as a whole. The HoB is strongly covered with forest, 85% forest coverage, only 55% of Borneo is still covered with forest. More than one-third (36%) of the HoB is protected area while for the whole of Borneo this figure is only 17%. Production forest is the major commercial land use in the HoB and 41% of the area is to be retained as sustainable production forest. 8% of the HoB is not yet allocated for production nor protected forest and these areas can potentially be allocated for conversion.



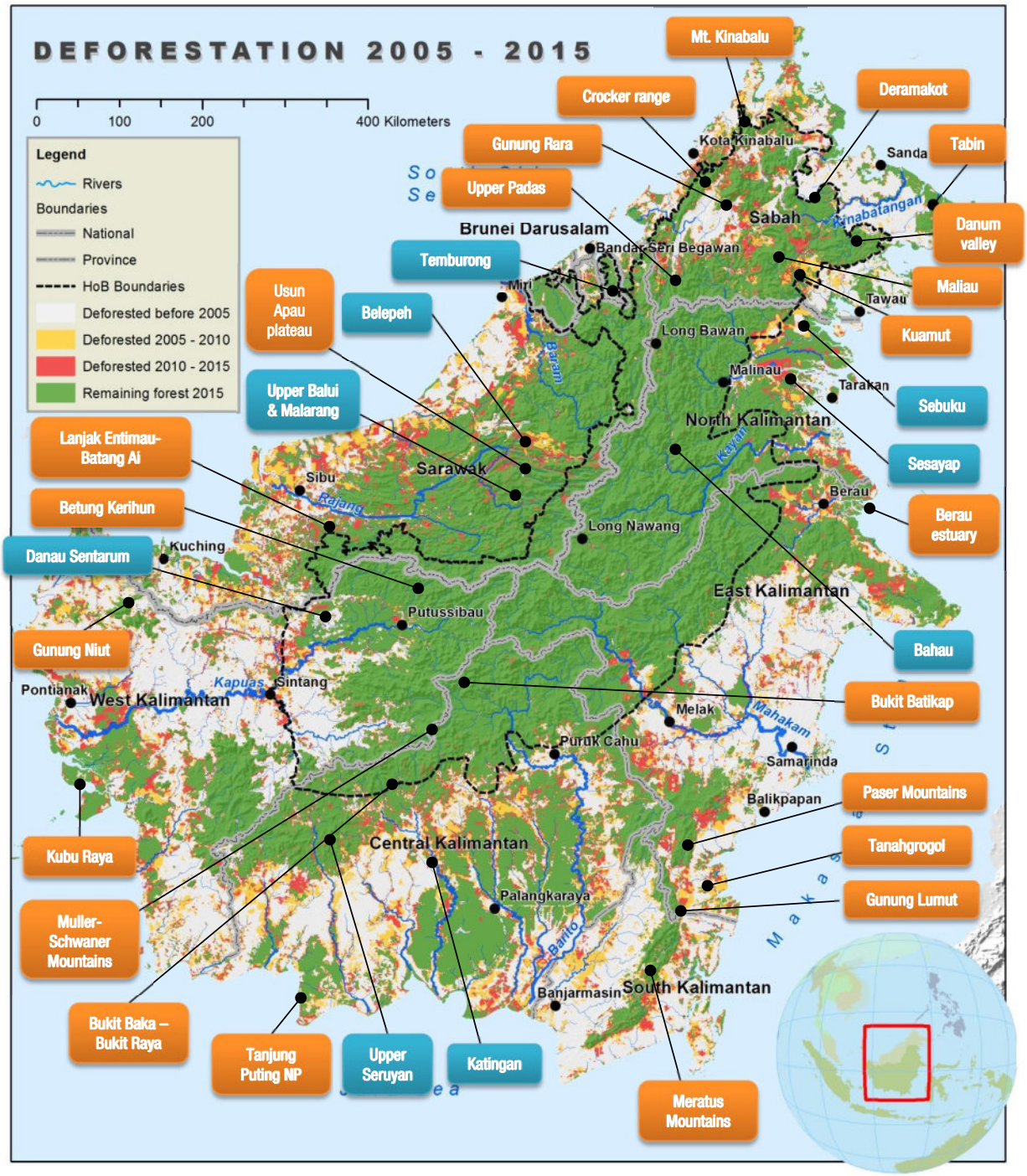
Deforestation rates of most of the ecosystems of the HoB are much lower than in Borneo as a whole, as can be seen in the graph below. Lowland rainforest in particular is faring much better in the HoB than in the whole of Borneo. Deforestation of montane forest and heath forest in the HoB could be controlled better.



Locations mentioned in the text, on forest cover map, see page 21



Locations mentioned in the text, on deforestation map, see page 22



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Rainforest in Sabah, Malaysia

CHAPTER 6 Methodology

The base of many of the environmental status analyses is the 2015 forest cover map for Borneo, which was derived from the MODIS cloud-free mosaic for 2015. The MODIS satellite provides images daily for the whole of Borneo and a selection was made from images and image sections without a cloud cover from the last months of 2015. In this way, an entirely cloud-free composition of satellite images could be produced with matching spectral bands, allowing for uncomplicated classification.

The resolution of MODIS images is rather low, 250 m, but sufficient for mapping of forest cover at Borneo-wide reconnaissance scale. Locations where forest cover could not be clearly distinguished were checked with satellite images with a higher resolution.

The forest cover classification was developed in such a way that forest with a closed canopy, as well as forest with an open canopy, but with a well-developed understorey, are classified as being forest. The assessment was made to establish the 2015 forest cover without underestimation of forest recovery. In certain areas, logged-over forest and young secondary forest have been given the opportunity to recover, and sometimes even enrichment planting has been conducted. These areas, even though temporarily having an open canopy, should still be considered forest. For verification, samples of such forest locations were analysed with high resolution (30 m) Landsat images and field records.

It should still be mentioned that notwithstanding our careful analysis and checks, a 100% accuracy can never be guaranteed. Misclassifications of particularly forest cover could occur, but will gradually be improved when more accurate analysis from the field is incorporated.

The major ecosystems were mapped with data from the Biodiversity Information Monitoring System (BIMS) and where required, refined with geomorphology data from land system maps.

The base map for each ecosystem and species was updated with the 2015 forest cover.

With respect to the species specific sections.

- The calculation of the habitats for viable populations of clouded leopards was based on the paper from Hearn et al 2016 in RBZ Special Supplement 33.
- The banteng distribution map was made by combining reliable field records from literature and WWF surveys.
- The orangutan distribution data is based on the latest (2016) IUCN Red List assessment.
- The proboscis monkey distribution map was produced by modelling in MAXENT with all reliable field records from WWF surveys and literature.
- The elephant distribution map is based on Alfred et al (2013) Current status of Asian elephants in Borneo, refined with WWF field records.
- The estimated rhino distribution was approximately mapped by combining field records from J. Payne and WWF.
- The information on high concentrations of endemic Dipterocarpaceae and endemic Fagaceae was obtained from the Flora Malesiana and the Tree Flora of Sabah and Sarawak.
- The information on high concentrations of endemic Nepenthaceae was derived from C. Clarke (1979) Nepenthes of Borneo, with additional records from WWF surveys.

The map data on Protected areas and Production forest was based on sources (published or otherwise) provided by the Forest Department of Sarawak, Sabah Forestry Department and the Ministry of Environment and Forestry of Indonesia.

The maps on oil palm plantations were produced through digital interpretation of satellite images.

The map data on mining concessions in Indonesia was provided by the Ministry of Energy and Mineral Resources of Indonesia.

The information on certified logging concessions was provided by the Global Forest & Trade Network (GFTN) team of WWF-Indonesia.

