



# The Environmental Status of the Heart of Borneo







WWF

REPORT

HoB

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# The Environmental Status of the Heart of Borneo



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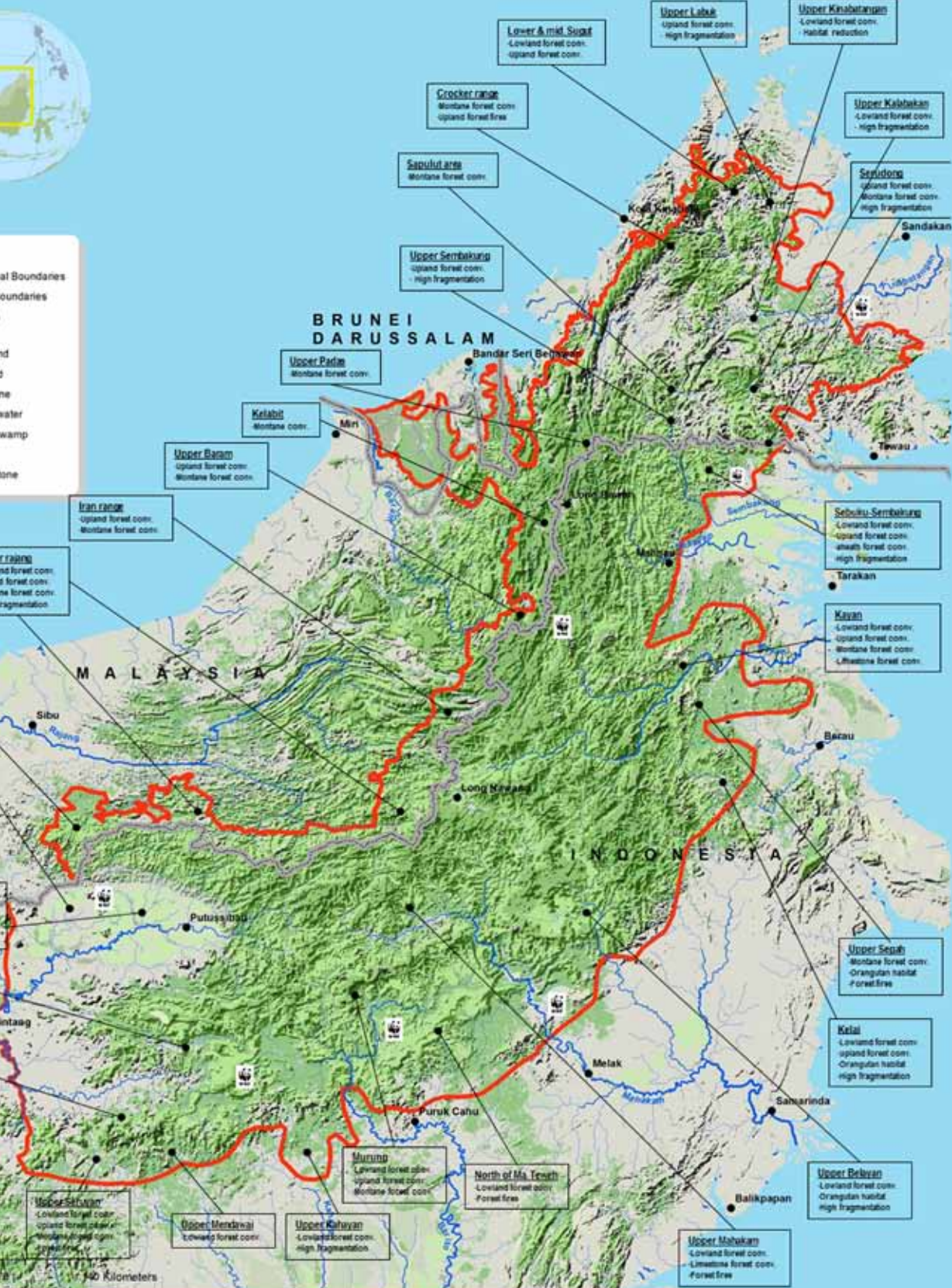
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WWF is one of the world's largest and most experienced independent conservation organisations, with more than five million supporters and a global network active in more than 100 countries.

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.







# Introduction

The island of Borneo, encompassing parts of Indonesia, Malaysia, and Brunei, is recognized as a global conservation priority, yet over the last few decades the lowland portions of the island of Borneo in Indonesia has suffered from deforestation, forest fire, and conversion to estate crops. The central upland portions of the island are more remote and generally less suitable for industrial exploitation – these areas are relatively intact.

The urgent need to address the lowland conservation issues notwithstanding; initiatives to take advantage of the opportunity represented in the intactness of central areas have gained traction in the last ten years. 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 forests and other sustainable land uses in the upland HoB. The major partners in this process are the local and national government, in particular the agencies involved in land use planning, but the participation from the industrial sector (timber, oil palm, mining) is considered crucial.

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 rainforests of the HoB cover almost 30% of the third largest island in the world and form one of the largest contiguous forests remaining in all of Southeast Asia. Most of the original forest ecosystems and wildlife of Borneo is still present in HoB and the preservation of this region is being given the highest conservation priority by WWF.

HoB is also known for the cultural and linguistic diversity of the several ethnic groups of indigenous peoples collectively known as Dayak. 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 Dayak communities have contributed to sustainable management of natural resources of the area 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. The objectives then were: (1) Develop a set of practical indicators that might be representative of the ecological status of the HoB and could be monitored at appropriate time intervals; (2) develop a larger set of indicators that are representative of the overall conservation status of the HoB and (3) analyze data for those indicators to assess the overall ecological and conservation health of the HoB.

The environmental status of the Heart of Borneo (HoB) was measured for the first time in 2008 with historical data and spatial as well as field data from 2007. A comprehensive set of indicators was developed that proved to be informative while at the same time practical enough to provide a useful overview of the status. 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 are used for monitoring, followed by evaluation of effectiveness and then formulation of adaptive management.

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# Executive summary

## Size of HoB:

The total area of the HoB is 23.4 million hectare.

The total forest cover of the HoB is 17.4 million hectare, almost three-quarters of the HoB.

## Forest cover of the HoB per state/province:

- Brunei- 0.63 million ha
- Sabah- 1.81 million ha
- Sarawak- 1.83 million ha
- East Kalimantan- 7.99 million ha
- West Kalimantan- 2.92 million ha
- Central Kalimantan- 2.43 million ha

## Key ecosystems:

- Lowland rainforest- 3.54 million ha
- Upland rainforest- 7.78 million ha
- Montane forest- 5.30 million ha
- Peat swamp forest- 0.41 million ha
- Heath forest- 0.18 million ha
- Smaller areas of freshwater swamps, limestone forest, mangroves

## Key species status:

- The elephant population is estimated to number about 2200 individuals, distributed over 2.23 million ha, with fair connectivity.
- An estimated 80% of the historical locations of banteng distribution within the HoB are still occupied.
- Clouded leopards still have almost 17 million ha of habitats available that are suitable for viable populations.
- The orangutans have a distribution of 3.3 million ha within the HoB.
- Probably less than 25 individuals of the Borneo rhinoceros are remaining.

- Endemic groups of key plant families are doing well with most of the historical locations still present.

## Key land uses:

- Almost 3 million ha of the Heart of Borneo is inside protected areas (national parks, nature reserves), which is 12.6% of the HoB, and 17% of its forests.
- The extent of established oil palm plantations in the Indonesian part of the HoB was 1.03 million ha in 2012, and another 0.33 million ha of forest inside concessions are about to be converted to oil palm plantations. The land use planning has allocated 0.25 million ha inside the HoB for future conversions.
- 0.49 million ha timber plantations were already established in the Indonesian part of the HoB in 2012, while there were another 0.077 million of natural forests inside concessions to be converted.
- 4.4 million ha of the Indonesian part of the HoB is inside active logging concessions. Another 1.8 million ha of forests are allocated to future logging concessions.
- A total area of 2.1 million ha of the HoB is inside mining concessions, but this includes exploration concessions. The actual area that will be exploited is only a portion of this.

## Comparison to Borneo as a whole:

- 8.3% of the the total area of Borneo is inside protected areas, compared to 12.6% of the HoB.
- Oil palm and timber plantations comprise 32% of the Indonesian part of Borneo, versus 9% of the Indonesian part of the HoB.



- 22% of the Indonesian part of Borneo is inside logging concessions, but the percentage for the HoB is 31%.
- The extent of mining concessions in Borneo is 4.5 million ha, and almost half of this is within the HoB. This makes a ratio of 6% for Borneo versus 18% for the HoB.

#### **Overall rate of deforestation:**

The standardized annual rate of deforestation of the HoB between 2007-2012 was 2.19%. The standardized annual rate of deforestation for the whole of Borneo (2007-2012) was 4.68%.

#### **Key ecosystems/species suffering deforestation:**

There are still considerable large areas remaining of most of the ecosystems of the HoB. Forest conversion however still continued to occur, though deforestation rates for the HoB were considerably lower than for the whole of Borneo.

- Lowland rainforest was one of the ecosystems affected most by forest conversion between 2007-2012. Deforestation rates were particularly high in Sabah and Central Kalimantan.
- Most of the heath forests of the HoB had been converted by 2012. This occurred particularly in West Kalimantan and in East Kalimantan.
- Peat swamp forest within the HoB is found mainly in West Kalimantan, and much of this had been converted by 2012.
- Upland rainforest is the largest ecosystem of the HoB and still more than 80% of the historical extent remains in 2013. Deforestation rates were however rather high between 2007-2012, particularly in Sarawak and Sabah.

- Although the total population of Bornean elephants is still good, the distribution of this population decreased between 2007-2012.
- The orangutan distribution decreased by 14% between 2007-2012. This occurred mainly in West Kalimantan and in Sabah.

#### **Projections for the future:**

The projections with the current deforestation rates for 2020 indicate that way conversion rates for particularly lowland rainforest and heath forest but also many of the other ecosystems are too high to be able to reach the conservation goals. It is however still possible to reach the goals for most of the ecosystems if serious conservation interventions are applied.

#### **Main drivers of deforestation:**

- Industrial conversion of forests into oil palm and timber plantations is the major driver of deforestation.
- Uncontrolled conversion by local communities needing land for subsistence agriculture occurred in areas without concession holders and a large portion of these are actually protection forests.
- Many of the forests of the HoB, particularly lowland, heath, peat swamp and upland forest, have suffered from forest fires. This is a severe issue in particularly in West Kalimantan, Central Kalimantan and in Sabah. Burnt tracts of forest are often not given the opportunity to recover.
- Encroachment by smallholders is causing fragmentation of many of the forest areas throughout the HoB. Fragmentation is frequently followed by conversion.

# Overall Status Of The Ecosystems

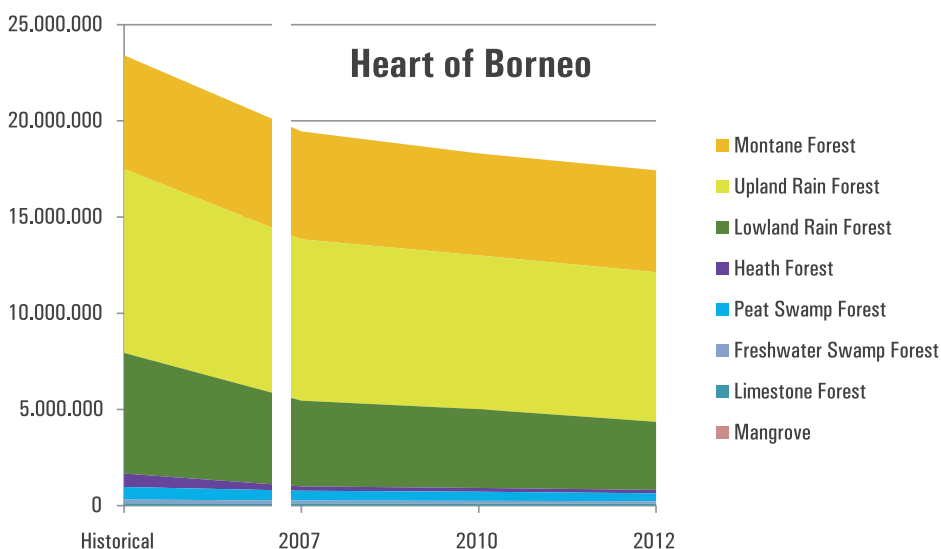
There are still considerable large areas remaining of most of the ecosystems of the HoB. However, conversion continues to occur at rather high rates.

The total area of lowland rainforest continues to decline at high rates. Heath forest is gradually disappearing. The conversion of peat swamp forests in the HoB has slowed down. Even though still very

large areas of upland rainforests remain, the decrease of the total extent of upland forest is high. The extent of montane forests decreased more than expected, but appears to have stabilized after 2010.

Forest fragmentation levels are high particularly for lowland ecosystems. Fragmentation often precedes conversion.

[graph all ecosystems HoB historical-07-10-12]



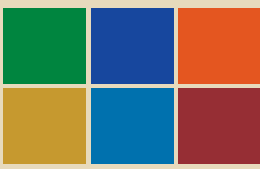
## Lowland rainforest ecosystems



Historically about a quarter of the HoB area was covered by lowland rainforests. In 2007 still 71% of the original area remained (4.46 million ha). This is a high percentage if considered for the context of the entire island of Borneo, particularly since lowland rainforest in Borneo is the most often converted forest type. (The situation for the whole of Borneo will be compared in a later chapter)

### Extent

Deforestation between 2007-2010 was quite high and even higher between 2010-2012. In 2012 only 56% remained (3.54 million ha) this implies that from 2007 to 2012 almost one million ha was deforested. Most of this forest was converted to plantations.



The 2007 environmental status of the first report indicates a total area of 63% of the historical lowland forest extent of within the HoB left. This area however applied the old HoB boundaries, which later were extended to include more foot slopes, and thus more lowlands, of the central mountains. The total area of lowland forest ecosystems in 2007 within the new boundaries of the HoB became 71% of the historical extent.

The desired rating for the 2020 goals of the extent of lowland forest ecosystems is 50-60%, with the rating of "Good". The current (2012) extent of 56% appears to fit well in the conservation scenario. The annual deforestation rate is however still very high and will, if it continues this way, cause the extent to decrease below 50% within the next few years.

It is projected that in this way the remaining extent of lowland rainforest in 2020 will be only 33% of the historic extent.

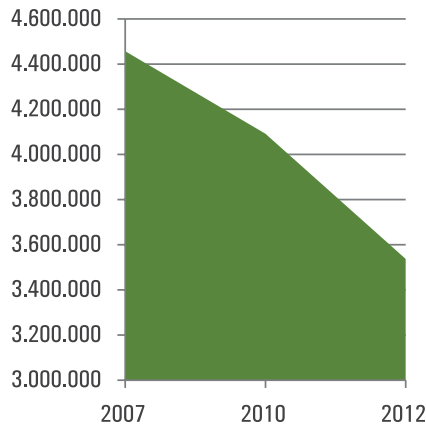
The extent of lowland forest in the HoB is not at all representative for the whole of Borneo and should not be extrapolated or misinterpreted. Less than 28% of the historical lowland forest extent is left in the whole of Borneo. Most areas were converted to plantation agriculture.

## Condition

Even though still 56% of the historical lowland rainforest ecosystems remain, many of the areas are not in good conditions. More than 40% of these forests are fragmented. This means that many of these forests are dissected by open areas or even worse remain only as isolated tracts. Large stretches of uninterrupted lowland rainforests are becoming rare in Borneo.

[graph extent 07-10-12]

### Lowland Rain Forest in HoB



## Connectivity

Connectivity of remaining lowland forests depends on the topography of the landscape. Lowland forests in wide flat or undulating areas are nowadays frequently dissected by disturbed or cultivated land and are in this way relatively separated. Many of the remaining lowland forests are however situated in valleys surrounded by slopes. In the more remote areas, these slopes are part of mountainous landscape and are often still covered by upland and montane forests. The separate lowland forests are then still connected in this way. This does however not guarantee the preservation of genetic resources as many typical lowland plant species, particularly those with large seeds, cannot spread through the different ecological conditions of the upland forests. A well-known example of this is the ironwood tree (*Eusideroxylon zwageri*).

The tracts of lowland forest in north of Sabah are rather isolated while most of the tracts in the south are connected by upland forest.

In Brunei nearly all lowland forests are connected through upland forest.

All lowland forest within the HoB part of Sarawak are connected by upland and montane forest. The situation in the rest of Sarawak is different.

Most of the few remaining lowland forests of West Kalimantan are connected by upland forests, but these are very fragmented. There are also several isolated tracts.

Along the southern edges of Central Kalimantan area several isolated areas of lowland forest, while other edges are still connected but fragmented. Most of the central area is still connected and in better conditions.

Nearly all of the lowland tracts of East Kalimantan are still connected to upland forests of the interior. Fragmentation is rather high.



[Table & graph - historic, 2007 and current extent - forest loss 2007-2010-2012 + table with colored ratings]  
Table - forest fragmentation]

Ecosystem	KEA	indicator (baseline in ha)	2007		2012		Rating	bold-current (2012)		italics-desired goal	
			raw data (ha)	result (%)	raw data (ha)	result (%)		Poor	fair	Good	Very Good
Lowland Rain Forest	Extent	% of historical extent (baseline= 6,269,000)	4,457,300	71.1	3,537,100	56.4	good	<35%	35-50%	51-60%	>60%
	Condition	% unfragmented	2,658,500	60.3	2,045,500	58.4	fair	<40%	40-60%	61-80%	>80%
	Connectivity	% forest blocks connected		80		75	good	<50%	50-70%	71-90%	>90%
Upland Rain Forest	Extent	% of historical extent (baseline= 9,560,000)	8,384,800	87.7	7,775,400	81.3	very good	<40%	40-60%	61-80%	>80%
	Condition	% unfragmented	6,080,600	73.0	5,685,200	73.6	good	<40%	40-60%	61-80%	>80%
Montane Forest	Extent	% of historical extent (baseline= 5,910,000)	5,610,900	94.9	5,300,000	89.7	very good	<40%	40-60%	61-80%	>80%
Limestone Forest	Extent	% of historical extent (baseline= 115,000)	106,800	92.6	96,500	83.6	very good	<40%	40-60%	61-80%	>80%
Heath Forest	Extent	% of historical extent (baseline= 698,000)	224,600	32.2	177,800	25.5	poor	<40%	40-60%	61-80%	>80%
Freshwater Swamp	Extent	% of historical extent (baseline= 193,000)	150,000	77.4	127,900	66.0	good	<40%	40-60%	61-80%	>80%
Peat Swamp Forest	Extent	% of historical extent (baseline= 653,000)	511,200	78.2	411,100	62.9	good	<25%	25-50%	51-75%	>75%
	Canopy cover	% forest with closed canopy	307,600	60.1	249,000	60.6	good	<40%	40-60%	61-80%	>80%
Mangrove	Extent	% of historical extent (baseline= 8,000)	7,700	92.0	7,200	86.6	very good	<40%	40-60%	61-80%	>80%

# Upland rainforest ecosystems



Upland forest has been the largest ecosystem of the HoB area since historical times, occupying some 40% of the total land area.

## Extent

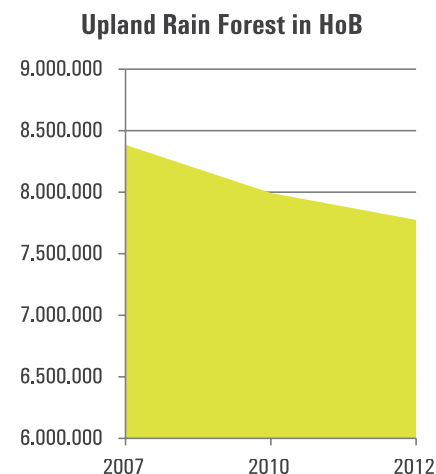
Still 81% of the historical extent is remaining (7.78 million ha). However a rather strong decrease occurred since 2007, when there was still 87% remaining. More than 600,000 ha of upland forest was deforested between 2007-2012.

The first environmental status report of the first report indicates a total area of 82% of remaining historical upland forest extent within the HoB. Again, this area refers to the old HoB boundaries, which were afterwards extended. The total area of upland forest ecosystems in 2007 within the new boundaries of the HoB became 87% of the historical extent.

The desired goal for HoB for 2020 was defined as 80% or more of the historical extent remaining (appendix 4). If the deforestation trend continues [calculate] (see graph) then the percentage will soon decrease below the desired rating.

The projected extent in this scenario will be that 71% of the historical extent will remain

[graph extent 07-10-12]



## Condition

More than one quarter (26%) of all upland forests is fragmented. This is a very large area given that most of the upland forests are still remaining. Most of the fragmentation occurs at hills and lower mountains that are not directly connected to the central montane massif. However, fragmentation is also high along the lower slopes of the central mountains. Part of this is caused by shifting cultivation.





# Montane forest ecosystems



All different montane ecosystems were grouped together for the sake of measuring the changes in the HoB in a practical way. One quarter of the HoB consists of montane ecosystems, usually sub-divided into lower montane, upper montane and sub-alpine zones.

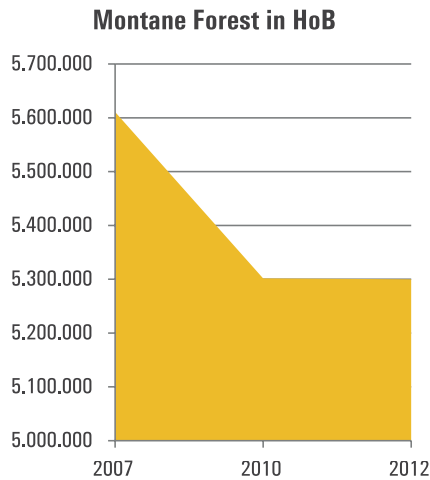
In 2007 this ecosystem was almost intact with 95% of the historical extent remaining. In

2012 the percentage had declined to 90% (5.3 million ha). Some 300,000 ha was lost, though mainly between 2007 and 2010. This happened mostly at the outer mountain ranges, but also in core areas particularly in Sarawak.