Fragmentation

The forest fragmentation maps are based on the application of filters to the forest/non-forest base maps. Each pixel of forest cover was checked for its neighbouring pixels and if a certain number of these pixels was non-forest then the forest pixel would be classified as being fragmented. The automated choice for the number of pixels took into consideration landscape features such as water bodies and mountain ridges.

CHAPTER 7

Conclusions

Overall forest cover

The forest cover at the turn of the 20th century in Borneo was 74 million hectares, close to the historical extent of 96% of the island. By 2005, this had dwindled to 71% and the latest report indicates by 2015, this had fallen to little more than half the island at 55% - a figure which includes both intact and degraded forest. While the overall rate of deforestation in Borneo is high, deforestation in the HoB area is significantly lower, with the forest cover at 91% in 2005 and 85% in 2015.

The status of key ecosystems and species

Box 1: Summary of the status of key ecosystems and species between 2005-2015

- Freshwater swamp forest has a very poor status, with 23% remaining and more than half of that not allocated to be retained.
- Lowland rainforest, peat swamp forest and heath forest ecosystems have a poor status with 42%, 42%, and 23% remaining, respectively.
- Limestone forest and mangroves have a weak status with 53% and 50% remaining respectively.
- Upland rainforest and montane forest ecosystems have a good status with 90% and 96% remaining respectively.
- Orangutans, proboscis monkeys, elephants and endemic Nepenthaceae have a weak status.
- Clouded leopards, bantengs, endemic Dipterocarpaceae and endemic Fagaceae have a good status.

The state of the Borneo's states

- All provinces and states of Borneo, except Brunei, have a poor to very poor status of freshwater swamp forest and heath forest.
- Sabah has undergone a decline of particularly lowland and upland rainforest.
- Sarawak has a very poor status of peat swamp forest and a poor status for lowland rainforest.
- West Kalimantan has a poor status for peat swamp forest and lowland rainforest.
- Central Kalimantan has a very poor status of peat swamp forest.
- South Kalimantan has a very poor status of lowland rainforest and peat swamp forest.
- East Kalimantan has a very poor status of peat swamp forest and a poor status for lowland rainforest.

Ecosystems status in Borneo

The status of the ecosystems in Borneo ranges from very good to poor. Montane forest was mainly preserved in 2015 with the status classified as 'very good'; 96% of the historical extent still remains, of which 8% of the remaining forest has been allocated for other land use.

For upland rainforest, the status was 'good' with 11 million ha or 90% of the historical extent still remaining with 9% of remaining upland rainforest allocated for other land use. Upland rainforest is now the largest intact ecosystem of Borneo. It is now vital for species conservation as Borneo had lost vast expenses of lowland rainforest that once harboured the highest wildlife diversity.

Lowland rainforest was the most affected ecosystem. It had the largest converted area of more than 6 million ha between 2005 and 2015, leaving only 13 million of the historical 31 million ha. The status was classified as 'poor', because 58 % of the historical extent had been converted. The remaining 28% lowland rainforest has not been allocated or designated by the respective government authorities as protected or production forest. Under a business-as-usual scenario, this forest could face conversion. Further, a quarter of this remaining 13 million ha has been fragmented, rendering it unsuitable for conservation of species that require large intact forest.

The status of peat swamp forest was also classified as 'poor'. By 2015, 58% of the historical extent had been converted. The remaining 3.9 million ha of peat swamp forest should be protected or conserved. Of this remaining forest, 25% had already been allocated to other land use area (APL) and Production Conversion Forest (HPK) as in Kalimantan.

Freshwater swamp forest had undergone the highest conversion rate, from 45% in 2005 to only 23% remaining in 2015. As such, the status was classified as 'very poor', with 77% of the historical extent converted. Even so, 56% of this remaining freshwater swamp forest has been allocated for other land use. The status of mangroves was classified 'weak', with 50% converted by 2015 and 45% of that remaining not been allocated to be retained as protected or production forest despite mangroves being widely recognized as important for coastal protection.

The highest conversion rate occurred within the heath forest ecosystem. The remaining forest further dropped drastically from 42% in 2005 to 23% in 2015. Consequently, the status was classified as 'very poor', with 77% of the historical extent converted. Despite this, the 20% of the remaining heath forest had not been allocated for protected forest.

As for limestone forest, 47% has been subject to deforestation. The remaining forest was 70% in 2005, with 53% left in 2015. The status was classified as 'fair', with 15% of the remaining limestone forest allocated to other land uses.

Key species status in Borneo

Overall, the status of viable populations of clouded leopard in 2015 was 'good'. However, there are areas with 'weak' status where deforestation and fragmentation have severely damaged available habitat. These are mainly in the lowland areas of Sabah, Sarawak, West Kalimantan and East Kalimantan.

Banteng occurs only in a few locations in Borneo. The status is classified as 'good' but the population in East Kalimantan and Sabah are affected by habitat conversion. The overall status of orangutan in Borneo is 'weak', with the exception of Sarawak, where it is good.

The status of proboscis monkey remains generally 'weak', though in Sabah and Brunei it is regarded 'good' as most habitats remained intact. In all other regions, the status is 'weak' to 'very poor' because of habitat conversion and illegal hunting.

The Elephant status is considered 'weak' due to continuing habitat conversion. This species is present only in Sabah and in a narrow strip of the northern part of North Kalimantan. Rhinoceros status in Borneo is rated at 'very poor', with only a small number of individuals left in some remote locations of the island. The status for the only three individuals in captivity in Sabah is declared as locally extinct since natural production is deemed impossible.

With respect to high concentrations of endemic Dipterocarpaceae, the status, based on the locations of the baseline year of 2005, is 'good' as most of these locations were still in good conditions. For high concentrations of endemic Fagaceae, the status is even better at 'very good', with only a few sites facing deforestation between 2005 and 2015. High concentrations of endemic Nepenthaceae, however, are considered 'weak', due to disturbance in prime locations in West Kalimantan and Sarawak.

Status in Borneo according to States and Provinces

In the following table, the indicators status in Borneo has been classified as ranging from ‘very poor’ to 'very good.' Following the Legend (next page), 'very poor' is rated at less than 20% of the historical extent remaining, and more than 20% allocated to other land uses. `Very good` is rated with more than 85% remaining, and less than 5% allocated for conversion.

Using the same analysis, the matrix below shows the status in the Malaysian states of Sabah, Sarawak and the five Indonesian provinces in Kalimantan.

Ecosystem & Key Species

Total Borneo

Matrix showing ranking status of the ecosystem and key species according to States and Provinces

Ecosystems & Key Species	Sabah	Brunei	Sarawak	West Kalimantan	Central Kalimantan	South Kalimantan	East Kalimantan	North Kalimantan	Total Borneo
Lowland rainforests	2	4	2	2	3	1	2	3	19
Upland rainforests	3	5	3	4	5	4	4	5	33
Montane forests	4	5	5	5	5	5	5	5	39
Peat swamp forests	3	n.a.	1	2	2	1	1	3	13
Heath forests	2	5	2	1	2	1	1	2	16
Limestone forests	3	n.a.	3	5	3	2	3	4	23
Freshwater swamp forests	1	4	1	1	1	0	1	2	11
Mangroves	4	5	3	3	3	3	2	3	26
Viable populations of clouded leopard	3	4	3	3	4	2	3	4	26
Banteng	3	n.a.	n.a.	4	4	n.a.	3	5	19
Orangutan	3	n.a.	5	3	3	n.a.	2	2	18
Proboscis monkey	4	4	2	2	3	1	2	3	21
Elephant	3	n.a.	n.a.	n.a.	n.a.	n.a.		3	6
Rhinoceros	1	n.a.	n.a.	1	1	n.a.	1	n.a.	4
High concentrations of endemic Dipterocarpaceae	4	5	4	4	4	n.a.	4	4	29
High concentrations of endemic Fagaceae	5	n.a.	4	5	5	4	5	5	33
High concentrations of endemic Nepenthaceae	5	n.a.	3	3	n.a.	n.a.	4	5	20

Legend showing ranking status

very poor	poor	weak	good	very good	
1	2	3	4	5	
<20% remaining	20%-40% remaining	40%-60% remaining	60%-85% remaining	>85% remaining	= percentage of historical extent remaining
>20% allocated to other land use	10-20% allocated to other land use	10-20% allocated to other land use	5-10% allocated to other land use	<5% allocated to other land use	= percentage of remaining allocated to non-forest land use

Sabah

Most of the lowland rainforest of Sabah has been converted and part of the remaining forest area is allocated for other land use. Sabah is the only state or province where large areas of upland rainforest have been converted, and part of the remaining is allocated for other land use. Montane forest has been heavily converted and part of the remaining area is allocated for other land use. Most of the freshwater swamp forest is gone.