The desired goal of preserving at least 80% is probably feasible as deforestation rates strongly declined after 2010.

It is projected that 81% of the historical extent will remain in 2020, if the deforestation rate remains the same.

[graph extent 07-10-12]



About 20% of all montane forests are fragmented, which is much higher than expected. This high fraction is probably partly caused by very high impacts of shadows to the spectral reflections of the satellite images but also caused by shifting cultivation.

All in all, montane ecosystems are still the best preserved ecosystems in Borneo.

## Peat swamp ecosystems



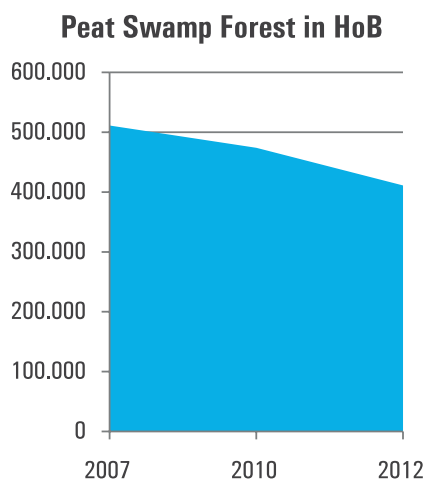
This is a very important ecosystem for the island of Borneo, with originally almost 10 million ha. It has undergone a very high rate of deforestation, through conversion and forest fires, with only 35% of its historically extent remaining in 2012.

In the HoB this ecosystem is very much under-represented and is found mainly around Danau Sentarum. Here we see a drastic reduction in the last five years. In 2007 there was still 78% remaining of the historical extent but in 2012 this was reduced to 63%, a loss of 100,000 ha of peat swamp forest. This might seem to be a relatively small area compared to the whole of Borneo, but it should be kept in mind that the peat swamps of the interior of Borneo are ecologically quite different from the coastal peat swamp and provide unique habitats to many endangered species.

The desired rating for the HoB 2020 goals of the extent of peat swamp ecosystems is 51-75%. This goal can still be reached; unless the current rate of destruction continues at the current level. If no decent conservation measures are taken then the remaining extent will get below 50% of the historical extent before 2018.

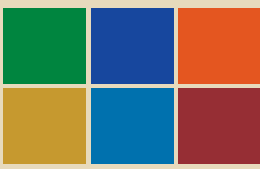
The projected extent for 2020 will then be 38% remaining.

[graph extent 07-10-12]



Almost 40% of all remaining peat swamp forests are 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. A large portion of this fragmentation is however not natural and is caused by fires and activities such as illegal logging and small scale agriculture.



## Heath forest ecosystems

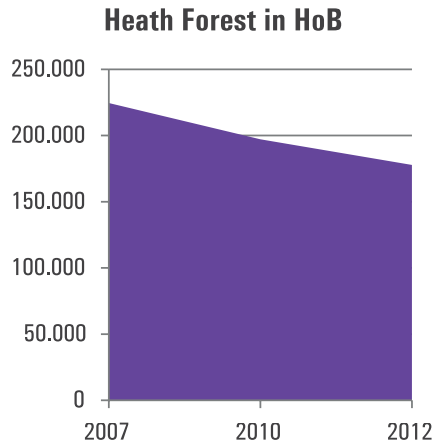


Historically there were rather large stretches of heath forest in the HoB, particularly at the Indonesian sides. Many of the large areas had already disappeared in 2007, with only 32% left of the original extent. Between 2007 and 2012 this was further reduced to 25% of the historical extent. In 2012 there is only 178,000 ha left, a loss of 46,000 ha in five years.

Scattered throughout the HoB 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. The total area of these tracts is however small and the most unique ecological conditions usually occur in the larger stretches of heath forest.

The desired goal for 2020 of 61-80% is not realistic, also because of the fact that it is extremely complicated to restore heath forest ecosystems. The deforestation trend indicates a continuing extent reduction. The goal for the next years should to stop this trend and ensure that no further heath forests disappear. A goal of 20% of the original extent might still be possible. However, if the current deforestation rate continues than it is projected that in 2020 only 15% of the historical extent remains.

[graph extent 07-10-12]



More than 45% of the remaining heath forest ecosystems is fragmented. Logging of a relatively low volume of timber has already a large impact on this fragile ecosystem, leaving many open spots. The impacts of forest fires are even worse and heath forest cannot completely recover

## Limestone forests



There are not many large areas of limestone ecosystems within the HoB and most are rather isolated ridges and hills. Many of the smaller hills could not be mapped due to the low resolution of the satellite images used. In 2007 still 92% of the historical extent remained. This was reduced to 84% in 2012. The largest reduction occurred between 2007 and 2010. This was partly caused by forest fires and over-harvest. Damage by fires is often irreversible in limestone ecosystems.

The desired goal 61-80% of the historic limestone extent in the HoB is realistic. Many of the limestone ridges and hills in the HoB are in remote locations and

therefore difficult to exploit. The largest area of limestone forests within the HoB is in the protected GunungMulu national park. If deforestation of limestone forests continues at the current rate, then the projection is that in 2020, 69% of the historical extent will remain.

The largest extent of limestone ecosystems in Borneo is at the Sangkuliran peninsula in East Kalimantan. This area is highly threatened.

A large portion of 34% of the remaining limestone ecosystems is fragmented. This fragile ecosystem is very sensitive to disturbances, particularly fires.

## Freshwater swamp ecosystems



The total area of freshwater swamps in Borneo amounted to more than 2 million ha, but three-quarters of this was already converted before 2007.

in the HoB the total extent of freshwater swamps is small, found mainly around DanauSentarum and the lower Belait watershed in Brunei. However there are also many small but ecologically important stretches along the major rivers. These could not be mapped with the applied scale that is limited by the satellite image resolution.

In 2007, still 77% (150,000 ha) of the historical extent of freshwater swamps within the HoB was still intact. In 2012

this extent had declined to 66% (128,000 ha). Nearly all deforestation occurred in the vicinity of DanauSentarum. The rate is alarming and if continues like this, than only 48% of the historical extent will remain in 2020.

One third (33%) of the remaining freshwater swamp forests was measured to be fragmented. Freshwater swamp forests generally have an average natural level of fragmentation of 10-20% because small lakes and swamps with low non-forest vegetation are common. A large area of the fragmentation is however caused by disturbances.



## Mangroves



Borneo has very important areas of mangroves, naturally all located in terrains with tidal influence. The HoB delineation only reaches the coast in Brunei and therefore the only mangroves within the HoB occur in Brunei. Most of these were still present in 2012. However, deforestation does occur and each year more than

1% of the historical extent is lost. This could in the long term lead to a significantly lower extent, such as the projected 78% remaining in 2020.

The high level of fragmentation (43%) is however a potential threat that should be addressed.

## River ecosystems



Most of the major rivers of Borneo arise in the HoB and the mountains to the interior are extremely important catchment areas. The forest cover of the entire drainage area of each of these rivers provide a useful impression of the environmental status of these watersheds. Forest covers decreased in all of the watersheds of Borneo Between 2007-2012.

Borneo has three very large watersheds of more than 6 million hectares (Kapas, Mahakam and Barito) and three large watersheds of more than 2 million ha (Rajang, Kayan and Baram).

The lower and middle sections of the Kapas watershed had already undergone much deforestation since the 1960's. In 2007 it nevertheless still had a 47% overall forest cover, mainly in the upper sections. In 2012 the forest cover decreased to 42% of the total area of the Kapas watershed. The remaining forest is not all in good condition and some 35% is fragmented.

The lower and middle Mahakam watershed also has a long history of forest conversion. In 2007 the total remaining forest cover was 53%. Between 2007-

2012 the area decreased to 49% of the drainage area. More than 25% of the remaining forest is fragmented.

The Barito watershed is doing somewhat better in terms of forest cover. Major forest conversion of this watershed was historically restricted to its lower section. In recent years however developments occurred in the other sections. While the total forest cover was still 64% in 2007, it decreased to 54% of the watershed area in 2012. The fragmentation level of 37% of the remaining forests is reason for concern as part of this fragmented forest might disappear in the near future.

The forest cover of the Kayan watershed is much more intact. In 2007 still 97% of the forest cover remained. In 2012 the forest cover was 91% of the area of the Kayan watershed.

The forest cover of the Rajang watershed appears to be still high with 62% in 2012 -down from 80% in 2007, but almost half of the remaining forests are fragmented.

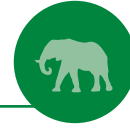
[Table & graph - historic, 2007 and current extent - forest loss 2007-2010-2012 + table with colored ratings]  
Table - forest fragmentation]

River eco-systems	forest cover 6 large watershed	2007	2012	Rating	bold-current (2012)		<i>italics</i> -desired goal		2007	2012
		result (%)	result (%)		Poor	fair	Good	Very Good		
Kapuas	% forest cover (base-line= 8,343,900)	47.3	41.6	fair	<30%	30-50%	51-70%	>70%	montane 5.7%; upland 18.3%; lowland 12.8%; peat swamp 8.0%; heath forest 3.0%	montane 5.6%; upland 17.5%; lowland 9.7%; peat swamp 6.2%; heath forest 2.2%
Mahakam	% forest cover (base-line= 7,665,700)	53.3	48.6	fair	<30%	30-50%	51-70%	>70%	montane 14.8%; upland 20.7%; lowland 14.6%; peat swamp 2.1%; heath forest 1.5%	montane 14.5%; upland 20.1%; lowland 11.5%; peat swamp 1.4%; heath forest 0.8%
Barito	% forest cover (base-line= 6,050,700)	63.6	53.7	good	<30%	30-50%	51-70%	>70%	montane 4.1%; upland 18.3%; lowland 24.4%; peat swamp 7.7%; heath forest 6.7%	montane 3.9%; upland 17.8%; lowland 19.4%; peat swamp 6.3%; heath forest 5.6%
Rajang	% forest cover (base-line= 4,514,300)	80.0	62.2	good	<30%	30-50%	51-70%	>70%	montane 13.8%; upland 37.4%; lowland 25.4%	montane 11.9%; upland 32.3%; lowland 17.8%
Kayan	% forest cover (base-line= 2,991,600)	96.8	90.9	very good	<30%	30-50%	51-70%	>70%	montane 50.3%; upland 33.0%; lowland 10.3%	montane 48.7%; upland 32.5%; lowland 8.0%
Baram	% forest cover (base-line= 2,252,600)	85.6	68.5	good	<30%	30-50%	51-70%	>70%	montane 21.7%; upland 31.2%; lowland 25.5%; peat swamp 4.3%	montane 20.7%; upland 29.4%; lowland 15.2%; peat swamp 2.1%





## Elephants and bantengs



Bornean elephants are found only in the south-east of Sabah and the upper north of East Kalimantan. The extent of forested elephant habitats strongly decreased to 157,000 ha in 2012, a loss of 125,000, which is 45% of the extent in 2007.

This analysis is based on forest cover, and since elephants can forage well in shrubland the remaining total extent of all elephant habitats is somewhat larger.

It is nevertheless a radical decrease and many of the deforested habitats are no longer available to the elephants.

The current and potential decrease of connectivity between the separate elephant populations is a major concern. Elephant groups in the eastern and southernmost part of Sabah might become cut off by plantation develop-

ments. The largest population, in the Kinabatangan area is virtually isolated by now.

The total elephant population is slowly decreasing, caused by lack of regeneration of estranged populations and killing of elephants.

The distribution of bantengs was largely unknown in 2007. A preliminary distribution map made in 2012 can therefore not indicate any habitat reduction. Bantengs are forest edge herbivores and show a clear preference, if not requirement, for large open spots in forest environments. Areas of remaining known banteng populations appear to be relatively stable.

## Rhinoceroses



The two-horned rhinoceros of Borneo is on the brink of extinction and the situation has not considerably improved since 2007. Some minor achievements can be reported about protecting the remaining individuals and efforts for captive breeding in Sabah. The discovery of rhino footprints in East Kalimantan indicates that at least a few animals have survived in the remotest parts of Borneo.

The distribution itself of the remaining population as mapped in 2007 is more or less stable. In 2012, there was still 92% remaining of the 2007 distribution, based on forest cover analysis. Rhinos occasionally enter shrub land and even oil palm plantations.

Notwithstanding several efforts for captive breeding, the population size has not increased so far and it might not even be feasible to reach the humble 2020 goal of having 50-200 individuals.

## Orangutans



The major habitats of orangutans are lowland rainforests and peat swamp forests. Most of the orangutan populations are found outside the HoB lines, particularly in the remaining peat swamp, lowland and lower upland forests of West and Central Kalimantan. The HoB has nevertheless many smaller populations. The total extent of all populated orangutan habitats within the HoB was still more than 2.7 million ha in 2007. In 2012, 84% of this extent remained, a loss of more than 400,000 ha.

Most of this habitat loss is due to deforestation of peat swamp forests and lowland rainforests, added by conversion of upland forests at lower slopes. The populations of these areas were generally not isolated but long-term survival of the orangutans that have fled their destroyed habitats is still not secure, given the limited carrying capacity of the remaining habitats.

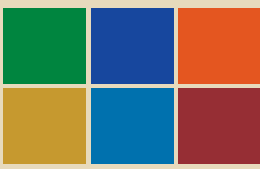
## Clouded leopards



It is assumed that the clouded leopards are still widespread throughout the HoB. These top predators occur in low densities and are generally hard to detect. A viable population with a size of at least 50 individuals, needs an area of uninterrupted forest blocks with an ultimate minimum size of 40,000 ha, although in most cases with less than ideal prey densities the area should be much larger.

Between 2007-2012, a total area of 1.7 million ha with these conditions became deforested, which is a reduction of more than 9%.

The clouded leopard can serve as a good indicator keystone species for survival conditions of many endangered species of the HoB. Unlikely the other keystone species mentioned here, clouded leopards occur in most parts of the HoB. By preserving the habitats for viable populations of this top predator, many other animal and plant species will be protected simultaneously.



## Endemic plants



Nearly all of the endemic pitcher plants (the Nepenthaceae plant family) of Borneo have a very limited distribution, often confined to fragile specific habitats such as high mountain summits and heath forests. Some species are found in only one or few very locations.

The total area of concentrations of endemic Nepenthaceae became reduced by 8% between 2007-2012. The only good news is that these reductions occurred only in distributions areas of the more common endemic species.

Currently there is still 88% of the historical distribution remaining, but if the trend continues then in 2020 this percentage is reduced to 76%. This fits however still in the 2020 HoB goal of 71-90%.

The Fagaceae is an important plant family with many tree species including tropical oaks and chestnuts. Some of the more

common species are spread throughout Borneo, but most of the endemic species have a limited distribution. The highest concentrations of endemic Fagaceae occur mainly in wide forest areas with higher elevations in the interior of the HoB. These areas have remained mostly intact, with still 96% of the historical area left in 2012.

Trees of the Dipterocarpaceae family often dominate the canopy of the lowland and upland rainforests of Borneo. The very long continuous presence of rainforest in Borneo is one of the main reasons that a very high number of endemic species have developed. Certain areas of the HoB harbor high concentrations of endemic Dipterocarpaceae. These species are mainly found in lowlands and the concentration areas suffered from a rather severe reduction of more than 5%.

[Table & graph - historic, 2007 and current extent - forest loss 2007-2010-2012 + table with colored ratings]  
Table - forest fragmentation]

Species	KEA	Indicator	2007		2012		Rating	bold-current (2012)		italics-desired goal	
			raw data	result	raw data	result		Poor	fair	Good	Very Good
Elephant	Population size	% of historical popu- tion size	±2000	80	2040 in 2010	80	good	<60%	60-80%	81-99%	>100%
	Population distribution	% of historical distribution (baseline 3,287,000 ha)	2,761,000	74.3	2,232,000	41.3	fair	<40%	40-60%	61-80%	>80%
	Connectivity	% of subpopulations that are connected		70		60	good	none	<60%	>60%	all
	Amount of suitable habitat	% of remaining habitat that is suitable	2,484,000	90	1,786,000	80	good	only concen- trations	all re- maining habitats	all re- maining suitable	all original habitats restored
Rhinoceros	Population size	total number of individuals		<50		<25	poor	<50	50-200	201-500	>500
Clouded leopard	Amount of suitable habitat	area of suitable habitat for viable populations (>50 individuals)	18,684,000	98	16,919,000	90.5	very good	<40%	40-60%	61-80%	>80%
Orangutan	Population distribution	% of historical distri- bution	2,761,000	84.0	2,323,000	70.7	fair	<50%	50-70%	71-90%	>90%
Banteng	Population distribution	% of historical loca- tions occupied				80?	good	<50%	50-70%	71-90%	>90%
endemic Ne- penthiaceae	Distribution	% of historical loca- tions still viable	21 locations	95.4		87.8	good	<50%	50-70%	71-90%	>90%
endemic Dip- terocarpaceae	Extent of high concentrations	% of historical extent	1,103,000	97.6	1,046,000	92.5	very good	<50%	50-70%	71-90%	>90%
endemic Fagaceae	Extent of high concentrations	% of historical extent	1,192,000	97.7	1,175,000	96.3	very good	<50%	50-70%	71-90%	>90%



# Overall Threat Status

## Industrial conversion of natural forests



Conversion of natural forests into industrial plantations is the highest threat to the ecosystems of Borneo and the HoB.

The total extent of oilpalm plantations in 2012 in Borneo was 11.72 million ha Borneo; 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 Borneo; of which 0.49 million ha was inside the HoB.

The timber plantations of Kalimantan use mainly fast-growing species used for the production of pulpwood. [species mentioned in map section; any meranti or jati plantations?]

The extents of the remaining forests that are inside plantation concessions were analyzed. These forests have not yet been converted and can theoretically partly be saved.

Most affected by conversion to plantations are lowland rainforest and peat swamp ecosystems

more than 6% of the remaining lowland rainforest is inside plantations.

The oil palm plantations in 2012 still had 170,000 ha natural lowland rainforest to be converted.

The timber plantations in 2012 had 43,000 ha natural lowland rainforest to be converted.

almost one quarter of the remaining peat swamp forests within the HoB is inside designated plantations. This is some 100,000 ha that is mainly inside oilpalm concessions. [planting oil palms on peat swamp terrains has already been problematical in several locations and might often not be continued or even abandoned. These locations have a good chance of becoming green belts .]

More than 55,000 ha of upland rainforest is located within plantation concessions, but this is a less than 1% of the total area of upland rainforests of the HoB. These are mainly sites of the upper slopes of lowland areas.

There is very little montane forests within plantation concessions. Neither oil palm nor the commonly used pulpwood species grows well at higher elevations.

almost 16% of the remaining heath forests of HoB is inside plantations and could be converted depending on the whims of the plantation managers. [Using the extremely nutrient-poor soils of heath forests for plantations seems to be irrational, but if prices for palm oil are high enough, applying large volumes of fertilizers can still be profitable. - in maps section]

Limestone forests within plantations, almost 5% of the remaining limestone forests of the HoB, might not be converted as it will be impossible to plant oil palm or pulpwood trees on these terrains.





# Mining



A large total area of more than 2 million ha within the HoB is allocated for mining in general.

These allocations include all of stages of mining, from the exploration to the exploitation stage. After exploration of a large concession, only the locations with the larger deposits will be selected for the actual mining. Mining in Borneo is mainly open pit mining and drilling. The areas for digging are relatively small compared to the areas used for plantations. The indirect impacts are however large. [explain in mining map]

[The total area for mining in Borneo is 4.5 million ha and almost half of this is within the HoB]

Mining concessions overlap with other forms of land use allocation.

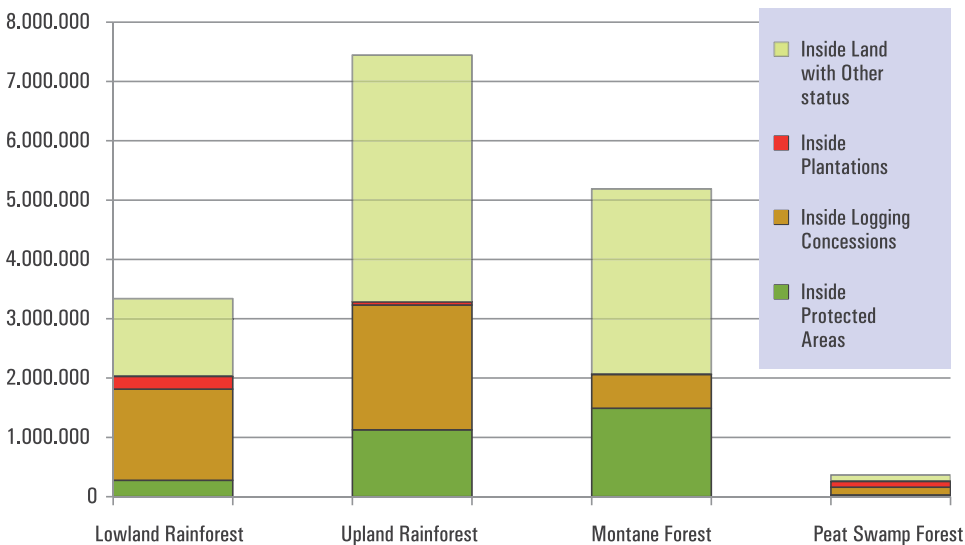
mining appears to be a top priority and can always go ahead. Even in oil palm plantations, the only restriction in protected areas is to mining as only allowed from under the surface

The largest areas of mining concessions are about coal, but there are also many concessions for minerals and metals.