On a positive note, mangroves are doing well in Sabah and most of the remaining mangroves are protected.

Viable populations of clouded leopards and orangutans are under pressure due to deforestation and fragmentation of the lowlands. The habitats of banteng and elephant populations have partly been converted to plantations and wildlife corridors are often not available resulting in severe population pressure over the remaining areas.

Brunei

Most ecosystems of Brunei are doing well, even freshwater swamp forest has much remaining area. The lowland rainforest has been partly converted. Proboscis monkey habitats have undergone small-scale conversion at the edges.

Sarawak

The lowland rainforest has mostly been converted and a large part of the remaining forest is allocated for other land use. Only a few areas are protected. Part of the upland rainforest has been converted with some of the remaining part allocated for other land use.

Nearly all of the peat swamp forest and the freshwater swamp forest have been converted. Much of the heath forest has been converted, and part of remaining allocated for other land use. A large part of the remaining mangroves has been allocated for other land use. A major area with high concentrations of endemic Nepenthaceae has been converted. Proboscis monkey habitats have been seriously reduced by developments of coastal lands and swamp forest. Viable populations of clouded leopards are under pressure due to deforestation of the lowlands.

West Kalimantan

Most of the lowland rainforest has been converted, but a large part of what is left will be preserved. More than half of the peat swamp forest has been converted, and part of the remaining forest is allocated for other land use.

Heath forest is becoming rare in West Kalimantan as nearly all of it has been converted. Some of the converted

forest contained high concentrations of endemic Nepenthaceae. Much of the little remaining area of freshwater swamp forest is allocated for other land use. Limestone forest on the other hand is nearly all protected. Proboscis monkey habitats and populations are threatened by ongoing conversion and illegal hunting. Orangutan populations are under pressure due to deforestation and fragmentation of the lowlands, peat swamp forest and the foot slopes of uplands.

Central Kalimantan

More than half of the lowland rainforest in Central Kalimantan has been converted and part of the remaining area is allocated for other land use. This province has the largest extent of peat swamp forest in Borneo but today only half of the original extent remains. Part of this remaining area is allocated for other land use. Much of the heath forest has been converted but most of the remaining area will be preserved. Most of the little remaining area of freshwater swamp forest is allocated for other land use.

Orangutan habitats are strongly reduced due to deforestation and loss of connectivity of the peat swamp forest and the lowland rainforest. Nonetheless, the Sebangau National Park located in Central Kalimantan contains the biggest population of orangutan in the wild. Proboscis monkey habitats, particularly along the major rivers and the rear mangroves, are under pressure.

South Kalimantan

Not much lowland rainforest is left. Peat swamp forest, heath forest and freshwater swamp forest are becoming rare or extinct. Upland rainforest and montane forest are doing well.

Remaining populations of proboscis monkeys are often not viable due to strong reduction of their original habitats.

East Kalimantan

More than half of the lowland rainforest has been converted and part of the remaining forest is allocated for other land use. This province used to have large areas of heath forest but most are gone. The small remaining area of peat swamp forest is mainly allocated for other land uses.

East Kalimantan has the largest limestone forest, compared to all the provinces and states, but a large part of it is allocated for other land use. Freshwater swamp forest is almost extinct. A large part of the remaining mangroves is allocated for other land use. The remaining viable populations of clouded leopards in the lowlands are under pressure due to deforestation.

North Kalimantan

Most of the lowland rainforest of this province remains intact, with part of it allocated for other land use. The original large heath forest areas have for the most part been converted and part of the remaining is allocated for other land use. Half of the mangroves have been converted and much of the remaining is allocated for other land use. Orangutan habitats are declining fast and the habitat and populations of proboscis monkey and elephants are also under pressure.

Box 2 Threats and developments:

- Expanding plantations: oil palm plantations have expanded rapidly between 2005 and 2015, occupying more than 10% of the total land area of Borneo in 2015; pulpwood plantations have also expanded rapidly.
- Forest fires have affected large areas of Borneo, with peat swamp forest and lowland rainforest particularly affected, with 55% and 21% respectively of the total number of hotspots detected.
- The high number of fire hotspots detected at the edges of oil palm plantations and inside production forest is indicative of 'expansion by stealth' by land owners.
- Mining concessions will particularly affect heath forest and lowland rainforest once an 'exploration' concession is approved for conversion to an 'exploitation' concession where mining will then take place.
- Large areas of the remaining forest (8 million hectares, or 20% of the 40 million ha of remaining forest cover in Borneo) are not yet allocated to be retained or designated as protected or production forest. Under business-as-usual scenario, they could be allocated to non-forest land use.
- Of these remaining natural forest areas, 20 million ha has been allocated as production forest. If sustainably managed, the preservation of these forest could be ensured.

Plantations

Oil palm plantations expanded rapidly between 2005 and 2015, from 2.4 million ha in 2005 to 7.0 million ha in 2015, representing 10% of the total land area of Borneo.

In addition, pulpwood plantations cover a very large total area. In Indonesian Borneo this was 5.9 million ha, with the provinces of West and East Kalimantan having by far the largest extent of pulpwood plantations.

Forest fires

The high number of hotspots in production forest was indicative of the low commitment or difficulty in compliance with sustainable practises.
A disproportionally high number of hotspots occurred in protected areas, lowland forest, peat swamp forest and on the edges of oil palm plantations.

Mining

More than half of the mining concessions in Borneo are in lowland rainforest, more than 20% are in upland rainforest and 10% of concessions are in heath forest. More than one-third of the remaining heath forest is already inside mining concessions. A very large total area (5.3 million ha) of Kalimantan is inside either an 'exploration' or 'exploitation' concession.

Forest allocated to non-forest land use

In 2015, a large section (20% or 8.0 million ha) of the remaining forest of Borneo has yet to be allocated as protected or production forest. 28% of this 8.0 million ha comprising 3.7 million ha of lowland forest and 1.3 million ha of upland forest (mostly at the lower elevation) could be allocated into other land use under business-as-usual scenario. In the Indonesian part of Borneo, part of these two forest types is already allocated to other non-forest land uses. Likewise, 8.3%, amounting to more than half a

million ha of montane forest could be allocated for conversion, mainly in Sabah and Sarawak.

Of the remaining peat swamp forest, more than a quarter (1.2 million ha) is allocated for conversion. This includes coastal and interior peat swamp forest in all the provinces of Kalimantan. As for the remaining heath forest, 320,000 ha or 20%, is allocated for conversion, primarily in Central Kalimantan. In limestone forest areas which are mainly found in the Sangkulirang Peninsula in East Kalimantan, 15% has been allocated for conversion.

The majority (56% or 300,000 ha) of the remaining freshwater swamp forest scattered throughout Borneo is not allocated to protected or production forest. Almost half (45% or 580,000 ha) of mangroves in almost all the provinces and states of Borneo, with the exception of Sabah and Brunei, is allocated for conversion.

Production forest

Production forest in Borneo has different classifications. In Sarawak, it is classified as Permanent Forest Estates (which is further sub-divided into Forest Reserve, Protected Forest and Communal Forest); in Sabah, it is Commercial Forest Reserves; and in the Indonesian provinces it is Production Forest and Limited Production Forest. Large forest areas (49% of the remaining forest) are retained as production forest.

The majority (56%) of the remaining lowland rainforest is inside production forest, while more than half (53%) of the remaining upland rainforest is allocated as production forest. For montane forest, a large part (38%) is inside production forest; but this forms specific parts of forest concessions where logging is actually prohibited.

One-third (32%) of peat swamp forest is in production forest. Two-third (66%) of the remaining heath forest and more than half (57%) of the remaining limestone forest is inside production forest. Similar to the situation with peat swamp forest, these forests contain few commercial trees; and with very high soil erosion risk, the gain from harvesting timber does not commensurate with the effort.

Box 3: Conservation management interventions

- The total land area of 12.6 million ha under protection is 17% as committed by the Governments under the Aichi Target of the Convention of Biological Diversity (CBD).
- This figure, however, includes large areas which do not entirely conform to the IUCN definition of protected forest.
- Several ecosystems are underrepresented in the protected areas system, particularly lowland rainforest and heath forest.
- Notwithstanding increased awareness and commitment to preserve wildlife, large areas of natural forest have been allocated for conversion.
- Only a minority of logging concessions are certified.
- Forest fragmentation occurs inside protected areas.

Protected areas

Protected areas comprise a total of 12.6 million ha or 17% of the entire land area of Borneo. Overall, this percentage of protected area meets the Convention of Biological Diversity's Aichi Target of 17% of the total land mass of a country's commitment, thus reflecting the relatively good status of protected areas. However, this figure includes large areas that do not conform to the IUCN definition of a protected forest, for example *Hutan Lindung* or protection forest in Indonesia.

Furthermore, the total figure masks the fact that the representation for each ecosystem is neither adequate nor well represented.

For lowland rainforest, only 16% of the remaining extent is protected, making up only slightly more than 3% of Borneo's land area. Heath forest is under-represented, with less than 14% of the remaining extent protected. A small section of the original extent of freshwater swamp forest remains, but only 30% of this is protected. Barely 38% of the remaining mangroves is protected, which implies that large sections of Borneo's coastline are not fully protected. Less than one-third of the remaining limestone forest is protected, although it should be added that in most limestone areas the possibilities for cultivation are limited.

Certification of production forest

The number of certified logging concessions is still relatively low in most provinces and states.

Box 4: Basic projections under business-as-usual scenario

- The extent of several ecosystems will be severely reduced if current deforestation rates were to continue.
- Only the conservation goals for upland rainforest and montane forest ecosystems can be reached.
- The conservation goals for all the other ecosystems cannot be reached.
- Freshwater swamp forest and heath forest ecosystems in particular continue to decline rapidly.

Projection under business-as-usual scenario

If the 2005-2015 deforestation rates continue as a business-as-usual scenario (BAU), then more than 6 million ha of forest may be deforested between 2015 and 2020. The largest projected deforestation will occur in lowland rainforest and peat swamp forest, while deforestation rates in heath forest, limestone forest and freshwater swamp forest will also be very high.

With regards to conservation goals (see page 156), only the original goals for upland rainforest and montane ecosystems at 80% and 90% respectively can still be achieved - and only then on condition of an immediate reduction in deforestation rates.

Unfortunately it is too late for some ecosystems. The original conservation goals for lowland rainforest, limestone forest, freshwater swamp forest and mangrove ecosystems can only be reached through concerted efforts for protection, restoration and reforestation. Likewise, the original conservation goals for heath forest and peat swamp forest of 50% and 60% respectively can no longer be

realistically met, unless there is policy change to provide enabling factors to reverse the trends.

Recommendations

We conclude our status of Borneo report for 2016 by stating urgent measures need to be taken up by the respective authorities, private sector that has been given concessions to extract natural resources and undertake industrial scale plantations, as well as other stakeholders to arrest the declining state of forest coverage. While there are different ways and means to improve the health of our forest condition, we suggest these key recommendations:

- Ensure ecological connectivity of the landscapes of Borneo through island wide spatial planning for effective conservation of biodiversity and ecosystem services.
- Evaluate spatial planning per location and per landscape, to ensure as much natural forest and species habitats as possible, be retained.
- Identify and establish a new baseline for all idle non-forest land, and consider it as the only alternative for new plantations.
- Develop monitoring systems and prescriptive action to ensure that all production forest remain under natural forest cover.
- Expand protected areas to include entire landscapes and achieve better representation of all ecosystems and species habitats.

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Appendix

Appendix 1. State and province statistics

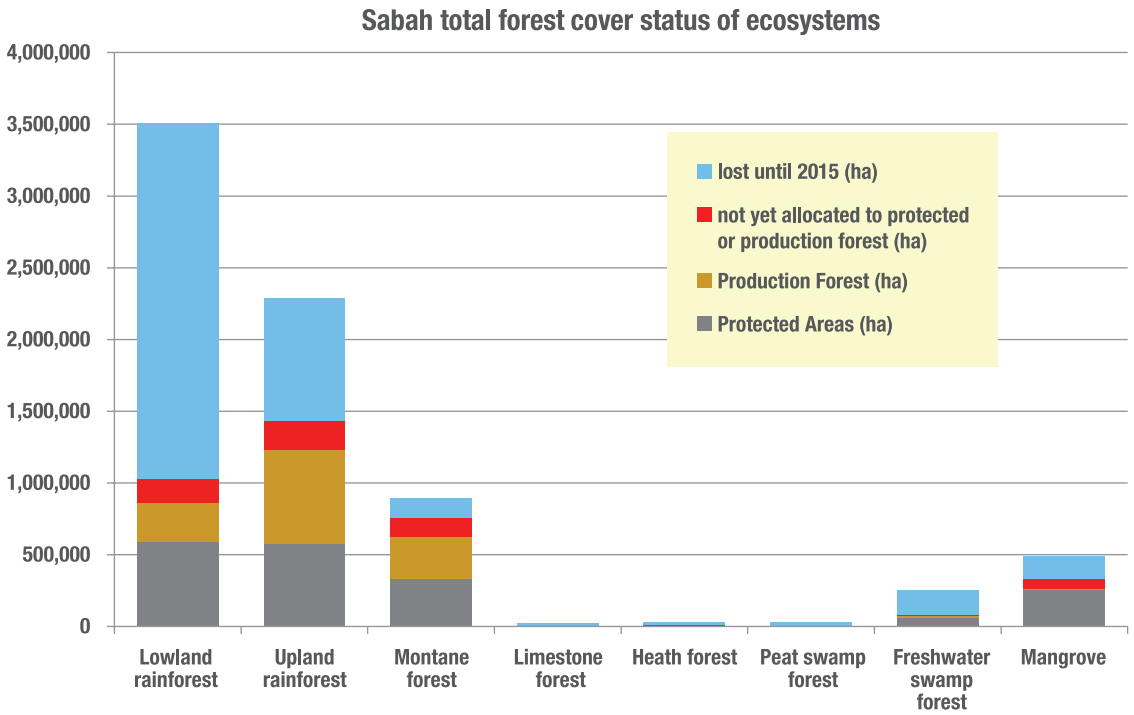


Table 26: Sabah total forest cover – status of ecosystems

Sabah	Protected Areas (ha)	Production Forest (ha)	Not allocated to protected or production forest (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	585,054	278,416	166,021	2,480,336	3,509,827
Upland rainforest	574,921	655,074	202,720	852,679	2,285,394
Montane forest	335,522	288,372	133,128	134,376	891,398
Limestone forest	5,237	0	290	13,822	19,349
Heath forest	4,732	0	2,260	21,197	28,189
Peat swamp forest	3,020	0	1,731	26,649	31,400
Freshwater swamp forest	61,916	9,448	11,430	171,426	254,220
Mangrove	256,784	9,396	63,843	160,211	490,233
Total	**1,827,185**	**1,240,706**	**581,423**	**3,860,696**	**7,510,010**