Almost one quarter of the remaining lowland rainforest area of the HoB is inside mining concessions, 838,000 ha. There is 853,000 ha of upland rainforest of the HoB within mining concessions. Mining could be a high threat to the montane forests of the HoB with 240,000 ha of concessions. Most montane areas of Kalimantan are very remote and infrastructure that is required for mining could potentially cause negative side effects.

Irreversible mining damage to former heath forest ecosystems occurred in several locations in Kalimantan. Currently 19% of the remaining heath forests of the HoB are within mining concessions.

Mining in peat swamp areas is mainly for oil and gas, and 22% of the remaining peat swamp forests of the HoB (91,000 ha) are in concessions.



## Forests in logging concessions



Production forests of logging concessions can be renewable sources of timber for future generations, if management and production systems are applied that carefully balance the timber harvest levels and regeneration requirements. In this way, healthy forests are left standing after a first round of logging and can recover for future harvest rotations. This is the principle of serious forestry.

The practices of logging concessions are however not always clear. For instance, in Kalimantan sections of natural forests in logging concessions can in many cases be cut down almost completely and then be replanted. This is mainly done not with quality-timber trees that are natural to the climax stage of these forests, but with fast-growing pulp-wood trees. In worse cases the forests become so degraded after over-logging (and perhaps even fires) that authorities allow the remaining vegetation to be converted to oil palm plantations.

Certification schedules to which logging companies can adhere include charters that should guarantee the preservation of habitats for wildlife and the general functioning of the forest ecosystems.

A very large part (43%) of the remaining lowland forests of the HoB is inside logging concessions. The total area was 1.54 million ha in 2012, yet down from 1.77 million ha in 2007. This implies that 0.23 million ha was converted between 2007-2012, particularly into plantations of timber trees. Not all natural forests in logging concessions are safe.

More than one quarter (27%) of the remaining upland forests are inside logging concessions. Nowadays many of the new logging concessions comprise almost entirely of upland forests. Lowland rainforest generally has the highest volumes of commercial tree species [per ha] particularly Dipterocarpaceae and Ironwood, but since most remaining lowland forests have been logged, it becomes economically feasible to harvest timber in upland rainforests even though volumes of timber species are lower.

More than half a million ha of montane forests are included in lowland and upland forest concessions, which is 11% of the remaining montane forests of the HoB. There are however no specific montane forest logging concessions and the sections or blocks of the concessions at higher elevations are more likely to survive through reduced impact logging. Timber yields of these sections are lower and conversion to plantation forests is less likely.

32% of the remaining peat swamp forest of the HoB are inside logging concessions. Logging of peat swamps requires an extensive infrastructure with heavy environmental impacts and these forests are frequently threatened by conversion.

High percentages of the remaining limestone and heath forests are also inside logging concessions.





## Other status

All land that is currently not operational and is not managed falls in the category of “Other Status”. Parts of these lands can become available to developers.

It also provides opportunities for conservation before the beginning of exploitation.

Data from Malaysia on the extents of logging concessions and plantation concessions is not to be available.

This implied that in our analyses all forest land of Sabah and Sarawak outside protected areas was included in “other status” class”

Land use functions have been allocated by the Ministry of Forestry and the Land Use Planning Agencies. In Indonesia, the following land use types have been allocated:

### **APL (Areal Penggunaan Lain) - other land use areas**

This land can be deforested and converted into any other land use including oil palm plantations, rubber plantations, settlements and other constructions. Mining can be developed without restrictions. Forest on land with APL status can be considered gone, except perhaps for strips of High Conservation Value Forests. Companies are not obliged by the government to retain HCVF areas and this is mainly on voluntary base.

The total area in the Indonesia HoB of forests allocated to APL was 244,000 ha in 2012. Remarkably, 40% of these forests are upland forest and 17% are

montane forests.

Between 2007-2012, in the Indonesian part of the HoB 45,500 ha of forest was converted in land with APL status. By far the most of this occurred in West Kalimantan.

### **HPK (HutanProduksiKonversi) - production forest to be converted**

The timber from the forests of these lands will be harvested through clear-cut. Afterwards the land will be planted with timber trees. These are usually fast-growing species for the production of pulp. The species most often used is the exotic *Acacia mangium*. It would be better for ecological aspects to use local species. Good results have been recorded from planting for instance *Anthocephaluscadamba* and *Pinusmerkusii*, (which are strictly speaking not local, but at least Sumatran species).

Retaining HCVF areas is not obligatory.

The total area in the Indonesia HoB of forests allocated to HPK is 13,000 ha. This is a relatively small area but most of land for timber plantations (79,000 ha) has already active plantations to which the HPK land will add up.

### **HP (HutanProduksi) - production forest**

These forests are allocated for the harvest of large volumes of timber. (allocated, but not yet operational) Production of timber from natural trees is however not always the long-term goal, as forest blocks can be replaced by plantation forests. In reality HP appears to be almost the same as HPK though with a stronger legal status to at least retain a forest



cover, whether this is natural or planted. The status of HPK can be converted to APL.

More than 150,000 ha of forest land is allocated as HP, though not yet being actively exploited. More than half of this (76,000 ha) comprises upland forest. The 18% of montane forests allocated to HP could potentially be susceptible to erosion issues.

### **HPT (Hutan Produksi Terbatas) - limited production forest**

These lands are allocated for sustainable forestry in which a semi-natural forest cover should be retained. Logging companies will need to develop timber production plans that incorporate rotation cycles. Reduced impact logging will minimize the impacts of infrastructure and felling on the remaining standing stock, which should benefit optimal growth and regenerations. Habitats of endangered species should be disturbed as little as possible.

A very large total area of more than 1.6 million ha is allocated to HPT. Half of this land is in upland forests and 31% is in montane forests. It might often be the best option to retain some of the last lowland rainforests of Kalimantan (266,000 ha) even though not in primary conditions.

However, between 2007-2012, in the Indonesian part of the HoB 77,500 ha of forest was converted in land with HPT status. This occurred in all the three provinces.

### **HL (Hutan Lindung) - protection forests**

Protection forest is a land use class that was originally allocated “by default” to areas with steep slopes. The principle was that high slopes should remain un-

der forest cover to avert potential erosion problems and secure hydrological functions for more intensive land use below (the concept was originally gazetted to protect the remaining forests on the higher slopes of the mountains of Java’s “schermbosschen”).

Areas with protection forest mainly comprise hilly and mountainous terrain. These can also occur in lowland areas, for instance large rock outcrops forming hills with steep slopes.

Protection forest is not the same as “protected forest”. The status of HL does not necessarily imply that the forests are entirely safe from conversion. Parts of it can be re-allocated in district land use planning and control of illegal logging or even conversion is often non-existent. Land with HL status can be “borrowed” particularly for mining.

If the legal status of protection forest can be strengthened then these areas could potentially be added to the total area of protected areas in Kalimantan.

There is in total more than 3.3 million ha of land with protection forest status within the HoB. Almost half of this comprises of upland forests and almost two-fifth are montane forests. More than 400,000 ha of lowland rainforest is protection forest, almost 10% of all remaining lowland rainforest. About one-third of all remaining heath forest within the HoB is protection forest.

Notwithstanding their semi-protected status, between 2007-2012, in the Indonesian part of the HoB more than 162,000 ha of forest was converted in land with HL status. This occurred largely in West Kalimantan and in East Kalimantan.

## Forest fires



Forest fires continued to occur between 2007-2012. The worst year was 2009 with 2385 hotspots within the HoB. These incidents appear to be very hard to control and even in 2012 there still more than 1400 hotspots.

by far the most hotspots were recorded in lowland rainforest areas; between 2007-2012 more than 4000 hotspots occurred, which is more than half of the total number.

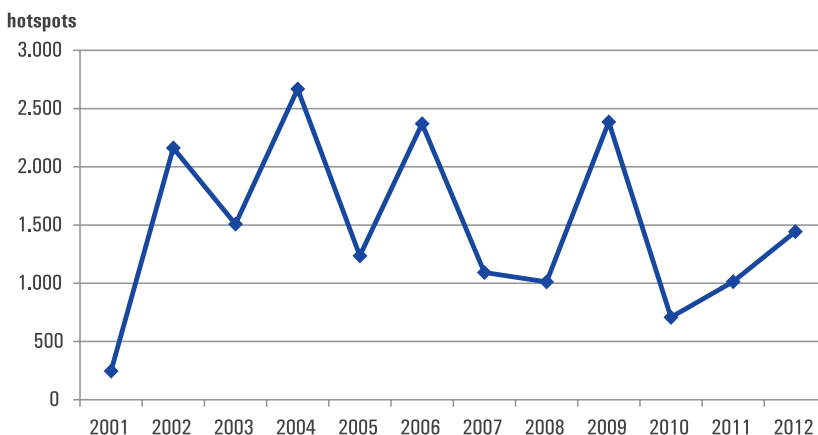
Nearly all of the remaining peat swamp areas in the HoB were affected by forest fires, with more than 1000 hotspots in this relatively small total area. Upland

forests were also frequently affected (>1200 hotspots).

The most damage per area was inflicted in heath forests, with 941 hotspots between 2007-2012. Fire impacts on heath forest ecosystems is often irreversible.

The largest number of hotspots between 2007-2012 were in remaining forests within oil palm plantation concessions. There was also a large number of fire incidences in logging concessions. This might imply that the concession holder is less committed to preserve the forests for long-term sustainable timber production.

[graph yearly fires HoB]



### **Concentrations** of shifting cultivation and hunting

Local communities have been practicing shifting cultivation for hundreds of years to cultivate rain-fed rice and other crops. Many communities are highly dependent on fish and meat from the forests for their protein needs.

The impacts of expanding shifting cultivation on the landscapes are nowadays much larger than in the old days. Formerly each tree of a new field had to be cut down by hand using axes and machetes, while nowadays people use chainsaws. This makes it much easier to open larger areas of forest.





# Overall Conservation Management Status

## Protected area representation



Only 7.8% of remaining lowland rainforest is inside protected areas in 2012. - 277,000 ha in 2007 the percentage was 6.8% which corresponded with 301,000 ha

The increasing percentage is a bit tricky as it might imply that with total remaining lowland forest reduced, percentage becomes higher. If we use the 2007 area as baseline, then the percentage of lowland rainforest in protected areas is 6.2%.

The protected lowland rainforests connect to upland forests that are also protected as long as these lowland forests are situated in valleys of national parks.

The lowland rainforests of Bukit Baka Bukit Raya all connect to the upland forests further up the slopes. Betung Kerihun national park has only lowland rainforests in the southern river valleys, and the naturally connect to the surrounding upland forests. Lanjak Entimau has a large area of lowland forest, which connects to upland forests in the south. The northern border does not always connect. The largest total area of protected lowland rainforest within the HoB is in Brunei, and most of the areas have good connectivities.

The total area of upland forest in the HoB that is protected is 1,1 million ha, 14.5% of all upland forests. In 2007 this was 1.2 million ha, 14%.

This looks like a sufficiently large area; however all of the protected upland forests are in the remote interior which are currently not the most threatened. The accessible upland forests bordering the lowland are in higher need of protection. Several of these are also part of the habitats of endangered species such as orangutans.

The only ecosystem that has an “ideal” representation in protected areas is montane forest. Some 28% of the remaining montane forests of the HoB are inside protected areas. The total area of 1.5 million ha remained the same since 2007.

The relatively large areas of protected montane and upland are particularly inside the large Kayan Mentarang and Betung Kerihun national parks.

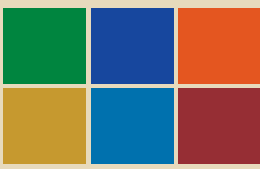
Only a very small part (7%) of the remaining peat swamp forests within the HoB are protected. Even though there are large protected peat swamps outside of the HoB, these have a very different ecology.

The percentage of protected freshwater swamps inside the HoB is also small, 11%. One quarter of the area of freshwater swamps inside protected areas was converted between 2007-2012.

Only 5.6% of the limestone forests of the HoB are inside protected areas. This is much too low given the unique ecology of this ecosystem. It is feared that at least the limestone areas inside logging plantations are somehow protected by local or traditional regulations.

Heath forest is also a very fragile ecosystem, but only 2.6% are protected. This is alarming because large areas are inside plantations and mining concessions.

The oft-cited policy-driven goal is for protected area representation 10%, but conservation science indicates that larger percentages (>30%) are increasingly



likely to support biodiversity, ecosystem services, and buffer against changing climate. Even if the goal is to have only 10% representation of each ecosystem in protected areas, then this goal is not met several ecosystems. It might be possible to increase the total area of protected lowland rainforests by gazetting of extensions of existing protected areas. The establishment of new large nature reserves or national parks in lowland is not likely to happen. The legal status of protec-

tion forests (Hutan Lindung) should be strengthened.

It might be possible to have additional peat swamps and freshwater swamps protected when these have high water levels and economically not feasible to exploit. Limestone forests with very steep terrains will already have the status of protection forests. Heath forests are generally undervalued and will probably only be protected if there are spectacular species present.

## Protected area intactness

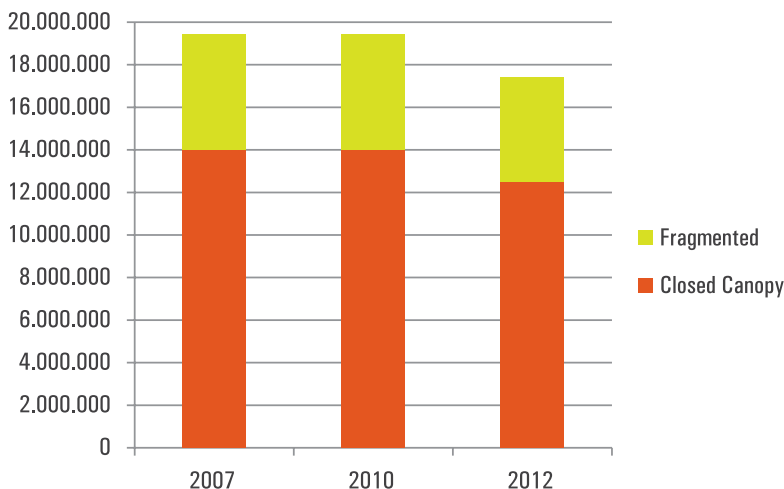


Forests in protected areas should naturally have closed canopies and be connected rather tightly. Gaps generally occur but these are never very wide. Somewhat larger open spots can occur naturally in places of landslides or strong storms. Otherwise fragmentation should only be visible in the vicinity of large rivers, lakes and swamps.

Fragmentation often occurs at edge areas of protected areas with human populations. This is for instance clearly visible along the Crocker Range NP in Sabah and Danau Sentarum National Park in

West Kalimantan. Most sections of Bukit Baka Bukit Raya NP are strongly fragmented, with the exception of the central parts. Fragmentation is often caused by shifting cultivation agriculture, sometimes enlarged by (unintentional) forest fires. Harvest of timber trees can also lead the fragmentation if too many trees are cut down.

Fragmentation caused by shifting cultivation is clearly visible in Kayan Mentarang NP, where most of the accessible river valleys are fragmented.



## Status of remaining forests in concessions



Logging concession holders that are certified have a clear commitment to sustainable timber production for the long term. This should ensure that forests will be managed well or at least retained for the future.

In 2012 about 20% of all logging concessions inside the HoB were certified. About half of these consist of lowland rainforests and half of these consist of upland (and some montane) forests.

Most of the other logging concessions were identified by WWF as having a potential for certification.

Currently none of the oil palm plantations within the HoB are certified. Expansion of plantation areas will likely increase particularly into the HoB. One of the major requirements for certification is that oil palm plantations set aside High Conservation Value Areas and certification of plantation companies might ensure that at some of the remaining forests within these plantation areas will be retained.

## Deep peat conversion



Areas with very deep layers of peat are found only in the DanauSentarum area of the HoB. There is 12,000 ha of peat swamp with a depth of 2-4 m in the eastern and southern part; and 60,000 ha

of 4-8 m deep peat in the southern part of DanauSentarum. About a quarter of this area is threatened by conversion and forest fires.

## Protected area effectiveness



Management effectiveness can be represented by indices such as Rapid Assessment and Prioritization of Protected Area Management (RAPPAM). These assessments have been conducted in the four national parks in the HoB part of Kalimantan: BetungKerihun, DanauSentarum, Bukit Baka Bukit Raya and KayanMentarang.

In terms of management effectiveness, BetungKerihun and Bukit Baka Bukit Raya score high and , DanauSentarum and KayanMentarang score very high. The financing is also quite effective.

The assessments were conducted in 2004 and again in 2010, which provide good data sets for comparisons.

### Importance:

All four national parks score high to very in terms of biological importance. The score decreased for BetungKerihun and increased for KayanMentarang, while the for the other two national parks is was stable.

Socio-economic importance was high to very high in all four national parks in



2010. BetungKerihun showed a strong increase from low in 2004 to high in 2010.

**Threats and pressure:**

Encroachment threats and pressure remained low to medium in the four national parks from 2004-2010.

Logging threats and pressure increased in Bukit Baka Bukit Raya but became lower in the other three national parks.

Forest fire was a high threat in DanauSentarum in 2004 but apparently became low in 2010.

Mining remained in medium high threat in Bukit Baka Bukit Raya and somewhat increased in BetungKerihun.

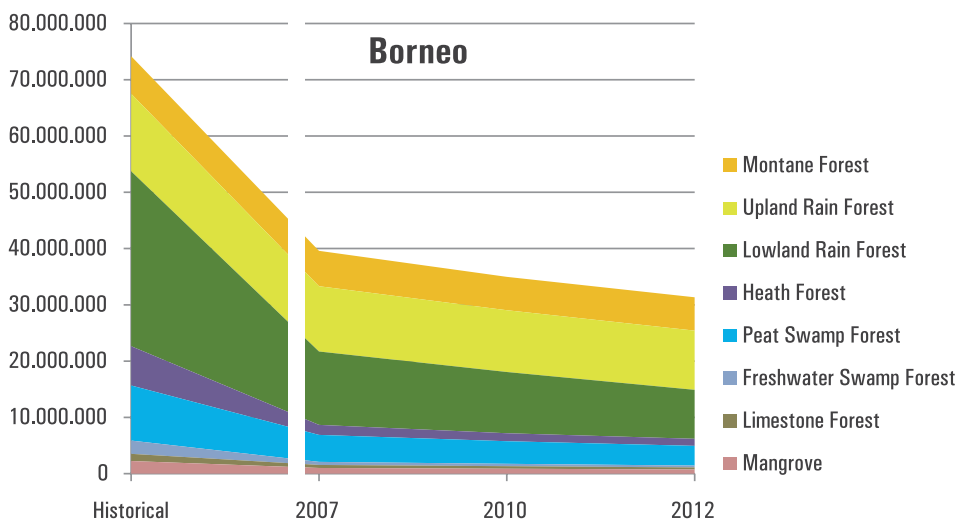
Hunting threats and pressure remained low in BetungKerihun and Bukit Baka Bukit Raya but is very high in DanauSentarum. Over-harvest of non-timber forest products is only an issue in KayanMentarang but is increasing.

Land use conflicts are threats in DanauSentarum and KayanMentarang and have increased from 2004 to 2010.

Pollution is a very high threat in DanauSentarum

# COMPARISON WITH (the environmental status for) THE WHOLE OF BORNEO

[graph ecosystems, forest cover]



## Protected area



4.02 million of the total forest area of Borneo is protected, of which is 2.95 million within the HoB.

The fact that three-quarters of all the protected forests of Borneo are within the HoB clearly demonstrates the importance for conservation. However it also underlines the problem of certain ecosystems not well represented in protected areas. Lowland rainforest is major issue: 277,000 ha is inside the HoB, but in the rest of Borneo is only another 150,000 ha of protected lowland rainforest. Many of the lowland rainforests with the highest biodiversity were in areas outside the HoB, and species composition differs for each ecoregion of Borneo.

Nearly of the protected upland and montane forests of Borneo are within the HoB.

Protected heath forest on the other hand appears to be under-represented in the HoB. A total of 92,000 ha of heath forest of Borneo is protected but less than 5,000 ha of this is within the HoB.

The protected peat swamp forests of Borneo include large coastal areas such as Sebangau and Tanjung Puting. The total area of protected peat swamp forests is 642,000 ha, of which 30,000 ha is within the HoB.



## Expanse of plantations and logging in Borneo



22% of the Indonesian part of Borneo is under logging concessions

compared to

31% of the Indonesian part of the HoB.

The higher percentage for the HoB reflects the fact that most lowland forests of Borneo have already been heavily logged, while the interior lowland and upland forests of the HoB are often still in good conditions. Data for Malaysia is not available.

The wide lowland of Borneo outside of the HoB are economically very suitable for the development of oil palm plantations. The higher elevations and limited accessibility of most of the HoB implies that only selected areas are suitable for oil palm plantations. Timber plantations have so far mainly used fast-growing lowland species.

28% of the Indonesian part of Borneo is under mining concessions

compared to

19% of the Indonesian part of the HoB.

This is the percentage of the land under all mining concessions, which includes large areas of exploration concession. The high percentage of the HoB implies that several interior locations are expected to contain volumes of valuable geological deposits.

32% of the Indonesian part of Borneo is under plantations (timber 10% + oil palm 22%)

compared to

9% of the Indonesian part of the HoB (timber 3% + oil palm 6%)

## Forest types inside logging concessions & plantations



A majority of the remaining lowland rainforests of the Indonesian part of Borneo, 3.39 million ha, is inside logging concessions. Almost half of this area, 1.54 million ha, is inside the Indonesian part of the HoB. As the total area of lowland rainforests inside protected area is not sufficient to ensure the survival of all aspects of this ecosystem, it will become

crucial to ensure that these logging concessions remaining under natural forest cover.