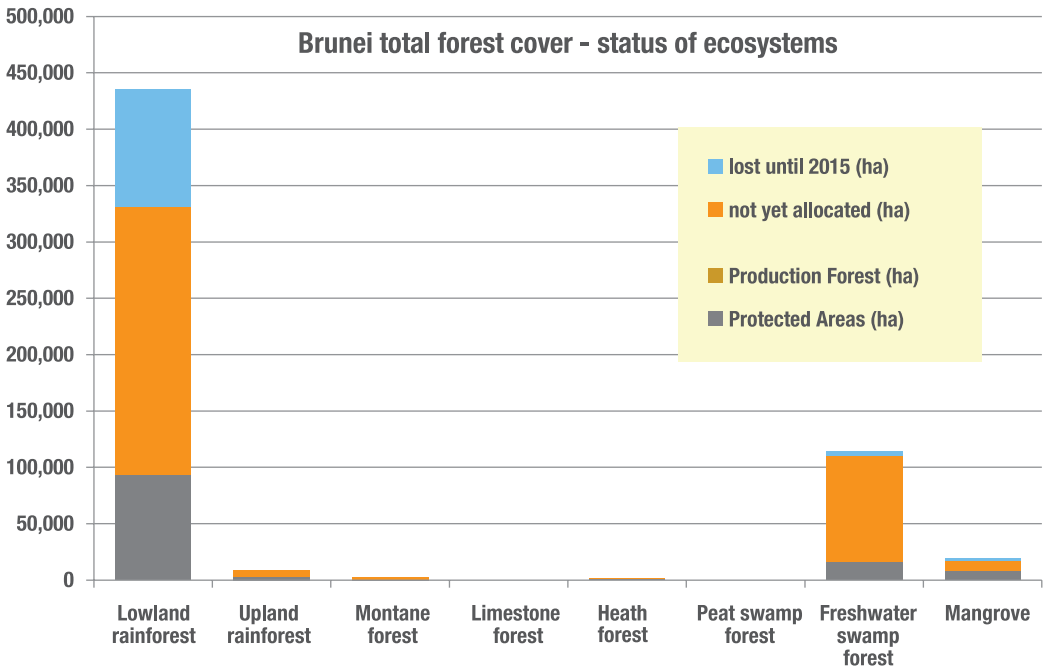


Table 27: Brunei total forest cover – status of ecosystems

Brunei	Protected Areas (ha)	Production Forest (ha)	Not yet allocated (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	93,486	12	238,065	103,894	435,457
Upland rainforest	2,905	0	5,772	0	8,677
Montane forest	190	0	1,850	0	2,040
Limestone forest	0	0	0	0	0
Heath forest	1,569	13	553	0	2,135
Peat swamp forest	0	0	0	0	
Freshwater swamp forest	16,349	0	94,016	4,381	114,746
Mangrove	7,990	501	8,560	2,091	19,142
Total	**122,489**	**526**	**348,816**	**110,366**	**582,197**

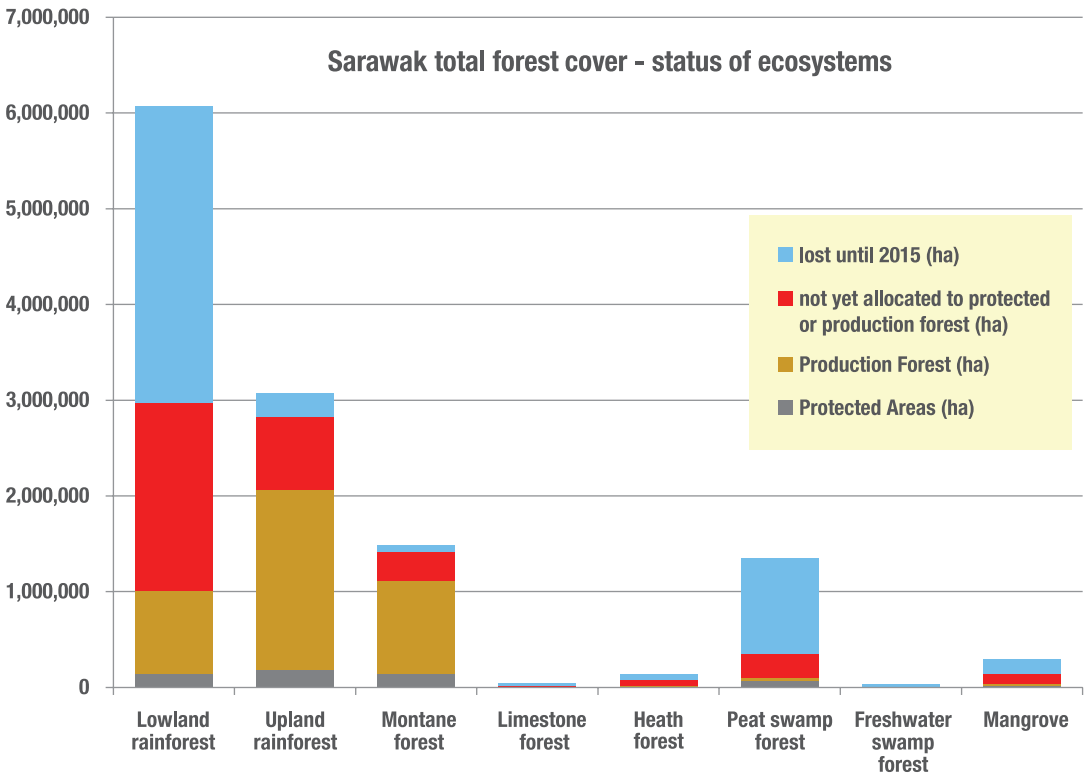


Table 28: Sarawak total forest cover - status of ecosystems

Sarawak	Protected Areas (ha)	Production Forest (ha)	Not allocated to protected or production forest (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	147,790	856,849	1,969,908	3,095,132	6,069,679
Upland rainforest	182,747	1,879,541	768,863	239,778	3,070,929
Montane forest	144,254	967,106	298,883	72,800	1,483,043
Limestone forest	8,998	19	5,540	23,700	38,256
Heath forest	11,816	4,282	58,509	59,465	134,071
Peat swamp forest	66,025	37,296	248,067	991,309	1,342,698
Freshwater swamp forest	1,371	485	3,055	28,293	33,204
Mangrove	21,781	13,581	102,811	157,124	295,297
Total	**584,782**	**3,759,159**	**3,455,635**	**4,667,601**	**12,467,177**

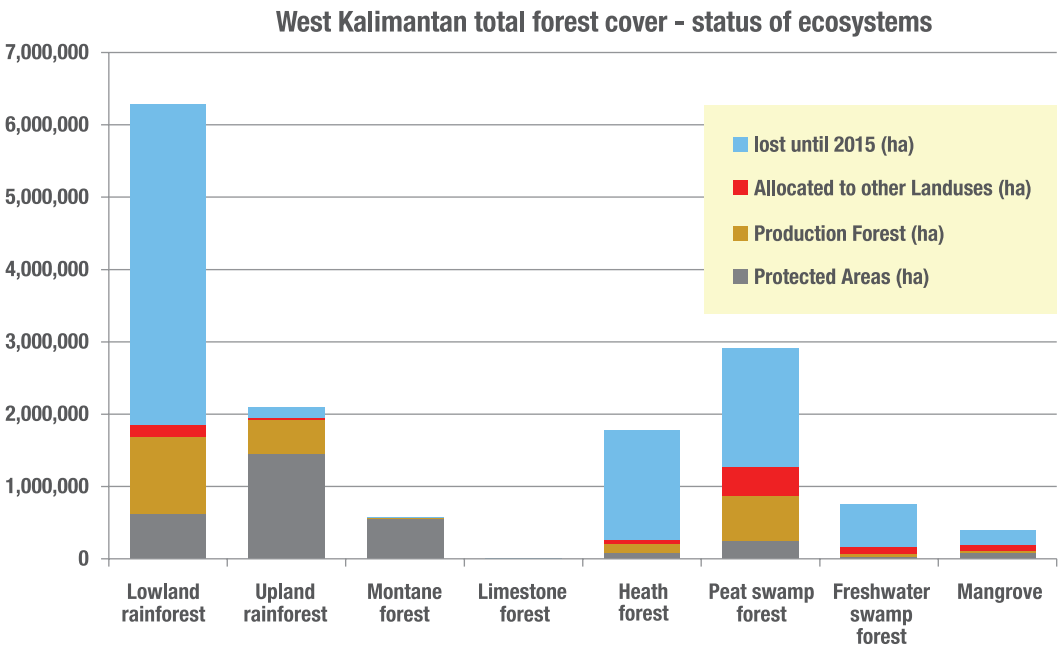


Table 29: West Kalimanatan total forest cover - status of ecosystems

West Kalimantan	Protected Areas (ha)	Production Forest (ha)	Allocated to other Landuses (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	626,253	1,055,507	176,212	4,432,915	6,290,887
Upland rainforest	1,452,459	478,857	15,509	148,209	2,095,034
Montane forest	552,530	19,491	1,181	4,041	577,244
Limestone forest	6,027	1,442	0	81	7,550
Heath forest	87,792	122,097	54,766	1,516,182	1,780,837
Peat swamp forest	252,389	625,761	395,529	1,637,215	2,910,893
Freshwater swamp forest	37,508	42,929	84,892	577,737	743,066
Mangrove	82,046	26,952	78,022	204,302	391,322
Total	**3,097,005**	**2,373,035**	**806,111**	**8,520,682**	**14,796,833**

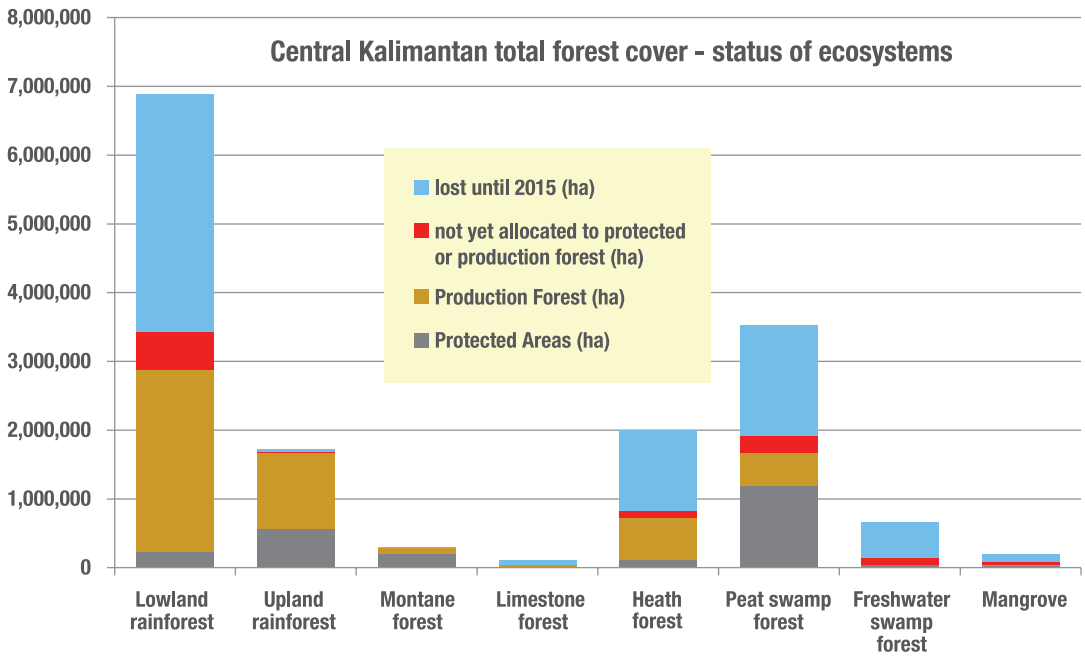


Table 30: Central Kalimantan total forest cover - status of ecosystems

Central Kalimantan	Protected Areas (ha)	Production Forest (ha)	Not allocated to protected or production forest (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	235,799	2,636,026	563,405	3,457,226	6,892,456
Upland rainforest	573,502	1,094,969	15,377	31,426	1,715,273
Montane forest	204,036	84,402	2,057	9,014	299,509
Limestone forest	5,483	35,089	2,482	70,918	113,973
Heath forest	110,644	619,271	92,431	1,174,328	1,996,673
Peat swamp forest	1,192,457	482,058	254,041	1,597,962	3,526,519
Freshwater swamp forest	44,195	5,836	91,341	516,843	658,215
Mangrove	33,483	16,658	36,558	110,067	196,766
Total	**2,399,599**	**4,974,309**	**1,057,692**	**6,967,787**	**15,399,386**