In 2012, there remained 945,000 ha of lowland rainforests inside plantations in the Indonesian part of Borneo. Most of these forests were to be converted, and 213,000 ha these were inside the Indonesian part of the HoB.

Out of the 2.50 million ha of upland forests inside logging concessions in the Indonesian part of Borneo, 2.10 million ha are inside the Indonesian part of the HoB. The upland forests of the higher elevations of the interior generally yield lower volumes of commercial timber than the lowlands, and harvesting with reduced impact logging should be feasible.

In 2012 there remained 107,000 ha of upland forest inside plantations in the Indonesian part of Borneo of which half was inside the HoB (55,000 ha). Most of these forests, often at the edges of lowland plantations, will be converted.

A large total area of montane forests of Indonesian part of Borneo, 580,000 ha, are inside logging concessions. Nearly all of these montane forest concessions are within the HoB. The total area is remarkably large given the fact that volumes of commercial timber in montane forests are generally low.

There is 7,000 ha of montane forest inside plantations in the Indonesian part of Borneo, all of which are within the HoB.

## Forest fires



A total of 288,286 hotspots were recorded from all over Borneo in the timespan from 2001 to 2012.

17,870 of these hotspots were recorded in the HoB, during the same time period.

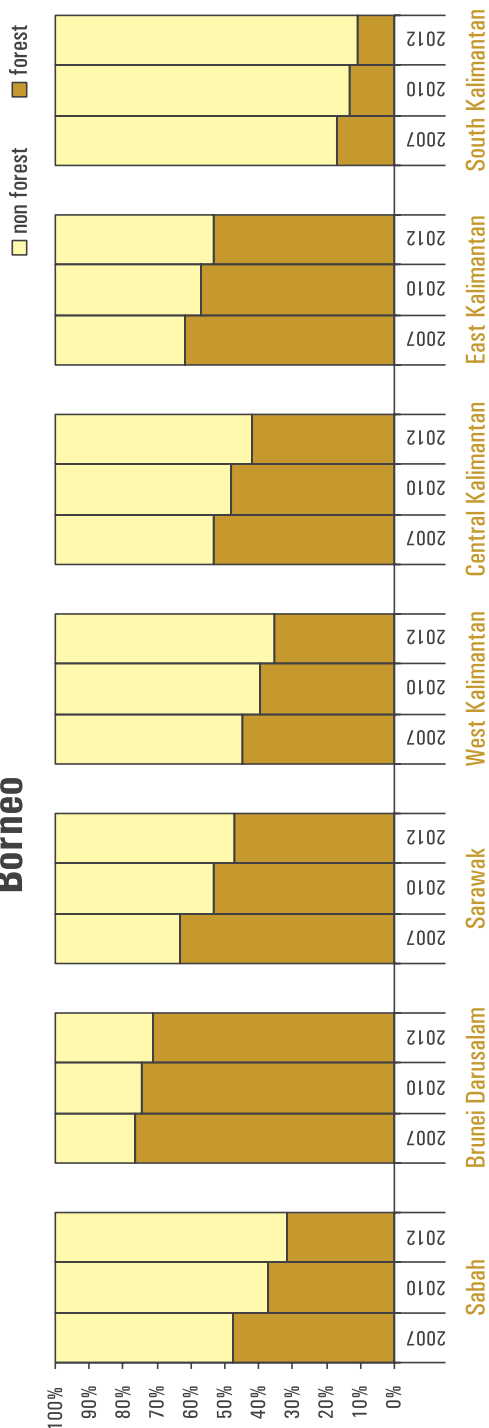
The size of the HoB is about a quarter of the area of Borneo, but only 6% of all hotspots were within the HoB.

A majority (42%) of the hotspots of Borneo occurred in peat swamp forests, followed by lowland rainforests (33%) and heath forests (12%).

In the HoB, a large majority (55%) of the hotspots occurred in lowland rainforests, followed by heath forests (15%) and peat swamp forests (13%).

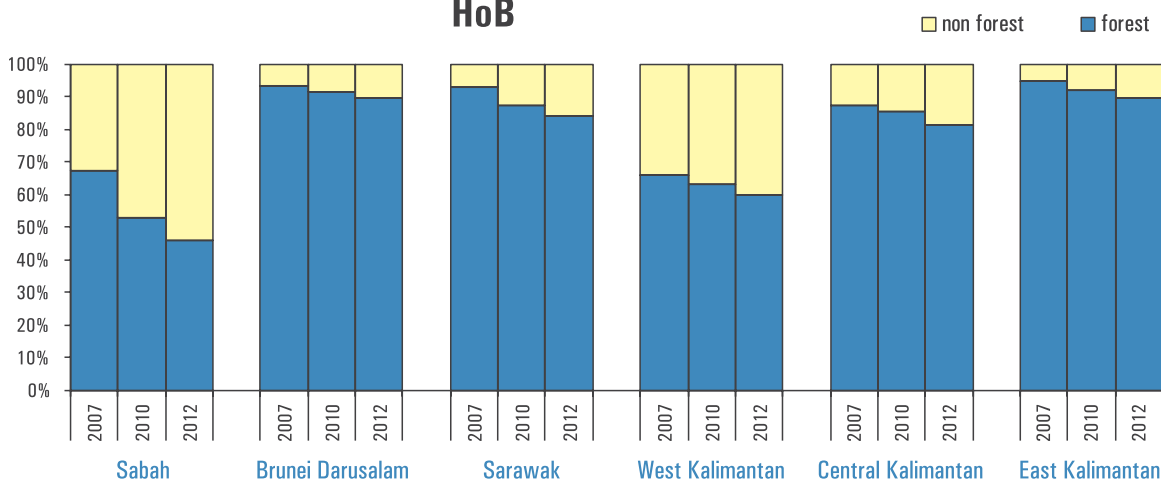


# Borneo



# THE ENVIRONMENTAL STATUS PER STATE AND PROVINCE

## HoB



## Sabah



Most of the historical lowland forest of Sabah was converted before 2007, mainly into plantations. Nevertheless, in 2007 there was still XX ha of lowland forest in the HoB part of Sabah. Particularly between 2007 and 2010, much of this lowland was converted. Conversion decreased after 2010 but this was mainly because there was not much left to convert. In 2013 only a few areas of lowland forest remain, and many of these are fragmented.

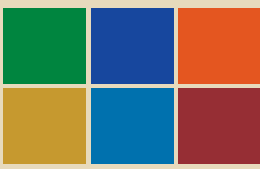
A large part of central Sabah was historically covered by upland forests but more than half of this area was converted before 2007. Conversion continued until 2010, after which very few more locations were converted. Forest fires are serious threats to the remaining upland forests and occurred up to 2012.

Sabah is the only state or province of Borneo where considerable areas of montane forests have been converted. Slopes of the Kinabalu and Crocker range mountains were converted for agriculture mainly before 2007, but the process continued until 2010.

Severe reduction of orangutan habitats occurred between 2004 and 2007 throughout Sabah. Many remaining small habitats were converted from 2007 to 2010. Up to 2012 conversion of orangutan habitats still took place at edge locations.

Habitats in landscapes that can support viable populations of clouded leopards became reduced from 2007 to 2012.

A strong reduction occurred between 2007-2010 of large areas of un-inter-



rupted forest blocks that can support viable populations of clouded leopards, particularly in central part/ upper Kinabatangan.

**Major land cover changes between 2007-2012 occurred in at least following areas:**

The Sugut watershed was subject to lowland forest conversion and upland forest conversion.

The Labuk watershed had many locations of upland forest conversion and much of the remaining upland forest is fragmented.

The montane forest conversion in the Crocker range occurred mainly at the eastern slopes. Many of the upland forests here were affected by forest fires.

In the upper Padas watershed were many locations of montane forest conversion.

Large areas of montane forests were converted in the vicinity of Sapulut (east of Maliau basin).

The upper Kalabakan area was affected by lowland conversion while the remaining lowland forests are very fragmented.

In the lower Segama area both lowland forest as well as upland forest conversion occurred.

Lowland forest conversion in the upper Kinabatangan had an impact on the habitats for viable populations of clouded leopards.

The Serudong river valley underwent large upland forest conversion while the remaining upland forest is strongly fragmented; the upper Serudong area has patches of montane forest conversion.

The upper Sebuk watershed underwent conversion of montane forest in several locations.

Much remaining upland forest of the uppermost Sembakung watershed is fragmented.

## Brunei



Relatively little forest conversion occurred in Brunei between 2007 and 2012.

The area most affected was the Belai watershed. Here both lowland forest

conversion as well as freshwater forest conversion occurred along the edges of the remaining forests.

## Sarawak



Only a small part of Sarawak lies within (imaginary boundaries of) the HoB and this land comprise mainly the uppermost sections of the major watersheds.

The area of lowland forests is therefore limited. Still many of the small areas of lowland forests were converted between

2010 and 2012 and most of the remaining lowland forests are fragmented. Deforestation of one area continued until no more lowland forest remained in that location.

Most of the western HoB section of Sarawak is covered by upland forests.

In 2007 most of the upland forests were intact, with the exception of an area that was converted in the last century. Between 2007 and 2012, several small areas of upland forests in higher valleys were converted throughout Sarawak. Edges of upland forests are partly fragmented.

Most of the eastern HoB section of Sarawak is covered by montane forests. Most of these forests are still intact, but some relatively large areas were converted before 2010. Large scale montane forest conversion did not occur after 2010.

#### **Major land cover changes occurred in at least following areas:**

In the upper Rajang watershed, particularly along the upper Katibas, Bangkit and Mengiong rivers, lowland forest conversion occurred until 2012. There is no more remaining lowland forest along the Bangkitriver. Most of the remaining

lowland forests along the Katibas and Mengiong rivers are fragmented. Upland forest conversion of these areas started in the last century and continued until 2012. The conversion was done gradually by clearing smaller but connecting areas.

The upper Baram watershed underwent both upland forest conversion as well as montane forest conversion. In the Kela-bit area are many small areas of montane forest clearing.

The upper Baleh had many small areas of upland forest conversion and montane forest conversion.

In the Iran mountain range are several large areas where montane forest was converted between 2007 and 2010.

The upland forests of the Batang Ai National Park and LanjakEntimau Wildlife Sanctuary were not subject to clear conversion, but many locations are highly fragmented.

## **West Kalimantan**



A large part of West Kalimantan comprises lowlands, formed by the basin of the Kapuas river and its tributaries. Most of the lowlands on dry land within the HoB used to be covered by lowland forest and heath forest. Large areas of the lowland forests were converted before 2007, and there is hardly any lowland forest left in the western part of West Kalimantan. The valleys within the mountain ranges of the eastern and south parts of West Kalimantan still have small areas of lowland forests, although small scale conversion occurred between 2010-2012. Most of the remaining lowland forests are fragmented. Orangutan habitats and thus their distribution suffered strongly from the all the conversions of lowland forests. A very large area of heath forest

in the south, the middle Melawi sub-watershed, was converted before 2007. Heath forest was the major ecosystem all around the foot slopes that border the DanauSentarum basin, but most of it was converted before 2007.

The basin itself was dominated by peat swamp forests but also had smaller areas of freshwater swamps. Parts of the peat swamp forests were converted before 2007 and conversion continued until 2012. Conversion of freshwater swamps is even more serious and in 2012 only a few areas were left.

The mountain areas of the upper Kapuas watershed appear to be less affected by forest conversion, although small scale conversion of upland forests occurred.



Several areas of upland forests are however fragmented. Many of the forests of the isolated hills of the western part of the province were converted before 2007.

West Kalimantan is the province/state in the HoB that suffered the most from forest fires. Nearly all of the lowland and peat swamp forest areas show fire hotspots and most of these are of recent years.

**Major land cover changes between 2007 and 2012 occurred in at least following areas:**

The western HoB edges, including the strip of land west of DanauSentarum were still subject to lowland forest conversion. In 2012 only a few fragments remained here. Some of these are inside plantation concessions.

The DanauSentarum area underwent all kinds of conversion and fragmentation: conversion of freshwater swamps, peat swamp forests and heath forests. Con-

version of freshwater swamps and peat swamps occurs continuously and gradually, by clearing small areas starting with intrusions from the most accessible locations.

The habitats of orangutans in the Labian-Leboyan corridors suffered from conversion of several small areas.

The foot slopes to the north of Bukit Baka Bukit Raya underwent much lowland forest conversion between 2010-2012. Part of the remaining lowland forests are inside plantation concessions. Conversion of upland forest occurred as well, though at a much smaller scale. Several of the upland forests are however highly fragmented.

The mountains of the uppermost Kapuas watershed had several small areas of montane forest conversion.

The forests of BetungKerihun appear to be in good shape with very little conversion of some upland forests. The western part of this national park is however highly fragmented.

## Central Kalimantan



The largest part of Central Kalimantan is lowland.

The HoB boundaries were drawn approximately along the boundaries between the flat lowlands and the hilly and mountainous uplands. Most of the lowlands forests are therefore located along the HoB edges. The hilly area to the north has however a geomorphology with many wide river valleys in between the hills and these are generally still covered by rather large areas good lowland forests. Much conversion of lowland forest in Central Kalimantan occurred before 2007 but conversion of small areas at a time continued until 2012, and

this process can gradually degrade much of the remaining lowland forests.

Upland forest appears to be rather safe currently, even though small-scale conversion occurred in many locations. Many of the more accessible upland forests were converted before 2007, but there are still large areas of upland forest left in the northern hilly and mountainous landscapes. The forests of some of these areas are however highly fragmented.

Conversions of montane forests occurred in a few areas at a rather large scale. The northernmost mountains were not affected.

Serious reduction of orangutan habitats occurred at all of the southern edges of the HoB.

Forest fires are major problems in Central Kalimantan and have affected many areas. Forest fires occurred in many of the logging concessions in the lowlands. This seems to be remarkable as one would expect concession holders to be more careful with their valuable standing timber stock. That is unless they have other plans with their land. Forest fires also frequently happened in the upland forests.

**Major land cover changes between 2007 and 2012 occurred in at least following areas:**

The upper Pembuang watershed was strongly affected by forest conversion. The Seruyan area in particular underwent much conversion of lowland forest between 2010-2012 and only a few core areas of lowland forest are still intact. Conversion of upland forest occurred at some locations. A rather large part of the remaining upland forests are within plantation concessions. The upper Pembuang has important orangutan habitats which became reduced in size during the last years.

The southern slopes of Bukit Baka Bukit Raya national park suffered from small-scale conversion of lowland forest, upland forest and even some montane forest. Most of the conversions occurred in the upper valleys of the Mendawai river tributaries. A large area of lowland forest was converted before 2007. The remaining lowland and upland forests are often fragmented. Many of these forests suffered from forest fires (2006-2012).

The upper Kahayan watershed is a large area with several tributaries, that had conversion of lowland forest in several locations. Most of the conversions happened before 2007 but the process continued from 2007 to 2012. The upland forest of this area is often highly fragmented.

The area north of MuaraTeweh suffered much from forest fires. In many of the upland forests fire spots were detected. The area has some of the highest densities of forest fires in logging concessions.

In the area west of Purukcahu montane forest conversion occurred in the form of numerous rather large spots. This is probably the result of coal mining.

Conversion of lowland forest occurred throughout the upper Murung watershed. Conversion of lowland forest directly along the Murung river and its tributaries has been going on for a long time but after 2009 many locations further inland from the rivers were also converted. The upper Joloiriver was very strongly affected and in 2012 there was hardly any lowland forest left. Conversion of upland forest also occurred and several upland forests of the upper Murung area are inside oil palm plantation concessions.



## East Kalimantan



The eastern part of East Kalimantan encompasses large stretches of lowland while most of the western interior parts comprise hilly and mountainous landscapes. Lowland forests are found mainly in the eastern coastal regions and in the valleys of the rivers that cut through the western hills.

The largest stretches of lowland forest within the HoB are located in the Mahakam watershed. Large areas were converted before 2007 but conversion slowed down after 2008. Other large stretches of lowland forest are in Berau and Bulungan. Most of these were still intact in 2007 but conversion strongly increased after 2010. Large parts of the remaining lowland forest is fragmented. The largest parts of the lowland forest area are in logging concessions but large areas in the Mahakam watershed are set aside for conversion into plantations.

East Kalimantan has very large areas of upland forest and relatively few areas have been converted. About half of the total area of upland forests is within logging concessions. Only few forest fires occurred in the lowland and upland forest logging concessions, which might imply that the conversion is not a major threat here.

By far the largest areas of montane forests of Borneo are in East Kalimantan. Most of the remote montane forests are still intact but many of the more accessible locations did not remain untouched.

The interior landscape has a very diverse geomorphology and many small areas of heath forest, lowland valleys and limestone ridges are present throughout the area. Most of these are however too small to map but the larger areas indicate that heath forest in particular is often subject to conversion.

Orangutan habitats in East Kalimantan are much smaller compared to the other provinces. Most of these are still present but have suffered strongly from fragmentation.

The elephants of East Kalimantan are only found in one area and habitat conversion is a major issue here.

### **Major land cover changes between 2007 and 2012 occurred in at least following areas:**

A very large area of lowland forest was converted along the middle Mahakam before 2007. Small-scale conversion occurs until 2012. Some of the remaining lowland forests are within plantation concessions. Rather large spots of limestone forest were converted, mainly before 2007, but some until 2012. The upland forests of this are often fragmented.

Along the lower and middle Belayanriver, rather large elongated areas of lowland forests were converted between 2010-2012. The upland forests of the middle and upper Belayan are often fragmented. This has affected the orangutan population of this area.

The upper Telen and Wahau river areas were affected by upland forest conversion in 2010-2012 and montane forest conversion in 2007-2010, generally in the form of small but connecting areas.

The river valley of the upper Mahakam was strongly affected by conversion of lowland forests. Nearly all of the riverbanks were converted before 2007 but conversion continued further inland from the river until 2012.

Kutai Barat suffered in particular from forest fires in upland forests.

The Kelai drainage area underwent conversion of areas of lowland forest and upland forest between 2010-2012. Much of the remaining lowland forest is inside plantation concessions. The remaining upland forests are often fragmented. This also reduced the area of orangutan distribution.

The upper Segah area was subject to montane forest conversion from 2007 to 2010. Many of the forests within logging concessions suffered from forest fires. Much of the remaining lowland forest is inside plantation concessions.

The area along the lower Kayanriver underwent conversion of lowland forest continuously from 2007 to 2012. The upland forests of this area are highly fragmented.

The middle Kayan area had large spots of forest conversion of the limestone ridges along the river between 2007-2010. Several rather large spots of conversion occurred in the montane forests also between 2007-2010.

Rather large areas of lowland conversion and smaller areas of upland conversion occurred in the vicinity of Malinauparticularly between 2010-2012.

The Seuku area west of Batu Mayo underwent much lowland conversion that appears to be encroaching until 2012. Small areas of upland forest conversion occurred as well and much of the remaining upland forest is fragmented. This also directly affect the habitats of the only elephant population in Indonesian Borneo.

The lower Sembakung area underwent much upland forest conversion and most of the remaining lowland forests are inside plantation concessions.

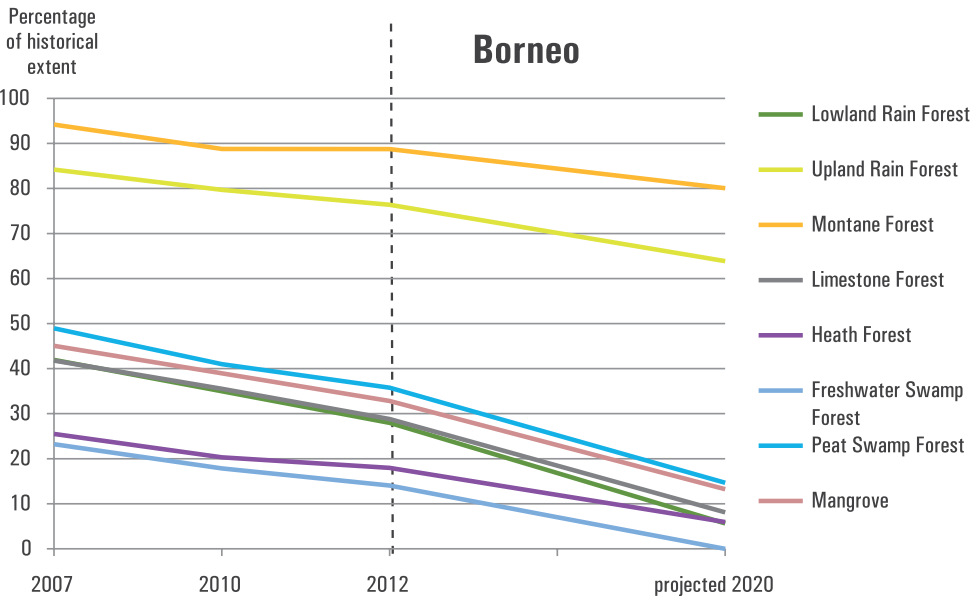
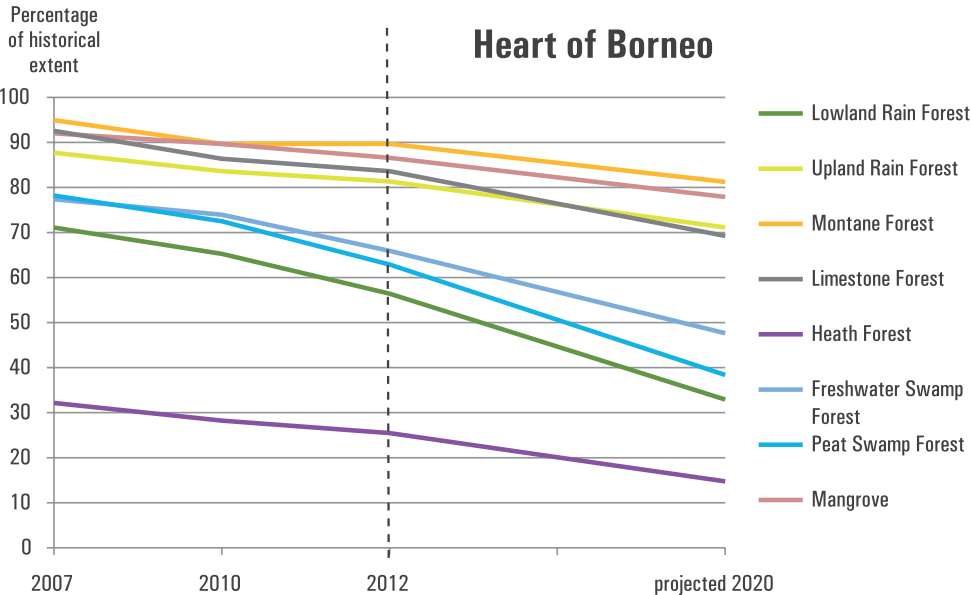
In KayanMentarang small areas of conversion of upland forest and montane forest occurred throughout the inhabited locations.

A large area of heath forest in Simenggaris was partly converted before 2007 and the remaining heath forest was converted between 2007-2010.





# Projections For 2020



The total forest cover of Borneo in 2020 is projected to be 24%. If the 2007-2012 deforestation rates continue. This is a total projected forest loss of 21.46 million hectares between 2007-2020. Less than 6% of the historical lowland forest extent might be left in 2020 with the same deforestation rates (and no conservation interventions are taken). Only upland forest and montane forest might fare better with large areas remaining in 2020.

## Conservation goals and projections for 2020

WWF has set goals for the ideal remaining extents of each of the major ecosystems of the Heart of Borneo in 2020. All of these goals were still met in 2012, with the exception of the heath forest goal.

Projections of the 2007-2012 deforestation rates up to 2020 indicate however that these goals will not be reached in 2020 if the current deforestation rates remain high. The good news is that there is a common willingness of the governments of Sabah, Sarawak, Brunei and Indonesia to reduce these deforestation rates and the goals can still be reached if sufficient conservation interventions are in place.

## Projection with 2007-12 deforestation rates

The goals for remaining extents for 2020 are:

Lowland rainforest: 50-60% of historical extent; upland rainforest: at least 80%; montane forest: at least 80%; limestone forest: 60-80%; heath forest: 60-80%; freshwater swamp forest: 50-60%; peat swamp forest: 50-75% and mangroves: at least 80% of historical extent remaining in 2020.

If the 2007-12 deforestation rates continue, then in 2020 the remaining extents will be:

Lowland rainforest: 33%; upland rainforest 71%; montane forests 81%; limestone forest 69%; heath forest 14%; freshwater swamp forest 48%; peat swamp forest 38% and mangroves 78%.

## Projection with conservation interventions

It is still possible to reach the 2020 goals for most of the ecosystems of the Heart of Borneo:

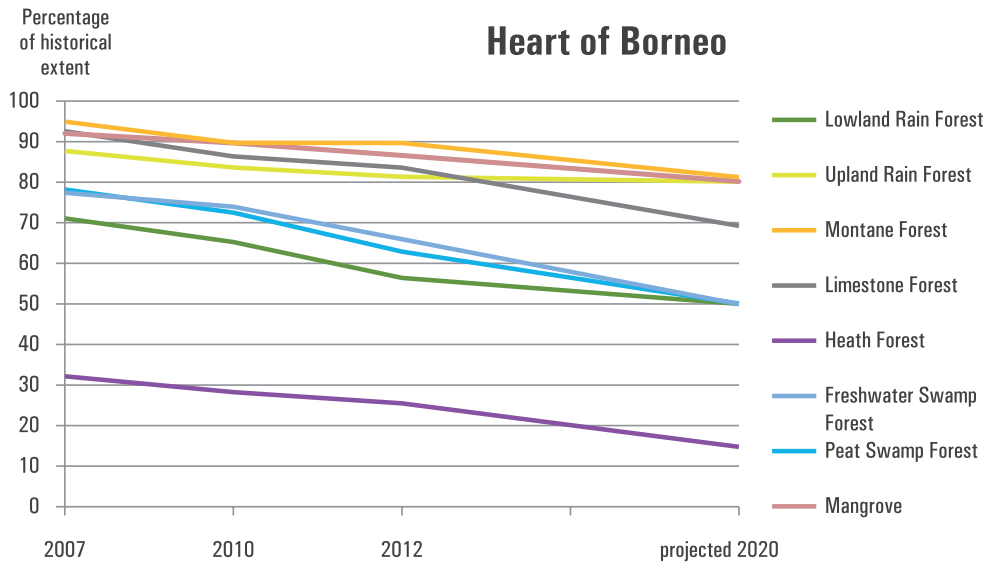
To preserve at least 50% of the historical extent of lowland rainforest, annual deforestation should be below 0.8%;

To retain at least 80% of the upland rainforests, annual deforestation rates should not exceed 0.15%;

Montane forests and limestone ecosystems can be mostly preserved if deforestation rates remain as low as in 2010-12;

Most of the heath forests have gone but 25% can still be preserved only if all deforestation is stopped;

To preserve at least 50% of the peat swamp forest, annual deforestation rates should be below 1.6%.







# PUTTING THE HEART OF BORNEO ON THE MAP

Discussions to the maps

## Lowland rainforest ecosystems

The remaining lowland rainforests are in a variety of conditions, but only about 20% can be considered pristine. Most forests have been subject to some form of timber exploitation.

Lowland rainforests are the habitats of thousands of exclusive animal and plant species that do not occur anywhere else, due to the very specific ecological conditions. Elevation is a key factor in determining the species distribution. Vegetation structure also reaches its highest diversity in the lowlands.

The historic extent and the land cover changes until 2007 were discussed in the previous environmental status report. Between 2007 and 2013 many alterations occurred in- and outside of the HoB. By the end of 2012 56% of the historical extent of lowland rainforest of the HoB remained, which implies a loss of almost 900.000 ha between 2007-2013.

Although many of the lowland rainforests of Sabah were converted before 2007, there were still some large areas left within the HoB in 2007. Many of these areas were deforested after 2007. The deforestation occurred particularly strong in upper Kinabatangan and Segama watersheds in the east and along the Sugutriver in the north. The remaining lowland rainforests are at least still connected to upland forests. The largest stretches are in the middle Kinabatangan watershed and in well-managed areas such

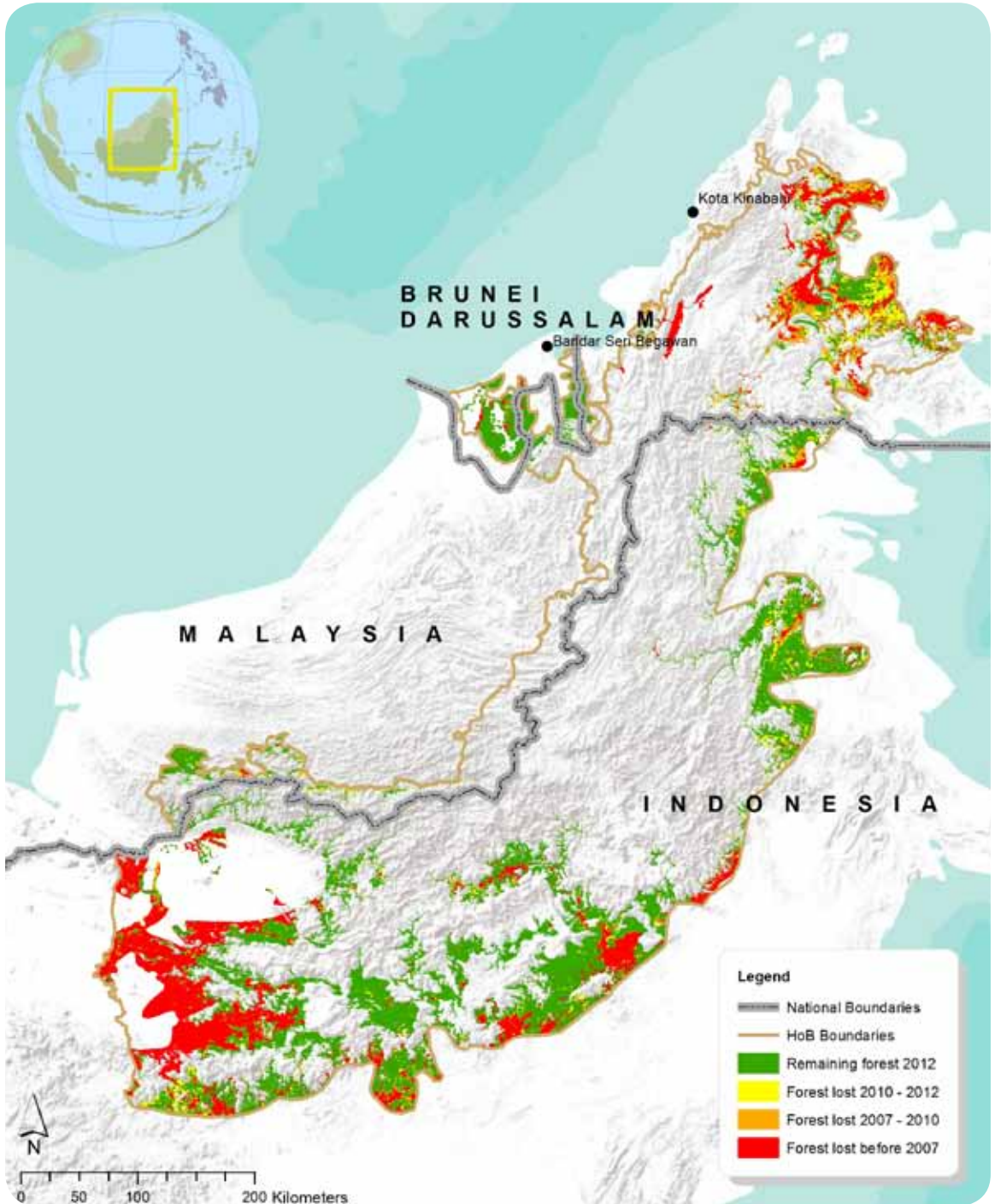
as Danum valley and Deramakot. Along the Labuk river in the north of Sabah are still valleys with lowland rainforest, that likely have unique species compositions.

Brunei has still large areas of lowland rainforests which remained mainly intact between 2007-2013. Some deforestation occurred in the upper Belait area.

Deforestation of small areas of lowland rainforest in the HoB part of Sarawak occurred in many valleys surrounded by upland and montane forests. The largest remaining area of lowland rainforest is in the LanjakEntimau Wildlife Sanctuary and is relatively undisturbed.

The few remaining lowland forests of West Kalimantan appear to be gradually disappearing, except inside in the valleys of the upland protected areas.

Most of the lowlands west of the DanauSentarum complex were converted earlier with only patches left in 2007. About half of these were converted in 2007-2012 and the process continues, which implies that in a few more years there will be hardly any lowland rainforest left in the part of the province. The northern foot slopes of Bukit Baka-Bukit Raya national park underwent



small-scale conversions, probably for shifting cultivation. The best surviving lowland forests are located in between the ridges of the northern and eastern mountains ranges.

The largest extent of lowland rainforest of the HoB is found in Central Kalimantan. The eastern foot slopes of the Muller-Schwaner mountain range, including the Bukit Bati-kap area are covered by wide stretches of lowland forests that are connected to upland and montane forests. The middle Barito watershed has many isolated lowland forests left in the valleys.

The southern foot slopes of the Bukit Baka-Bukit Raya however underwent much forest conversion between 2007-2012. An area of major concern is the upper Seruyan, where much lowland forest conversion occurred between 2010-2013 in a gradual, and thus less detectable, way. Forest conversion in the MuaraTeweh area has been going on for decades and still continues.

East Kalimantan still has vast areas of lowland rainforest, which occur mainly in the eastern part of the HoB. These are the lowlands of the middle Mahakam watershed the lowlands of Barau, and the footslopes and valleys of the northern mountain ranges.

Conversion of lowland forest occurred particularly along the Mahakam river and its tributaries, the Belayan, Senyur and Telen rivers. Deforestation in the Berau area is

generally patchy but occurs at a large scale throughout the area. The Sebuk area and the vicinity of Malinau underwent rather large areas of forest conversion.

The remaining lowland rainforests are in a variety of conditions, but only about 20% can be considered pristine. Most forests have been subject to some form of timber exploitation.

The consequences of the disappearance of this ecosystem can be measured on a global scale as it is home to thousands of species found nowhere else.

Regeneration of lowland rainforest is a very long process and it is not possible to completely restore the original primary species composition and vegetation structure of large disturbed forest areas.

The tropical rainforest is an extremely heterogeneous ecosystem and has many local variations of species composition, with many species found only in a certain part of Borneo. If for instance all of the lowland rainforests of West Kalimantan disappear while all of the remaining lowland rainforests of East Kalimantan are preserved, it still implies the extinction of multiple species.

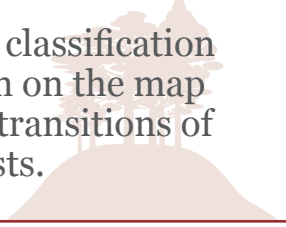




## Upland rainforest ecosystems

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Upland forest is actually a very broad classification and the delineation and identification on the map is based mainly on average elevation transitions of lowland and montane forests.



Upland rainforest has a less complex vegetation structure than lowland rainforest but can still be extremely rich in species. The canopy of this ecosystem has a higher variety of tree species than the canopy of lowland forest as the dominance of the Dipterocarpaceae is less strong.

Upland forest is actually a very broad classification and the delineation and identification on the map is based mainly on average elevation transitions of lowland and montane forests. Geomorphology and soils are major determining factors to the distribution of upland rainforest along the altitudinal gradients. A very wide ecological variation exists within upland forests and many interesting local types can be distinguished.

It is by far the largest ecosystem of the HoB.

Still more than 80% of the historical extent of upland rainforest remained in 2013. It should however be considered that between 2007-2012 a total of more than 600,000 ha was deforested. This might not be immediately noticed on the map, as the conversions were of relatively small areas, but it nevertheless occurred throughout the HoB.

The largest conversions of upland forest occurred in Sabah where the entire area east of the Crocker range was converted before

2007. This area with the town of Keningau in the center has been an important agricultural area for many decades. Conversions between 2007-2012 occurred mainly in the southern interior of Sabah. Along the upper Sembakung river most forests were converted, and the impacts are clearly visible from the turbid water of the lower Sembakung in East Kalimantan. The entire Serudong river valley was converted as well as many forest patches of the Segama watershed. Deforestation is also clearly visible along the Ranau-Sandakan road. Forest conversion declined after 2010.

In Brunei some smaller areas were deforested in the upper Temburong watershed. This is remarkable as the area is protected.

The HoB part of Sarawak is generally mountainous but the elevations of the southern section are largely below 800 m asl. and here are large stretches of upland forests. Patchy forest conversions occurred along many of the edges. The largest conversions occurred in the upper Baram SW of Long Banga and along the Malarang and Baleh rivers.

In West Kalimantan small areas were converted throughout the Nanga Pinoh area, adding up to a rather large total area of deforestation. Along the northern foot

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slopes of Bukit Baka-Bukit Raya also some conversion occurred, but much was converted before 2007.

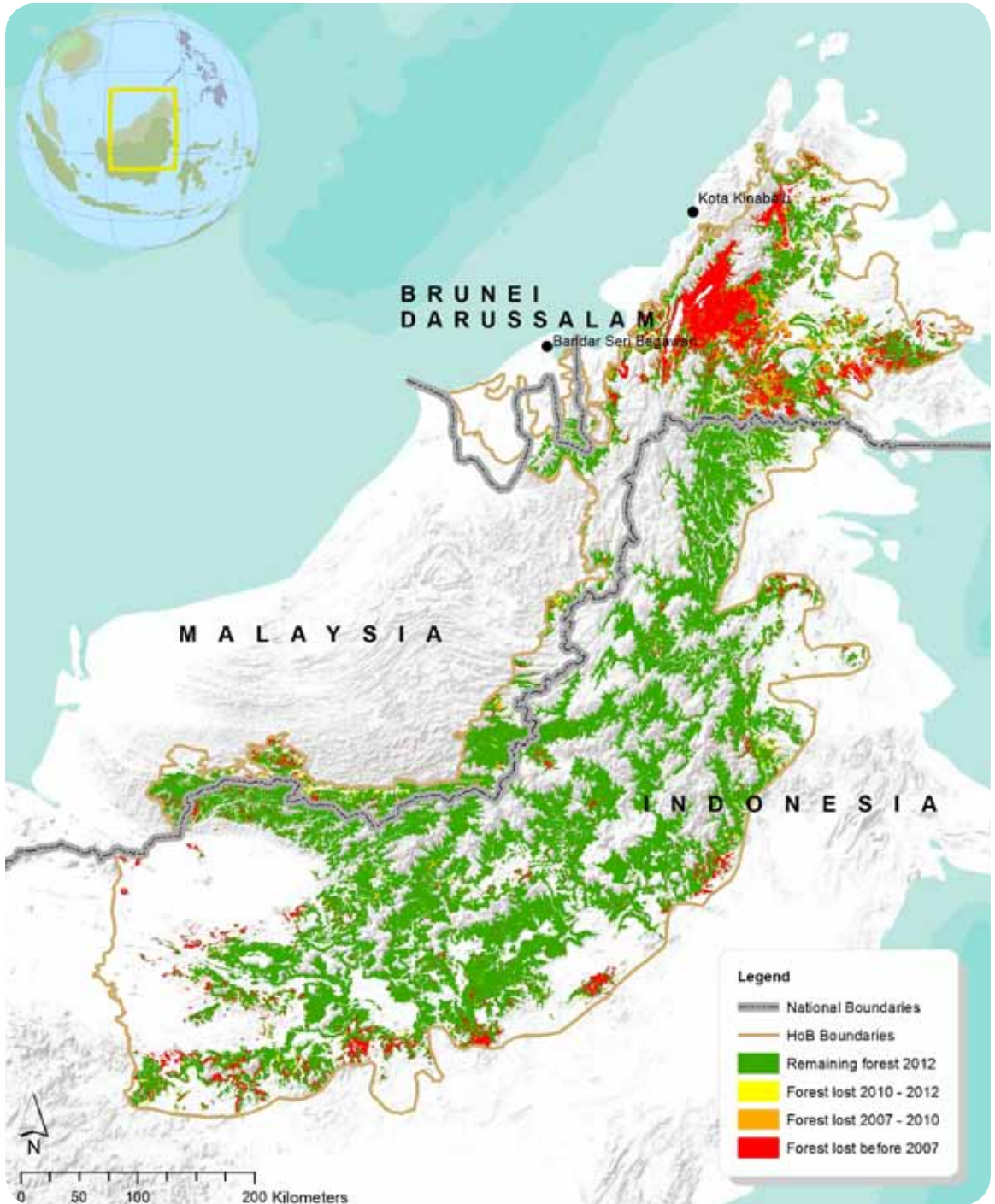
In Central Kalimantan patchy upland forest conversion occurred mainly in the southernmost section of the HoB such as the southern foot slopes of Bukit Baka-Bukit Raya, the upper Seruyan and the upper Samba. In the interior conversion took place particularly along the Joloi river.

In East Kalimantan conversion occurred in small areas throughout the province. Along most of the medium sized rivers such as the Telen, Wahau, Kelai, Malinau and Sebuku small-scale conversion occurred. Along the Kayan and Bahau rivers many patches were converted but mainly before 2007.

Most of the small-scale conversions in Kalimantan comprised opening of new land forest shifting cultivation. (land used for this rotation purpose that was converted less than 10 years ago does not appear as forest in the classification)

Continuation of changes as occurred between 2007-2012 can have large consequences.

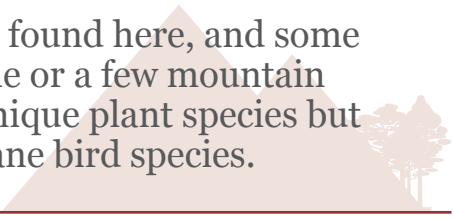
In Sabah it could lead to the loss of many species. The situation in Kalimantan is still relatively safe but should be guarded to avoid too much conversion of the edges where many upland species from lower elevations are centered.



## Montane ecosystems

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Many endemic species are found here, and some species occur only on one or a few mountain summits. These include unique plant species but also endemic montane bird species.



Since most of the mountain ranges of Borneo are inside the HoB boundaries, montane ecosystems naturally are very well represented here, comprising one quarter of the HoB.

Many endemic species are found here, and some species occur only on one or a few mountain summits. These include unique plant species but also endemic montane bird species.

Montane ecosystems remained mainly intact in 2007, and large scale conversions occurred only in Sabah, mainly for the cultivation of temperate vegetable species. These agricultural areas were expanded until 2010, after which no further conversions took place. Still 90% of the historical extent in the HoB remained in 2013.

The upper Padas area of Sabah however needs attention as rather large areas of montane forests were converted here with still some conversion going on.