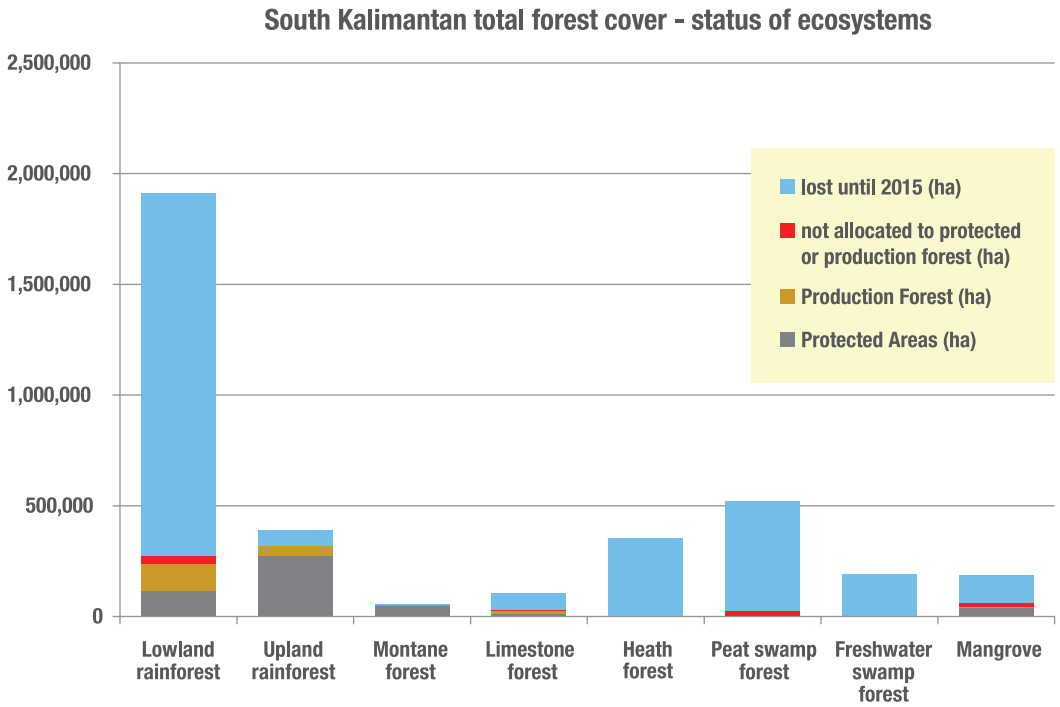


Table 31: South Kalimantan total forest cover - status of ecosystems

South Kalimantan	Protected Areas (ha)	Production Forest (ha)	Allocated to other Landuses (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	113,513	125,258	33,823	1,637,690	1,910,285
Upland rainforest	271,450	49,639	767	69,997	391,853
Montane forest	50,509	1,854	71	672	53,105
Limestone forest	12,770	14,081	9	77,613	104,473
Heath forest	12	904	1,258	351,856	354,030
Peat swamp forest	27	1,113	22,591	495,878	519,608
Freshwater swamp forest	25	630	968	187,945	189,567
Mangrove	40,431	4,244	14,630	126,550	185,855
Total	**488,737**	**197,723**	**74,117**	**2,948,200**	**3,708,777**

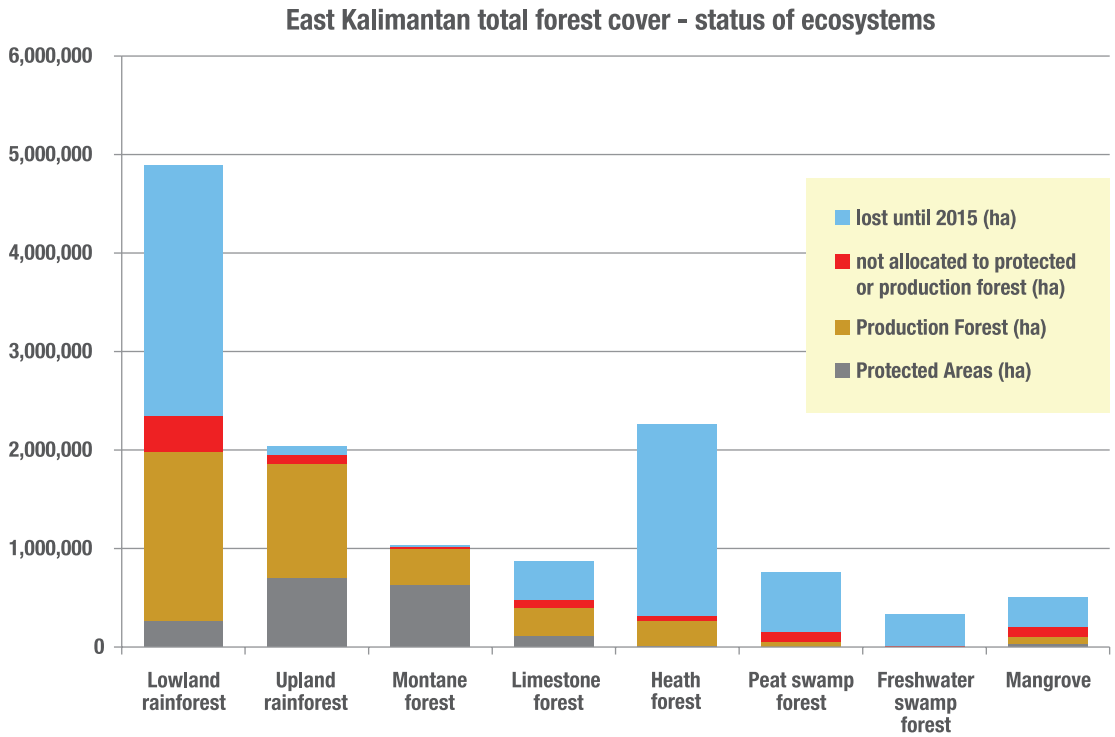


Table 32: East Kalimantan total forest cover - status of ecosystems

East Kalimantan	Protected Areas (ha)	Production Forest (ha)	Allocated to other Landuses (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	264,275	1,720,539	366,251	2,536,644	4,887,709
Upland rainforest	704,457	1,152,327	89,654	87,047	2,033,485
Montane forest	630,513	368,671	24,372	9,846	1,033,402
Limestone forest	109,192	288,195	85,638	391,595	874,620
Heath forest	11,404	253,518	48,992	1,948,714	2,262,628
Peat swamp forest	7,899	40,101	105,256	604,754	758,010
Freshwater swamp forest	619	1,733	6,591	323,723	332,665
Mangrove	36,327	62,327	110,512	297,746	506,912
Total	**1,764,685**	**3,887,411**	**837,265**	**6,200,069**	**12,689,430**

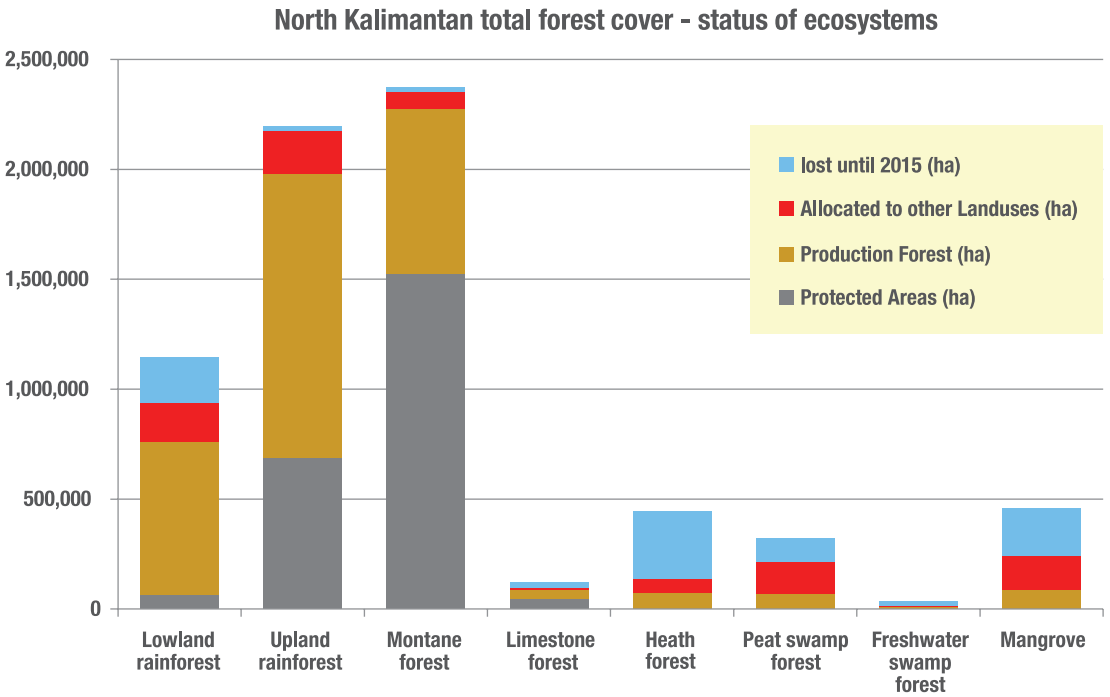


Table 33: North Kalimantan total forest cover - status of ecosystems

North Kalimantan	Protected Areas (ha)	Production Forest (ha)	Allocated to other Landuses (ha)	Lost until 2015 (ha)	Historical extent (ha)
Lowland rainforest	65,793	697,400	177,979	205,102	1,146,275
Upland rainforest	688,121	1,288,843	199,480	18,642	2,195,086
Montane forest	1,525,938	749,096	77,870	21,976	2,374,880
Limestone forest	44,643	45,281	4,619	25,311	119,854
Heath forest	33	71,856	65,892	307,004	444,785
Peat swamp forest	0	72,359	142,252	108,581	323,193
Freshwater swamp forest	0	10,823	5,917	18,583	35,322
Mangrove	4,096	82,478	153,786	215,592	455,951
Total	**2,328,624**	**3,018,136**	**827,794**	**920,791**	**7,095,346**

Appendix 2. Protected area effectiveness in the Kalimantan provinces.