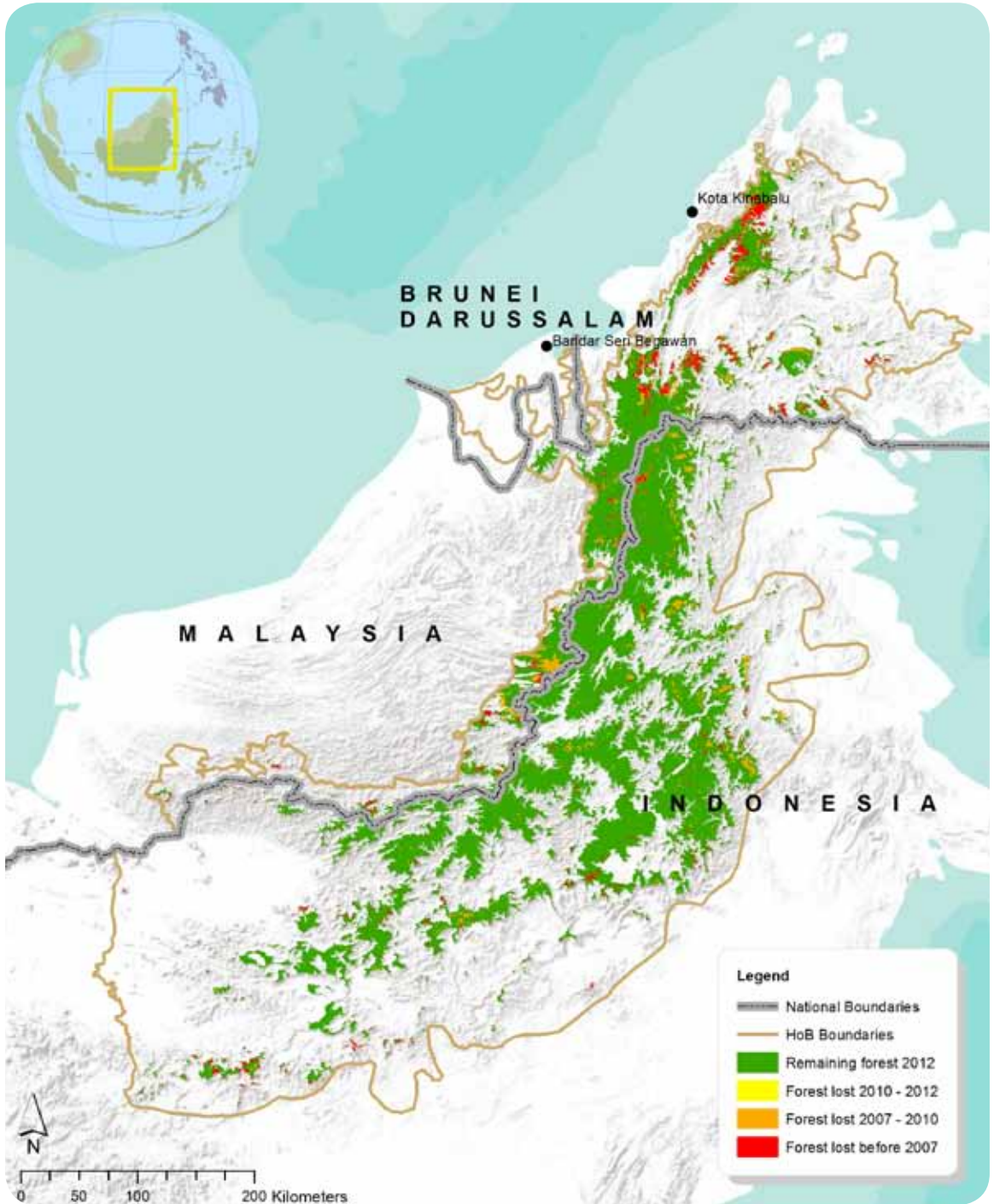
The deforestation of a large area in the Iran Range of Sarawak appears to be related to the harvest of *Agathis* timber. This montane tree species has a high commercial value and is particularly common in that mountain range. Small-scale conversions in Sarawak occurred in the upper Baram and upper Baleh.

In West Kalimantan, rather large areas were converted in the mountains south of Nanga Pinoh. The patchy conversions in the upper Kapuas watershed occurred mainly before 2007.

Rather large tracts were converted along the southern foot slopes of Bukit Baka-Bukit Raya in Central Kalimantan up to 2010. In the upper Barito/Murung area west of Purukcahu numerous small tracts were converted, though mainly for shifting cultivation.

In East Kalimantan patchy conversion occurred throughout the mountain areas. Some of these deforested tracts in the upper Segah and middle Kayan area are related to over-harvesting of montane timber species. Conversion for shifting cultivation in many locations, particularly around KayanMentarang national park, declined after 2010.

The ecosystem can be considered the least threatened of the HoB. However small-scale conversions need to be monitored not only because of species conservation but also to avoid erosion problems that are prone to occur in this fragile ecosystem





# Freshwater swamp ecosystems

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Large areas of freshwater swamps and forests are found only in Brunei and West Kalimantan.

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The soils of freshwater swamps are often extremely rich in nutrients and productivity is very high. Species composition is very different from peat swamp forest and also different, but with some species in common, from any surrounding lowland forest.

Not all natural freshwater swamps are forested and there are usually locations that are permanently inundated which are covered only by herbaceous vegetation.

Large areas of freshwater swamps and forests are found only in Brunei and West Kalimantan.

Smaller areas are often present along many of the major rivers throughout the HoB. However due to the scale and resolution of the images these cannot be clearly displayed on the maps here. Some of these small areas in Sabah and Central Kalimantan are reasonably well documented particularly when these are inhabited by conspicuous wildlife such as proboscis monkeys. Other small riparian freshwater swamps, particularly in East Kalimantan, remain unnoticed and might even disappear. Many of the downstream freshwater swamp areas have been converted to agriculture.

Really large areas of freshwater swamps are only present in Brunei and West Kalimantan.

The Belai watershed of Brunei has extensive stretches of freshwater swamp forest which

have remained mostly intact since historical times. Several spots of deforestation could however be detected not just along the edges but also in the interior, and these should be monitored.

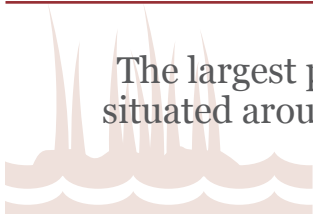
The situation in West Kalimantan is very different. Originally large areas of freshwater swamps were located in the middle Kapuas and Danau Sentarum area. More than half of these areas were converted before 2007 and conversion continued until 2013. This is a gradual process of opening small fields along the edges at a time, but in many locations. If this process continues then only a few small protected areas of freshwater swamps will remain in the near future.

Species composition of freshwater swamp forests differs strongly from place to place. The freshwater swamps of Brunei are completely different from those in West Kalimantan, and the small riparian swamps throughout Borneo are different again. It is therefore not sufficient for biodiversity conservation to rely on the preservation of the Brunei swamps only.



## Peat swamp forest ecosystems

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The largest peat swamp forests of the HoB are situated around the DanauSentarum area of the middle Kapuas basin.

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The peat swamp ecosystems were formed in areas where peat accumulation occurred for thousands of years. The peat is saturated with water and partly inundated for most times of the year. Water inflow is mainly from rivers and direct rainfall, but due to the permanent decomposition of organic material, particularly leaves, the water in peat swamps is acid and typically reddish-brown in color.

Peat swamp forest is a very important ecosystem on Borneo, defining wide landscapes in West and Central Kalimantan. These areas are however not part of the Heart of Borneo, as the defined boundaries of the HoB are located north of the coastal lowlands, following the foot slopes of the interior mountain ranges.

The larger peat swamps of the HoB are located in wide depressions of the landscape along major rivers. Smaller peat swamps can be found behind river levees and even in the high mountains, in locations with high rainfall and little drainage. These small peat swamps, usually with an area of less than 10 ha, are hard to map but are found throughout the HoB.

The peat swamps of the interior have a very different species composition compared to the lowland peat swamp forests of the coastal areas of West and Central Kalimantan.

The largest peat swamp forests of the HoB are situated around the DanauSentarum area of the middle Kapuas basin. These are also some of the best studied peat swamps of Borneo, but unfortunately this fact has not

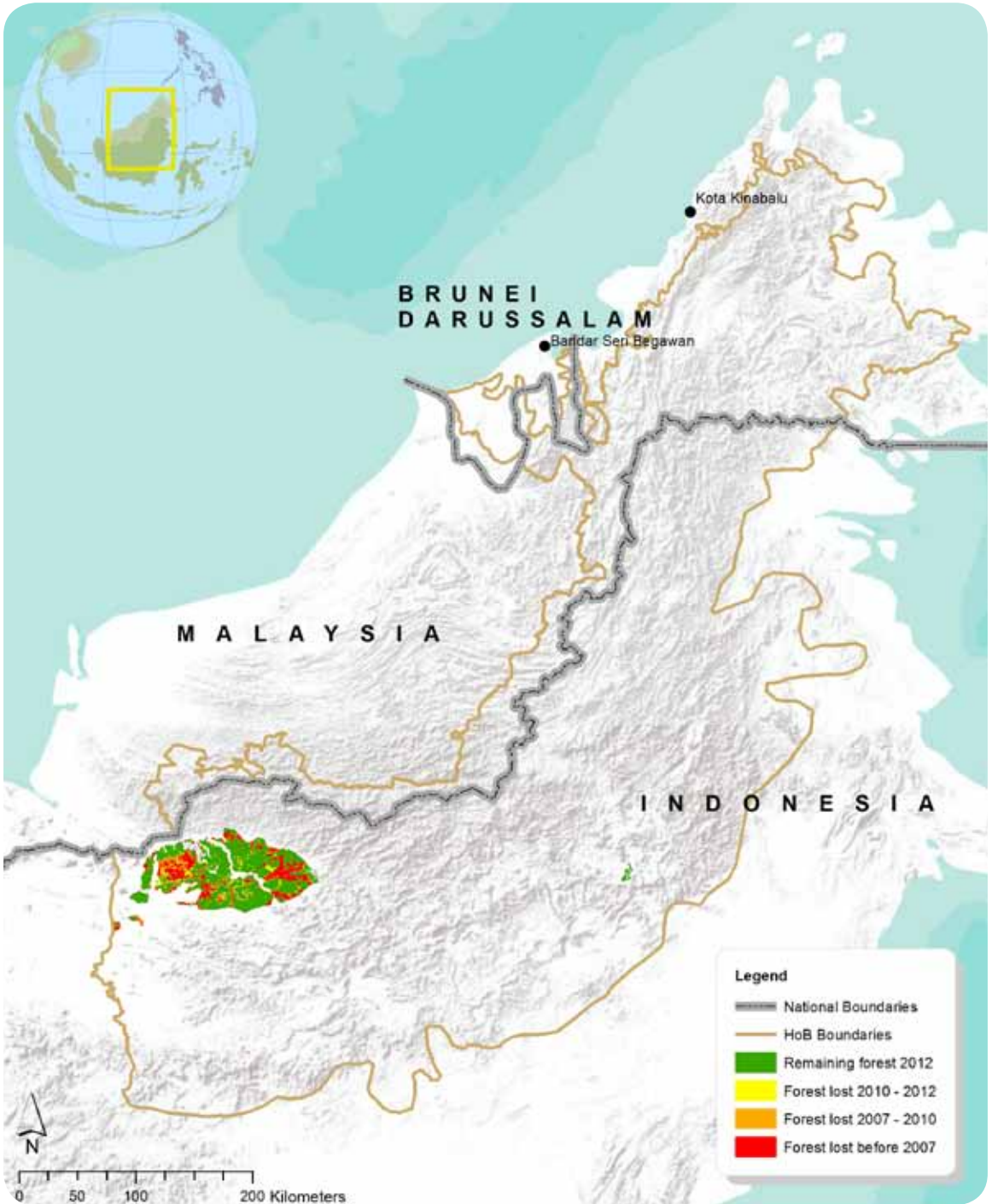
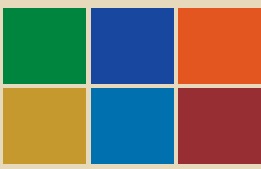
saved them from conversion.

Large areas were already converted before 2007. Conversion of large remaining tracts in the western section continued so that by the end of 2012 the entire area had been converted. In the eastern section conversion of patches occurred, but this area can still be saved.

The middle Mahakam landscape is comparable to the middle Kapuas in that it is also shaped like a wide basin with low elevations. Peat swamp forests are also present in the vicinity of the Mahakam lakes. The largest section of peat swamps is situated around MuaraAncalon and these swamps have not been converted. Development of this area for oil palm plantations was abandoned because of major problems of drainage and perhaps also because of pressure to preserve the unique ecosystem, which is home to the critically endangered freshwater crocodile *Crocodylus siamensis*.


It is true that still large areas of this ecosystem remain in Borneo. The species composition but also the vegetation structure of the interior peat swamps however is unique and incomparable to the coastal peat swamps. In fact these might be considered as two different ecosystems. Even the Kapuas peat swamps differ strongly from the Mahakam peat swamps. It is therefore a conservation priority to protect as much as possible of these peat swamp areas.





# Heath forest ecosystems

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Heath forest is the most threatened ecosystem of the HoB. It is often relatively accessible but cannot stand much exploitation.

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Heath forest is a unique ecosystem that developed on soils that are extremely poor in nutrients. In Borneo these are mainly terrains on sandstone plateaus with typically soils composed of white sand and loam. The vegetation is very different from surrounding forests that developed on the common soil types. The most striking difference noticed is the very high density of trees with small diameters, which often have small leathery leaves. The decomposition of these leaves is slow, resulting in thick layers of humus and reddish colored water draining from these forests. Degraded heath forest might never recover completely, but remain shrub lands for centuries. If disturbances continue than former heath forest can become almost completely devoid of vegetation, leaving large tracts of exposed white sands.

Small areas of heath forest developed throughout the Borneo where the specific geomorphology of sandstone required so. Montane heath forests can be found on small plateaus with high elevations and are often dominated by conifers. River levees in sandstone areas of the HoB are often covered by another type of heath forest. This is the habitat of the famous black orchid (*Coelogyne pandurata*). All heath forest types have small numbers of various species of pitcher plants (*Nepenthes*) in their under storey.

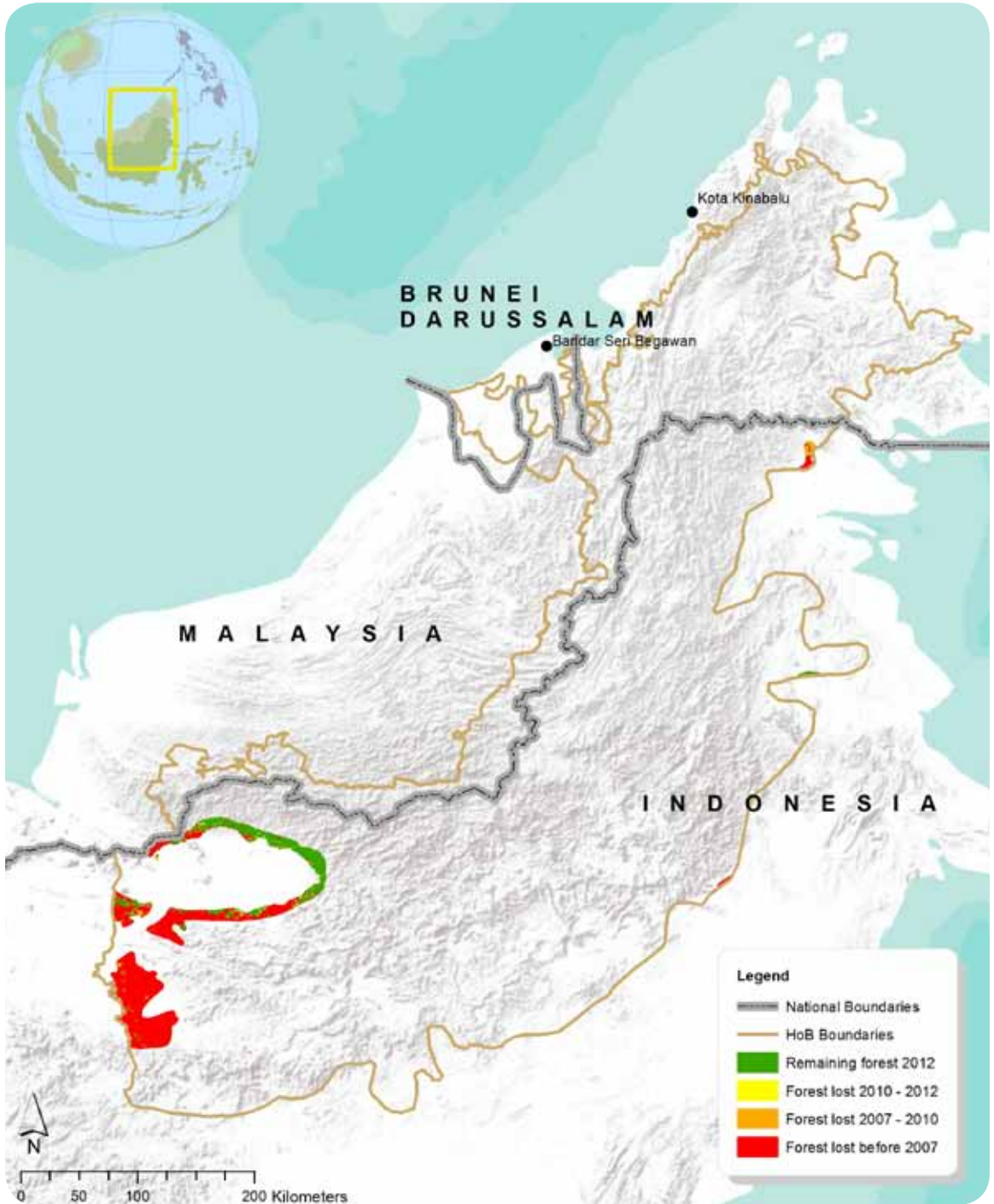
The heath forests of the Maliau basin of Sabah are all but inaccessible to heavy logging equipment and have never been disturbed.

The largest stretches of heath forest of the HoB are in the periphery of the Danau Sentarum of West Kalimantan

Most of the southern and northwestern section of this area was converted before 2007, with a few tracts remaining. Conversion continued from the edges inward after 2008, and in 2013 only a few of the inner and wettest parts remain. The northern and eastern sections were much better preserved until 2007, but then patchy conversion started to occur from the edges, and this still continues, albeit on a smaller scale.

A large area of heath forest used to be present in the Simenggaris area in the north of East Kalimantan. Half of this was converted before 2007, and all remaining heath forest was converted between 2010-2012. All what is presently left is a wide plain of mainly weeds with some open spots of white sand that indicates that this once was a heath forest.

Even though there are many small areas of heath forest left throughout the interior of the HoB, the stretches of heath forest around the Kapuas lakes had its unique ecology of wide heath areas. It is also a crucial part of the landscape that ranges from the lake bottoms to the hills.



## Limestone forest ecosystems

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Entire landscapes defined by limestone geomorphology are found in the Mulu area of Sarawak and the Sangkulirang peninsula of East Kalimantan. The latter is not part of the HoB but is in need of more attention for conservation.

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Smaller limestone formations and outcrops occur scattered throughout the HoB, often in the form of ridges or small hills. Even in high upstream areas surrounded by mountains. Such as for instance the upper Murung area, limestone formations can be found. Given the origin of these formations, being ancient coral reefs, this fact illustrates the complicated geological history of Borneo. Caves have often developed in limestone formations and the locations of these are usually well known to local communities, since edible bird nests can be harvested from here. The smaller limestone formations could not be mapped, but are generally not threatened by conversion.

The limestone forests of the Mulu area in Sarawak are well preserved, not in the least because of income generated from visitors who want to enjoy the natural beauty. It is therefore remarkable that a rather large limestone forest north of Lahad Datu was converted before opportunities for eco-tourism could be explored.

The limestone ridges south of Nanga Pinoh in West Kalimantan are still in good shape and completely undisturbed.

Along the middle Mahakam are several rather large complexes of limestone ridges which were partly disturbed before 2007. Although mainly remaining intact afterward, still a few deforestation spots could be detected.

It should be kept in mind that deforestation of limestone forests is almost irreversible.

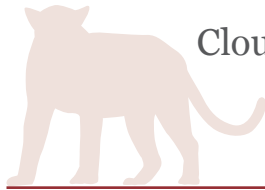
The limestone ridges and cliffs along the Kayan and Segah rivers were largely intact in 2007. Afterward deforestation occurred of rather large tracts of the more accessible locations. This appeared to be caused by opportunistic or illegal logging. [even though the volume of timber of these forests is low] The limestone complexes of these areas have never been seriously investigated even though they are clearly visible from the river.





# Viable populations of clouded leopard

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## Clouded leopards are among the top predators of Borneo

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Clouded leopards appear to be present in most of the forested areas of Borneo. Densities are always very low, as the species is territorial and leaves a solitary life most of the time. 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 and clouded leopard have been recorded from coastal peat swamp forests to mountain ridges more than 1500 m above sea level. The knowledge on clouded leopards has increased significantly in the last 15 years due to various research both on genetics as well as behavior. Sizes of territories are better understood which made it possible to make decent estimates of the total area required for a viable population. For an animal of these characteristics it is assumed that a population should number at least 50 individuals to remain viable in the long term. Areas should not just be large enough but also be devoid of large-scale disturbances, since clouded leopards are very sensitive to this and might not reproduce in such situations. The map of suitable clouded leopard habitats was therefore 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. The minimum area would be between 350 and 625 km<sup>2</sup> of uninterrupted forest blocks.

This is why the situation in Sabah appears as a drastic reduction - not because the area was completely deforested but because it

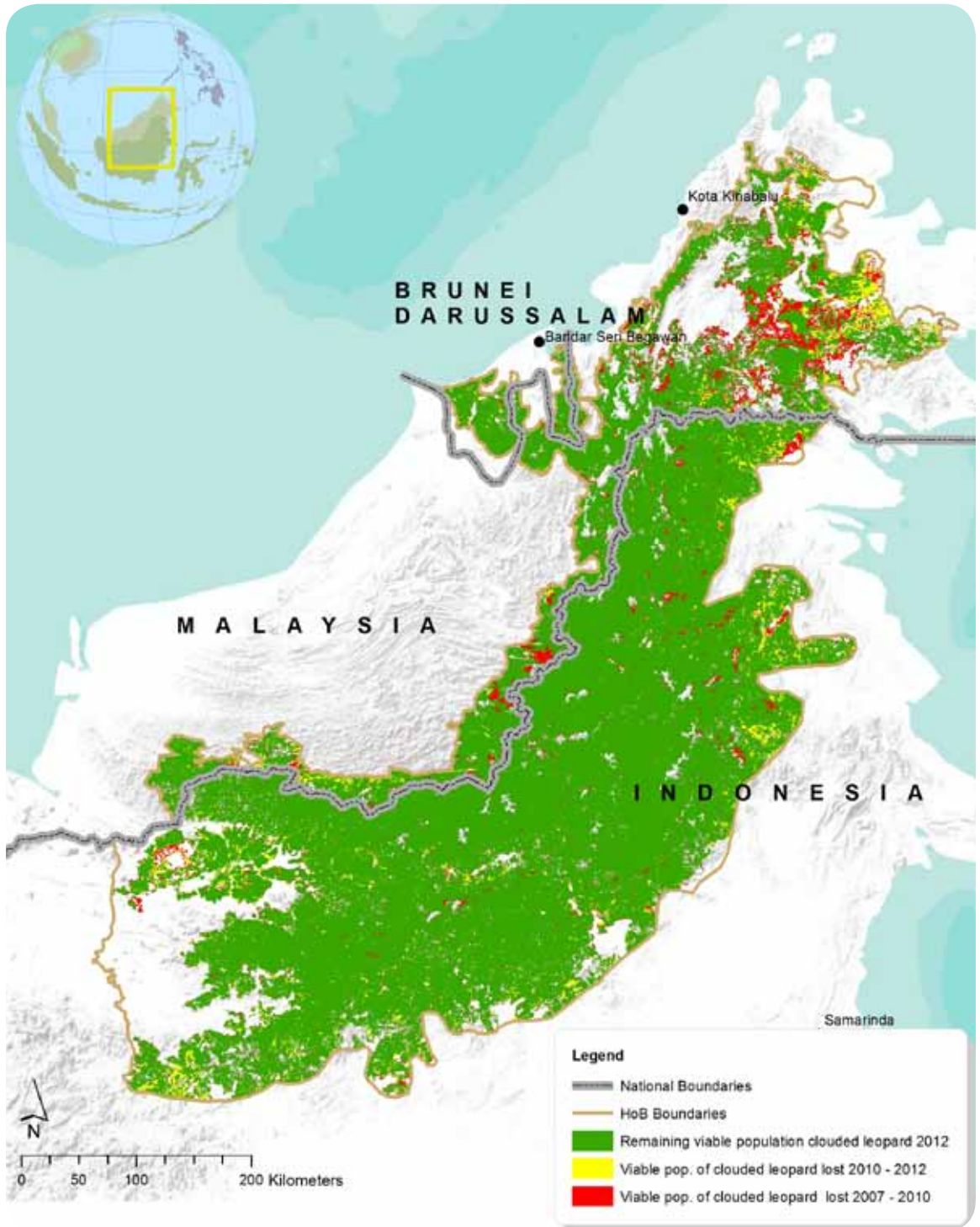
became fragmented and much less connected than before. This could have a negative impact on the survival of healthy populations of clouded leopards in the long term. The Kinabatangan watershed was particularly strongly affected and although solitary animals will continue to live there for many decades, this species might in the end disappear from here.

The upper Balui and Malarang sub-watersheds in Sarawak became strongly fragmented with large open areas between 2007-2010. This part of the HoB connects to forest areas that are still largely forested.

It is possible that clouded leopards become locally extinct in most of the lowlands of West Kalimantan. Nearly all of the western part of the HoB, particularly the area west of Danau Sentarum is severely fragmented.

The situation in Central Kalimantan looks generally much better for the clouded leopard, although the deforestation and fragmentation in one part, the upper Seruyan, is quite alarming.

The edges of the HoB part of East Kalimantan appear to become highly disturbed habitats for clouded leopards. Indeed several cases were reported from these areas of solitary clouded leopards entering villages or fields. The Berau and Sebuku districts underwent much recent fragmentation. Some of the many unsuitable tracts in the interior of the province might recover with secondary forests.



# Orangutan

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The HoB comprises predominantly highlands and mountains, and is therefore not the most suitable habitats for orangutans. Nevertheless most of the lower areas were historically inhabited by populations of orangutans. Forest conversion has severe impact on orangutan populations. Even good-willing plantation companies that set aside conservation areas can often not guarantee the survival of an entire population except for a few individuals. Orangutans require large areas to find enough fruit trees, and most tree species of Borneo bear fruit only during relatively short periods. The HCVF areas of plantations are often rather narrow strips of forest and even though companies went all the way to ensure connectivity to forest areas behind the plantations, it remains a fact that part of the foraging area of the orangutans has disappeared. On the other hand, forests that are exploited by logging companies can often still support orangutan populations.

In Sabah large areas of orangutan habitat were converted between 2004-2007. This process appeared to have continued afterward and particularly the habitats in the eastern and central part of Sabah were further reduced, while in the western part such as the Crocker range the habitats were saved. The orangutan habitats around Danum valleys are still in good conditions, but everywhere along the edges habitats were converted.

Orangutan habitats of the HoB part of Sarawak exist only in the south, particularly the Lanjak-Entimau and Batang Ai conservation areas. The situation has been stable after 2007 with no further habitat conversions.

In West Kalimantan surprisingly many tracts of orangutan habitat were converted in the Danau Sentarum-Betung Kerihun

corridor between 2010-2012. In the middle Melawi and Sebut areas rather large areas of orangutan habitat were lost before 2007, but nowadays the situation appears to be relatively stable.

In the HoB part of Central Kalimantan many rather large patches of orangutan habitat in the upper Seruyan were converted before 2007, and this occurred again albeit at a smaller scale, between 2010-2012.

The HoB part of East Kalimantan has only relatively small areas of orangutan habitats and even these have been subject to conversion and hunting. The upper Belayan used to be an important habitat, but many large patches were converted between 2010-2012. Individual orangutan are still living in a number of conservation forest strips, but it will be very difficult to retain them as a viable population.

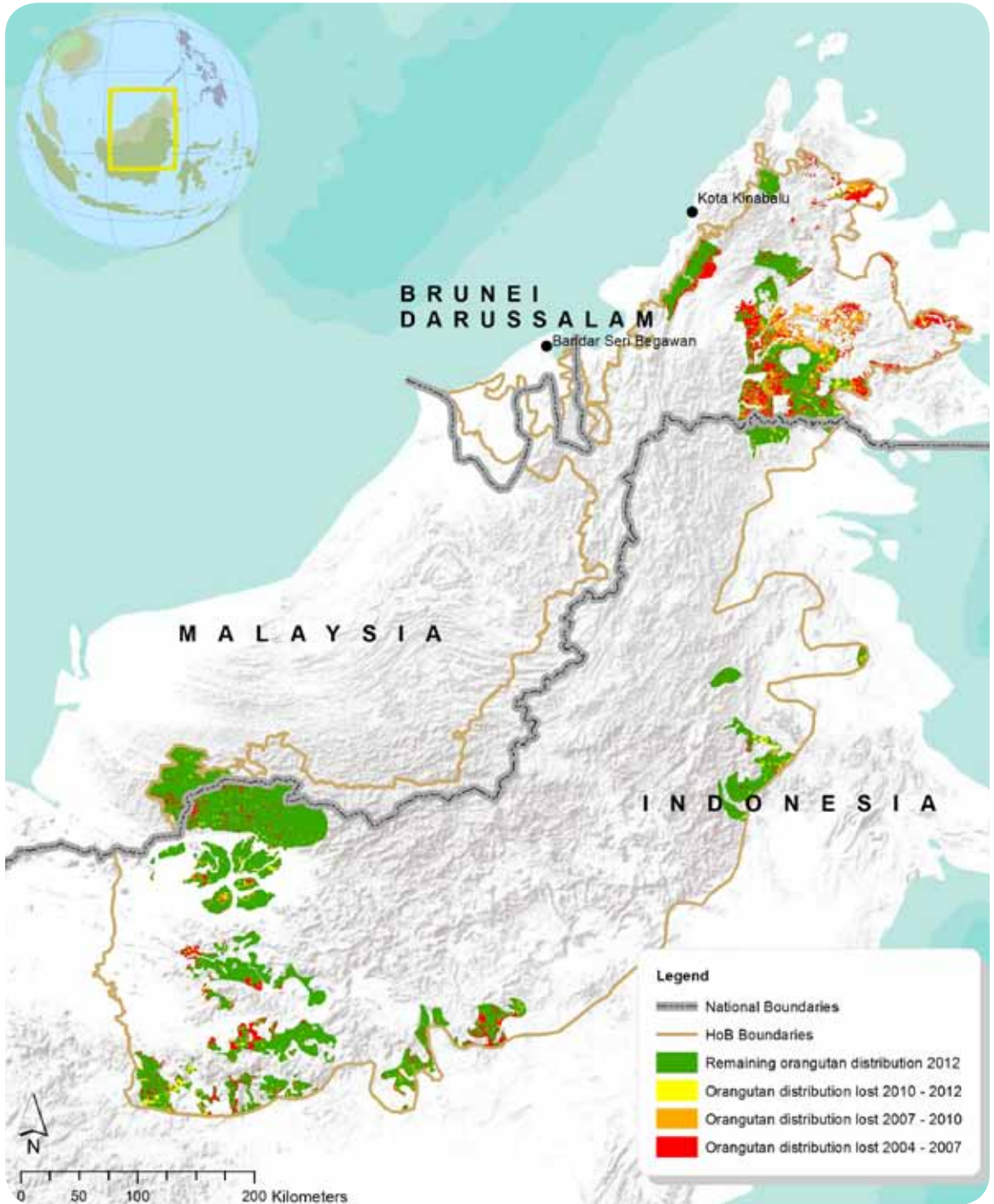
In the Kelai areas Segah of Berau also occurred conversion of habitats.

The Sebuorangutan distribution is a strange case. The remaining habitats are in reasonable good condition, but during several surveys in the last years, not a single orangutan could be found. Hunting was reported to be rampant in this area.

Nowadays three sub-species of orangutan in Borneo are distinguished: *Pongopygmaeus pygmaeus*, *Pongopygmaeus wurmbii* and *Pongopygmaeus morio*. The population of the subspecies *pygmaeus* is the smallest and was severely reduced until 2010, after which the situation has somewhat stabilized.

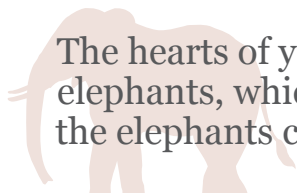
The third subspecies *morio* was considered the least threatened but in recent years their habitat and distribution has diminished much more than expected.





## Bornean elephant

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The hearts of young oil palms is very much liked by elephants, which leads to conflicts with parties that the elephants consider as food-providing intruders.

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The elephants of Borneo (*Elephas maximus borneensis*) always had a limited distribution concentrated in the south-eastern section of Sabah. This can be explained by the theory that the first elephants might have been released at the east coast of Sabah. A discussion on the issue was provided in the previous environmental status report.

The total elephant population appears to be stable, but the distribution and suitable habitats have been further reduced during the last five years. Killing of elephants did occur but on a relatively small scale. Most of the elephants that lost their homes moved to other areas, which have become increasingly less available.

Many elephants moved into the Kinabatangan area, which might now become overpopulated.

The connectivity between the remaining populations is also still decreasing. This particularly a very important problem between the Kinabatangan and southern areas.

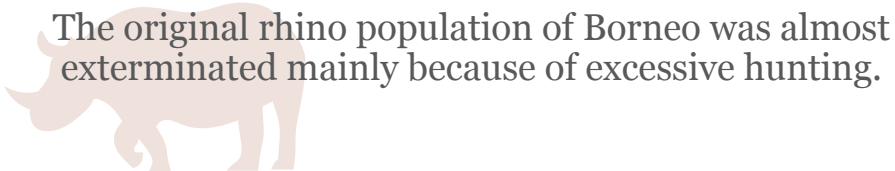
The connectivity between Sabah and the East Kalimantan habitats of Sebuku is also threatened. This could result in the disappearance of all the elephants of Indonesian Borneo, as this population needs to move between the Sebuku habitat and the southernmost part of Sabah to find sufficient food sources throughout the year.

The extent of suitable habitats has decreased in areas where the forests were converted into plantations that are not accessible to elephants. The hearts of young oil palms is very much liked by elephants, which leads to conflicts with parties that the elephants consider as food-providing intruders.



# Rhinoceros

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The original rhino population of Borneo was almost exterminated mainly because of excessive hunting.

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The major issue to conservation of the rhinoceros in Borneo is not the lack of habitat or decreasing distribution range, but quite simple the very low number of remaining individuals. The original rhino population of Borneo was almost exterminated mainly because of excessive hunting.

Monitoring the forest cover of the distribution range however gives a good indication of potential disturbances to the last rhinos there. Minor forest conversions occurred between 2010-2012, but mainly at the edges.

It is still possible for some of the remaining rhinos to move to additional suitable habitats in the the interior of Sabah, although they will have to cross through a fragmented forest landscape.

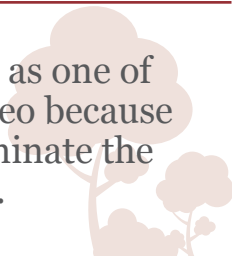




# Endemic Dipterocarpaceae

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The Dipterocarpaceae can be considered as one of the most important plant families of Borneo because of the many tree species that usually dominate the lowland and upland rainforests.



The Dipterocarpaceae can be considered as one of the most important plant families of Borneo because of the many tree species that usually dominate the lowland and upland rainforests. Although several species are very common and well-known timber trees, Borneo has also many endemic species with a limited and disjunct distribution. Some species are even classified as “hyper-endemic”, which means that they are found only in a single or a few small areas. These species deserve special attention as they are easily threatened by extinction. Most Dipterocarpaceae have commercial values and logging companies usually group several species in single classes, such as “red meranti”, “white meranti”. Hyper-endemic species can, whether or not accidentally, fall in these classes and be harvested.

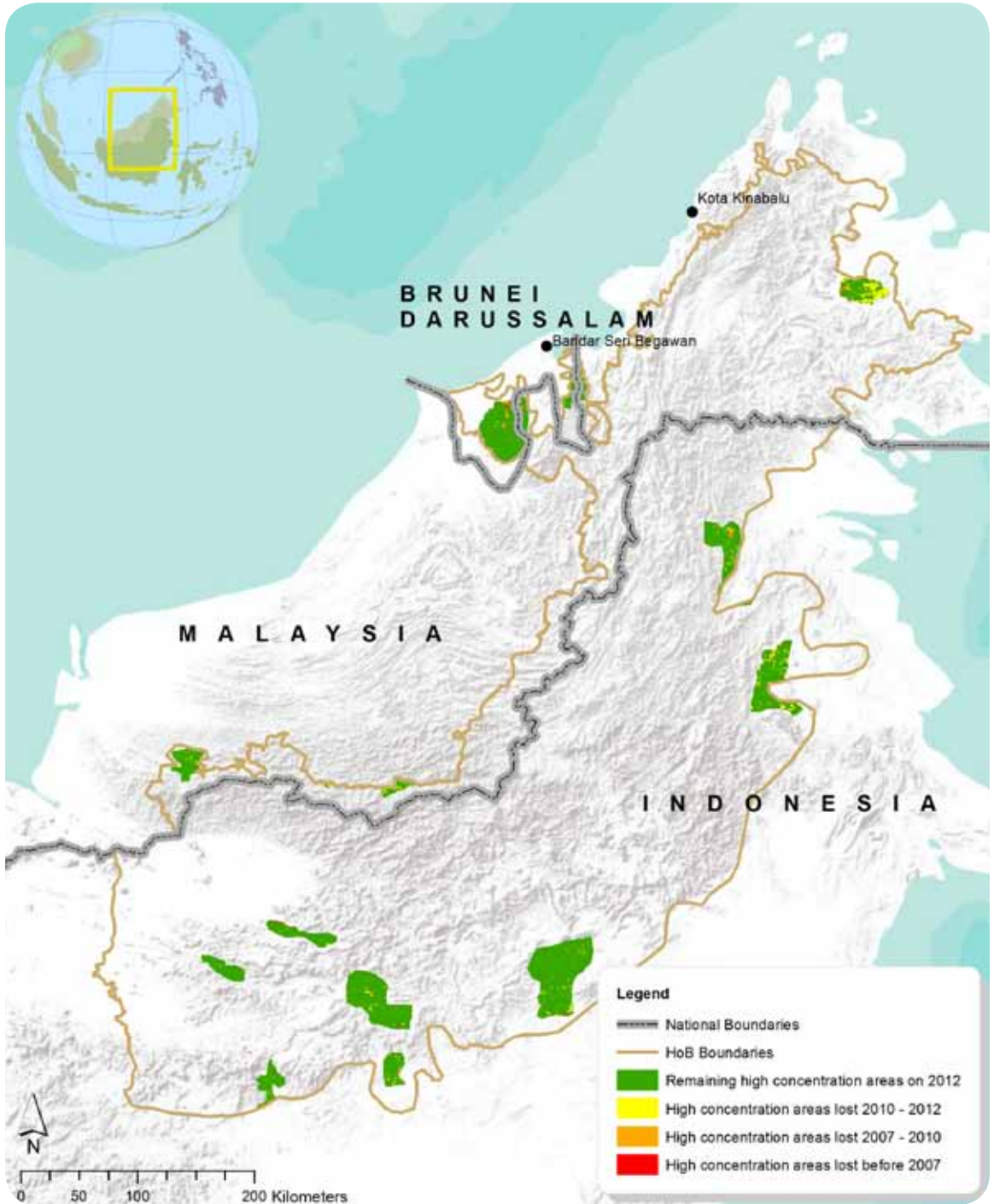
Endemic Dipterocarpaceae are present throughout the forests of Borneo but certain areas have high concentrations of endemics. These are usually wide lowland valleys and the foot slopes of wide uplands. The high concentration areas were tentatively

mapped by combining geomorphology information with distribution records from literature and field surveys.

The HoB has several areas with high concentrations of endemic Dipterocarpaceae. Many of these underwent only a limited area reduction during 2007-2012, which is quite remarkable as most of the locations are outside protected areas. Their remoteness makes these locations a less attractive target for plantations or even logging.

More accessible areas such as the upper Kelai and Segah in Berau however were partly converted between 2010-2012.

It might be possible that this could cause the local extinction of endemic species before their actual discovery.



## Endemic Fagaceae

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The species composition of Fagaceae and other plant families in the western part of Borneo is to a certain extent different from that in the eastern part.

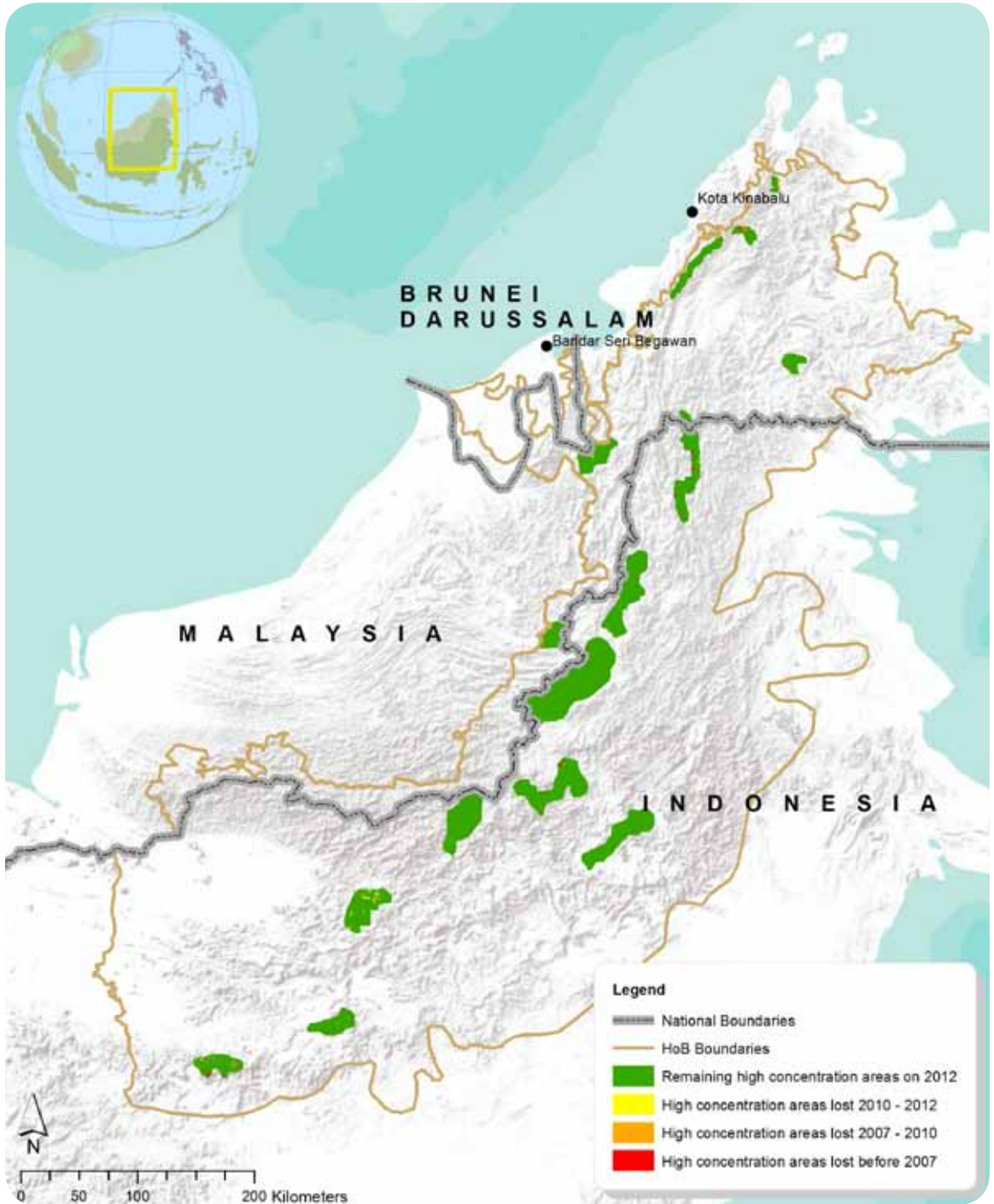


The Fagaceae is another important plant family in Borneo that usually make up a large section of the trees of the montane forests. At higher elevations these species are often dominant or co-dominant with the Myrtaceae. The Fagaceae are usually very common in upland forests, particularly in areas with less fertile soils. In lowland forests Fagaceae are usually common smaller trees of the lower canopies.