Snapshot

- Management effectiveness can be represented by indices such as Rapid Assessment and Prioritization of Protected Area Management (RAPPAM).
- In terms of management effectiveness:
  - Danau Sentarum (W. Kalimantan), Tanjung Puting (C. Kalimantan) and Kayan Mentarang (N. Kalimantan) score very high.
  - Betung Kerihun (W. Kalimantan), Gunung Palung (W. Kalimantan), Bukit Baka Bukit Raya (C. & W. Kalimantan), Sebangau (C. Kalimantan) and Kutai (E. Kalimantan) score high.
- Eight national parks score high to very high in terms of biological importance, but logging threats and pressure were very high in four national parks.
- Despite their 'protected' status – mining, encroachment, logging, hunting and land-use conflict threats are high in a number of Borneo's national parks.

Management effectiveness can be represented by indices such as Rapid Assessment and Prioritization of Protected Area Management (RAPPAM). These assessments have been conducted in all the eight national parks of Indonesian Borneo: Betung Kerihun, Danau Sentarum, Bukit Baka Bukit Raya, Tanjung Puting, Gunung Palung, Sebangau, Kutai and Kayan Mentarang.

In terms of management effectiveness, Danau Sentarum, Tanjung Puting and Kayan Mentarang score very high. Betung Kerihun, Gunung Palung, Bukit Baka Bukit Raya, Sebangau and Kutai score high.

Importance:

Eight national parks score high to very high terms of biological importance. The score increased for Gunung Palung, Tanjung Puting and Kayan Mentarang, and decreased for Betung Kerihun. The biological importance score for the other four national parks is stable.

Socio-economic importance was very high in Danau Sentarum and high in the seven other national parks. Kutai and Betung Kerihun showed a strong increase from low in 2004 to high in 2010.

Threats and pressure:

Encroachment threats and pressure were identified as very high in Kutai and Gunung Palung. In Kayan Mentarang it was medium, while in the other national parks was low and did not increase between 2004 and 2010.

Logging threats and pressure were very high in four national parks: in Sebangau they remained very high, in Gunung Palung, Tanjung Puting and Kutai they decreased. Logging threats and pressure were medium high in Bukit Baka Bukit Raya but increased; while in Betung Kerihun, Danau Sentarum and Kayan Mentarang they were low and even decreased.

Forest fire was a high threat in Danau Sentarum in 2004, but apparently became low in 2010. In Kutai and Sebangau, it was high and remained high, while in the other national parks it was low.

Mining remained a medium high threat in Tanjung Puting and Bukit Baka Bukit Raya. It was a very high threat in Kutai but decreased. In the other national parks it was low.

Hunting threats and pressure remained high in Danau Sentarum; it was high in Kayan Mentarang but decreased. In Kutai and Sebangau, it was medium high and in the other national parks it was low.

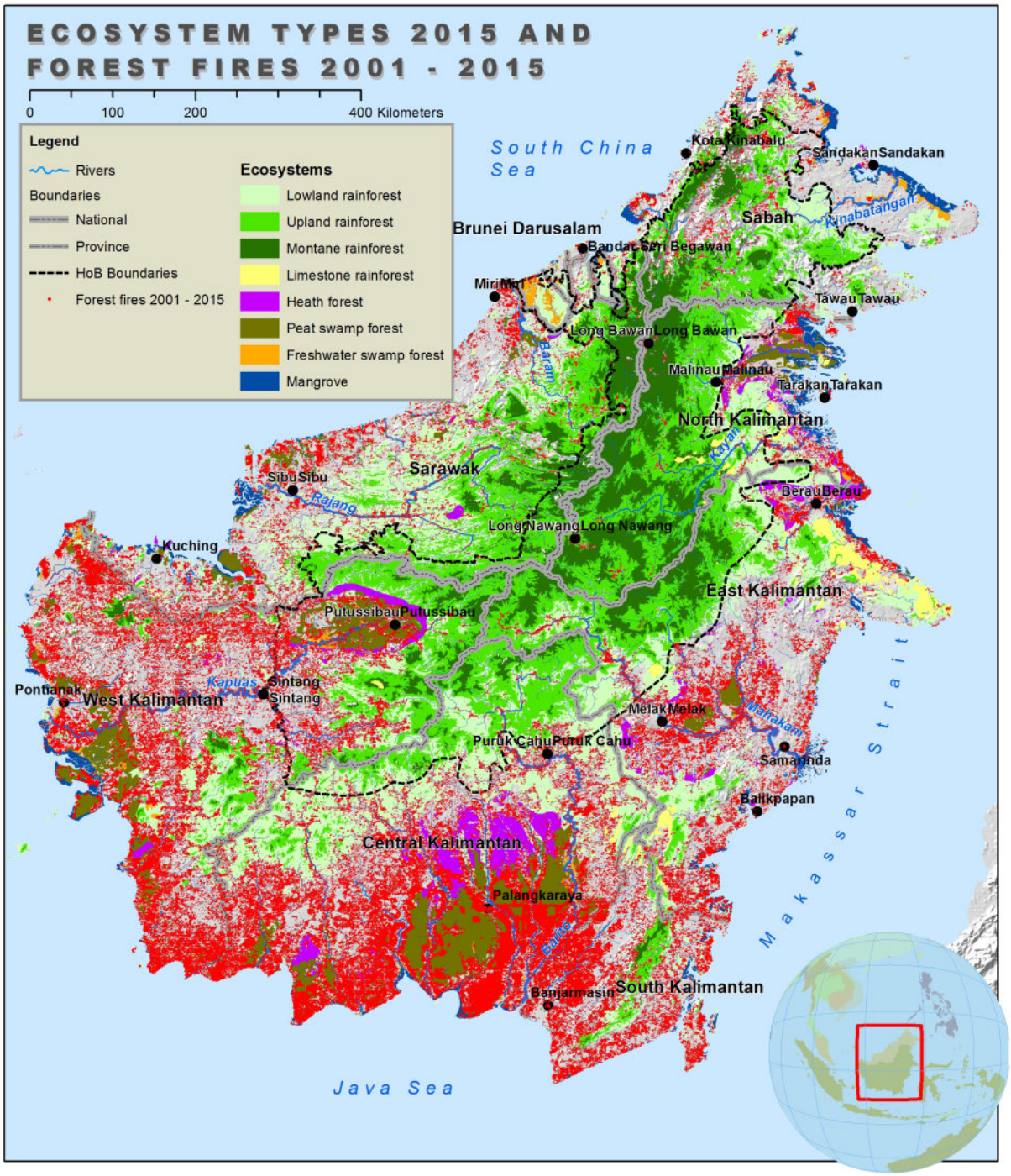
Over-harvest of non-timber forest products was an issue (but with increasing level of threat) in Kayan Mentarang and Tanjung Puting.

Land use conflicts threats were very high in Sebangau and medium high in Kutai, Danau Sentarum and Kayan Mentarang and have increased from 2004 to 2010. In the other national parks it was low or zero.

Pollution is a very high threat in Danau Sentarum and Kutai.

Kutai is the only national park of Indonesian Borneo where invasive species are mentioned as a threat.

Appendix 3: Forest fires in the ecosystem types 2001 - 2015



Note: This map combines the annual hotspot data from 2001 to 2015. Separate maps for each year are available on request.