A high number of endemic species are found on Borneo and most of these endemics are montane species. Hyper-endemism is probably not an issue with the Fagaceae, and most of the montane areas are wide and connected. 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. The map of high concentrations of endemic species in the HoB was made in the same way as for the Dipterocarpaceae.

Most of the locations are within protected areas and reduction of these areas was very limited. The locations in the upper Kapuas are of West Kalimantan should however be monitored. The species composition of Fagaceae and other plant families in the western part of Borneo is to a certain extent different from that in the eastern part.





# Endemic Nepenthaceae

The Nepenthaceae are good indicators for the condition and protection of fragile ecosystems.



The Nepenthaceae or Pitcher Plants are plant species that grow in extreme conditions with a very limited availability of nutrients such as heath soils and mountain summits. The species are adapted to these conditions by being able to extract nutrients from insects and other animals that get caught in the specialized pitchers. The Nepenthaceae are good indicators for the condition and protection of fragile ecosystems. The species of this plant family that are endemic to Borneo in particular are found only in very specific habitats.

The HoB has several *Nepenthes* species that are extremely rare and hyper-endemic, with species such as the famous giant *Nepenthes rajah* known only from a few spots on mount Kinabalu. The distribution locations of most of the hyper-endemic are well known and are frequently investigated. Many of the other endemic Nepenthaceae such as *Nepenthes veitchii* are less known though new records occasionally are found during surveys to remote locations.

Areas with concentrations of endemic Nepenthaceae were mapped mainly by using the distribution records from literature and field surveys. All of these areas encompass fragile habitats of upland sandstone plateaus as well as steep slopes and summits of mountains in the HoB. Most of these sites are within protected areas. However some of the areas, particularly in Kalimantan, are not strictly protected; this includes the area with the previously only known locations of *Nepenthes campanulata*.

A number of tracts were converted in Sabah between 2007-2010. This occurred mainly along the edges of the eastern concentration area of the Crocker range that is outside the national park. Some conversion also occurred in the upper Padas area.

In Central Kalimantan several tracts have been converted along the southern slopes of Bukit Baka - Bukit Raya. This process started already several years before 2007 and continued until 2011. Currently this national park appears to be better protected as no further conversions were recorded.

In East Kalimantan spots were converted in the mountain ridge north of Wa'yagung in KayanMentarang national park and in the southern part of the Apokayan. These were shifting cultivation field and some large landslides. A recovering landslide terrain where the top soil has disappeared is actually a good habitats for certain *Nepenthes* species which are often among the first re-colonizing plants here.

Concluding, it can be asserted that the conversions and habitat disturbances occurred mainly with the more common endemic species that are known from several locations. The rarest species are well protected though with some exceptions. The situation is critical with very high risk of extinction for *Nepenthes clipeata* which is only known from a single small area in West Kalimantan.



## Banteng

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The distribution of these wild cattle is still not completely understood but it is assumed that bantengs were formerly more widespread in the coastal regions of Borneo that have since been cultivated.



The wild cattle from Borneo, the banteng or tembadau (*Bos javanicus*) are typical forest edge herbivores, foraging mainly by grazing and browsing. Their preferred habitats are lowland and upland forests with an open vegetation structure. Dry forests with open spots of grassland and shrubs are their ideal habitats. These are usually areas of former but long-time abandoned shifting cultivation, and the grasslands are often retained as such through occasional burning by local communities. However this does not involuntarily imply that all of these secondary forest landscapes in Borneo are home to bantengs. The distribution of these wild cattle is still not completely understood but it is assumed that bantengs were formerly more widespread in the coastal regions of Borneo that have since been cultivated.

A reliable distribution for Borneo map has never been made and the current attempt is based mainly on records from “grey literature” and surveys.

The banteng distribution of Sabah is the reasonably well documented, starting with a large faunal survey in 1982. The banteng population of KayanMentarang is rather well known; here is a large population living around the (artificial) grasslands of the upper Bahau, with smaller groups in some other locations of the national park. Banteng records from other parts of Kalimantan are usually made on an ad hoc basis. Occasionally records appear from a few bantengs seen in the interior of Central Kalimantan. Documentation of banteng distribution from the 1930's indeed indicate many locations in Central and East Kalimantan. A number of these populations appear to have gone locally extinct since then. Bantengs are hunted in an opportunistic way for their meat but particularly for trophies.





# Lowland forest in protected, logging and plantations

## **protected:**

Only few of the lowland rainforests of the HoB are inside protected areas.

Small areas of pure lowland rainforest, below 300 m asl, occur in Danum valley in Sabah. The Temburong district of Brunei has a large area of protected lowland rainforest. Other small protected areas are present in the upstream borders with Sarawak.

Batang Ai and LanjakEntimau in Sarawak have significant areas of lowland forests very rich in species. The lowland forests of BetungKerihun are restricted to the river valleys of this mountainous national park. Bukit Baka Bukit Raya has large stretches of lowland forest on the wide southern foot slopes. The other protected areas of Kalimantan are mainly above 300 m asl and have only a few lower river valleys. In KayanMentarang for instance, there are a few tracts of lowland forest in the eastern Tubu area and along some tributaries of the Bahauriver.

## **forest under logging concessions:**

The only lowland rainforest outside protected areas in the HoB part of Sarawak is located in the river valleys of the upper Rajang watershed.

A large part of the remaining lowland rainforests of Kalimantan are inside active logging concessions. Selective logging 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.

The HoB part of West Kalimantan has large areas of lowland logging concessions in the Sintang and Melawi areas.

Most of the lowland rainforests of the HoB are found in Central Kalimantan and the largest areas are inside logging concessions. These include nearly all of the lowland south of Bukit Baka Bukit Raya and the upper Katingan in

the southernmost section of the HoB, but also most of the lowlands of the interior.

A large part of the lowland forest of the upper Mahakam area of East Kalimantan are inside logging concessions. Almost all of the lowland forests of Berau (upper Kelai and Segah rivers) are inside logging concessions as are the lowlands of the middle Kayan and Malinaurivers further to the north.

## **forest in plantations (thus will be converted):**

Several areas of lowland rainforests within the HoB are inside inside plantation concessions and are in the process of being converted.

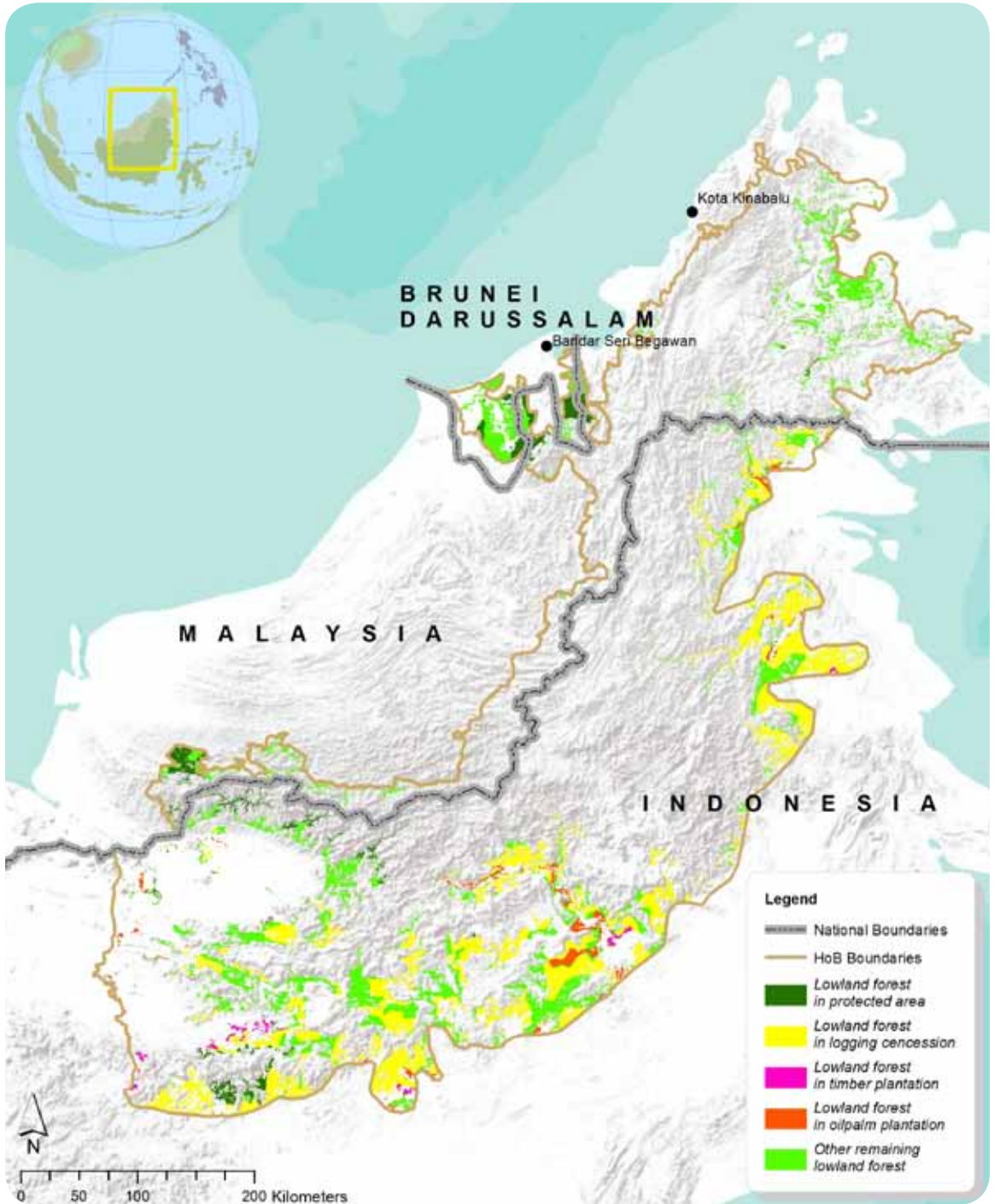
Many of the last tracts of the lowland forest west of DanauSentarum will be converted to oil palm plantations. Several areas in the south of West Kalimantan are to be converted to pulpwood plantations. In this area it particularly Pinus that is planted, while otherwise it is usually Acacia.

In the Seruyan area of Central Kalimantan are several smaller plantation concessions to convert lowland rainforest.

Plantation development and expansion in the Mahakam watershed of East Kalimantan has been going on for more than decade. Here are large areas of oilpalm plantations that will further convert lowland forest. The first oilpalm plantations in Malinau district and the Sembakung area were established some years later than in the south, but are now expanding.

## **remaining, with unclear status:**

Large areas of lowland rainforest are currently not inside logging or plantation concessions but all of these lands are allocated to a form of land use in the various spatial plans of the governments. Most of these areas in Kalimantan are allocated as limited production forest and are thus supposed to remain covered by forest, but there are also some areas that can be converted.



## Upland forest in protected, logging and plantations

Nearly all of the land in East Kalimantan between the highest mountain ridges in the west and the lowlands in the east is covered by upland forest.



### protected:

The total area of upland rainforest inside protected areas is rather large but probably not sufficient for adequate conservation of the entire ecosystem and all of its species in the HoB. Several forest areas however that are currently not strictly protected will still be preserved in some kind of conservation status to function as erosion- and hydrological protection on steep slopes.

The upland forests of the Crocker range of Sabah are all protected, as are the uplands of danum valley and Maliau. The status of the largest areas in the interior of Sabah however is unclear and part of it might become subject to conversion once there is no more lowland left to be developed.

The wide upland forests of LanjakEntimau and Batang Ai in Sarawak are inside these protected areas but otherwise hardly any uplands 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.

Most land of BetungKerihun 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 forests of West Kalimantan are strictly protected,

though several areas will probably retained as “protection forest” (hutanlindung).

Upland rainforest is the largest ecosystem of the HoB part of Central Kalimantan. The area that is strictly protected will increase once the Muller-Schwanner conservation initiative gets implemented.

Nearly all of the land in East Kalimantan between the highest mountain ridges in the west and the lowlands in the east is covered by upland forest. The area inside Kayan-Mentarang is strictly protected.

Danum, Maliau, Crocker range, LanjakEntimau&Batang Ai, LanjakEntimau, BetungKerihun, Bukit BakaBukti Raya, Muller-Schwaner, KayanMentarang

### forest under logging concessions:

The highest volumes of commercial timber are harvested from lowland rainforests where the highest densities of Dipterocarpaceae are found. Now that most of the lowland forests of Borneo have been logged, logging companies operate in the upland forests, their second best option. Upland forests generally have lower densities of commercial tree species and are more remote. The geomorphology of upland forest landscapes is more complex than the lowlands which implies that certain parts of the





areas cannot be logged without high risks of soil destruction or terrain degradation.

In West Kalimantan relatively few logging companies are currently active within the HoB. This is mainly because the remaining upland forests are all remote locations with limited accessibility that makes it difficult and expensive to transport logs to coastal areas.

The situation is different in Central Kalimantan, where several rivers that are still wide even far upstream 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 Central Kalimantan.

In East Kalimantan, logging concessions have been operating along the Mahakam river and its tributaries for several decades. Now that all lowland forests of these areas have been logged, concessions have expanding to the uplands and most of the upland forests being harvested. Further to the north the development of large-scale commercial logging started later (in the 1990's) but has since then rapidly expanded to most of the lowland and from there into the uplands.

### **forest in plantations (thus will be converted):**

Oil palms grow best at sites with low elevations and high volumes of rainfall throughout the year. Soil fertility is hardly an issue to companies as profits are thus high that they can afford it to grow the oil palms completely on fertilizers. The upland rainforests, which grow on land above 300 m asl, are therefore only marginally suitable for oil

palm plantation development. The upper elevation limit for productive oil palm is at around 500 m asl.

Some upland forests at lower elevations edging lowlands have been converted for oil palm plantations in Sabah and West Kalimantan. No oil palm plantations exist that are entirely in uplands.

Several upland forest areas in the interior of Central Kalimantan are inside oil palm concessions. These are interesting to companies particularly because of the favorable locations along the Barito and Murung river and are part of lowland plantations.

Certain tree species planted for pulpwood production can grow on higher elevations but fastest-growing species that are most profitable to companies (*Acacia* & *Albizia* spp.) are mainly lowland species.

A relatively large area of upland forest in the upper Seruyan (Arabela) area in West Kalimantan is processed to be converted to pulpwood plantations. The species usually planted in the upland plantations of West Kalimantan is *Pinus merkusii*.

### **remaining, with unclear status:**

#### **Sabah:**

In Sabah nearly all of the upland forests outside of protected forest is allocated as in production forest concessions "Forest Reserve" class II- Commercial forest

The upland forests of the upper Temburong area in Brunei are not strictly protected, but are still to be preserved as protection forest for the healthy landscape ecology functioning.

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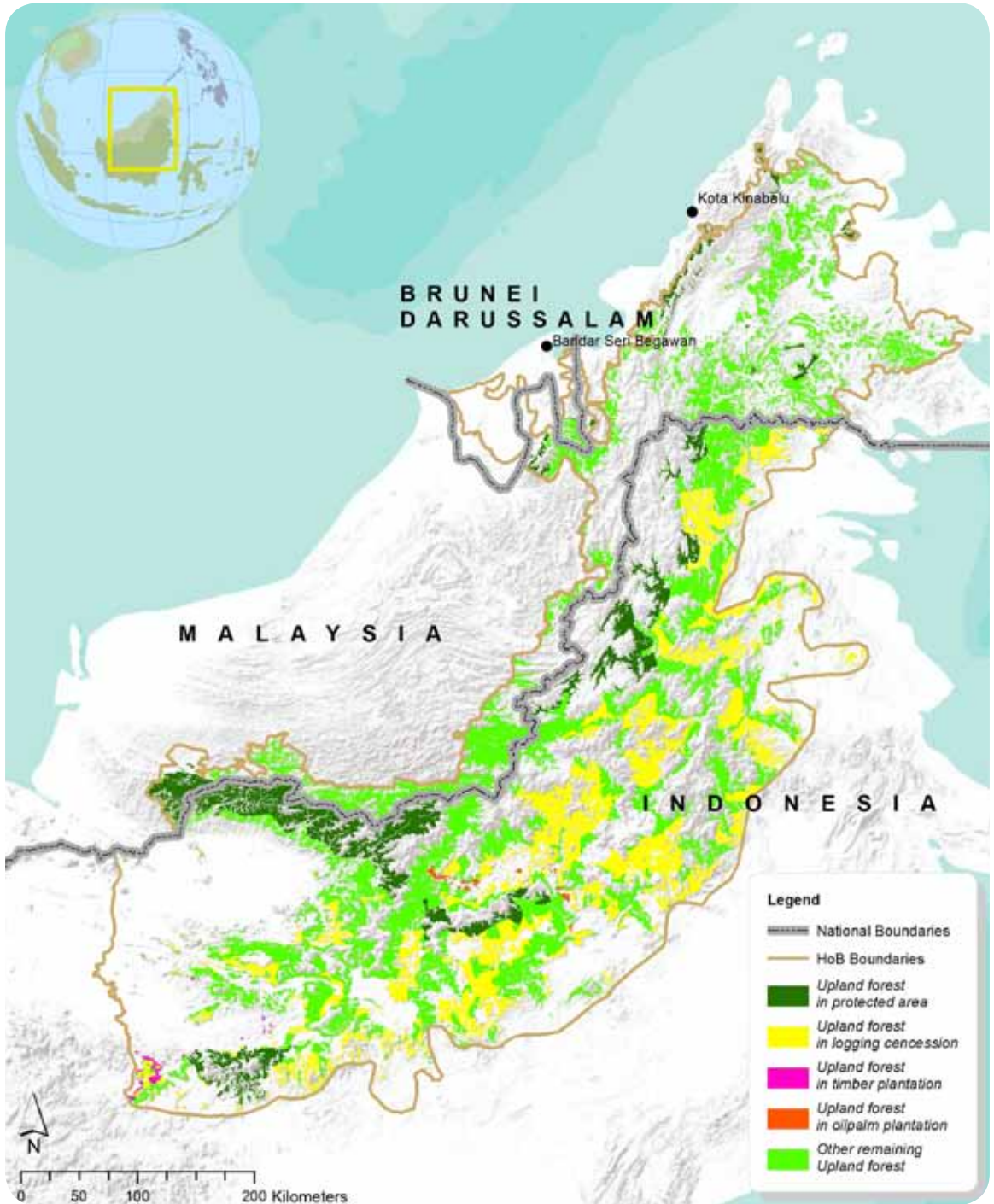
Most of the upland forests of Sarawak are not protected. The current status of most of these forests is production forest of which the largest part will be retained as forest.

large areas of upland forests to the east of the Danau Sentarum- Betung Kerihun corridor and south of the Kapuas river in West Kalimantan are currently not exploited in concessions. By far the most of these forests are allocated as limited production forest and protected forest.

Central Kalimantan has large areas of upland forests in the interior that are not in any commercial use: Gunung Mas, Murung

Raya, MuaraTeweh These areas often still connect to each other and it is one of the most important challenges of the HoB initiative to preserve these forests.

This propitious situation is similar or even better in East Kalimantan where large upland forest areas are present and still connected in the HoB parts of Kutai Barat, Bulungan, Malinau and Nunukang. The connectivity is particularly well preserved in the north, where all of the highest uplands are connected to and KayanMentarang national park.



## Montane forest in protected, logging and plantations

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Not all of the montane forests outside protected forests are allocated as protection forests.

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### **protected:**

A large part of the montane forests of Borneo are inside protected areas and this includes all of the land with elevations above 1500 m asl.

The national parks of the HoB encompass most the largest mountain ranges, as discussed in the previous environmental status report.

Not all of the montane forests outside protected forests are allocated as protection forests. The volume of commercial timber of the common lower and upper montane oak-myrtle forest is limited. However, many of the montane forests of Borneo have the misfortune of including terrain types with rather high numbers of Agathis and montane Shorea trees that have high commercial values.

### **forest under logging concessions:**

Most of the montane forests of Sarawak are inside logging concessions. The steep slopes and inaccessibility is hardly an issues with the high prices paid for timber, making it economically feasible to use helicopters for harvesting the logs.

The only Indonesian province with large areas of montane forests inside logging concessions is East Kalimantan. These are often operated by logging companies that started with lowland and upland concessions years ago, and now want to continue logging in the mountains using their previous infrastructure. They probably aim mainly for the wider ridges where they can take out Agathis and yellow meranti trees as helicopters are not used here.

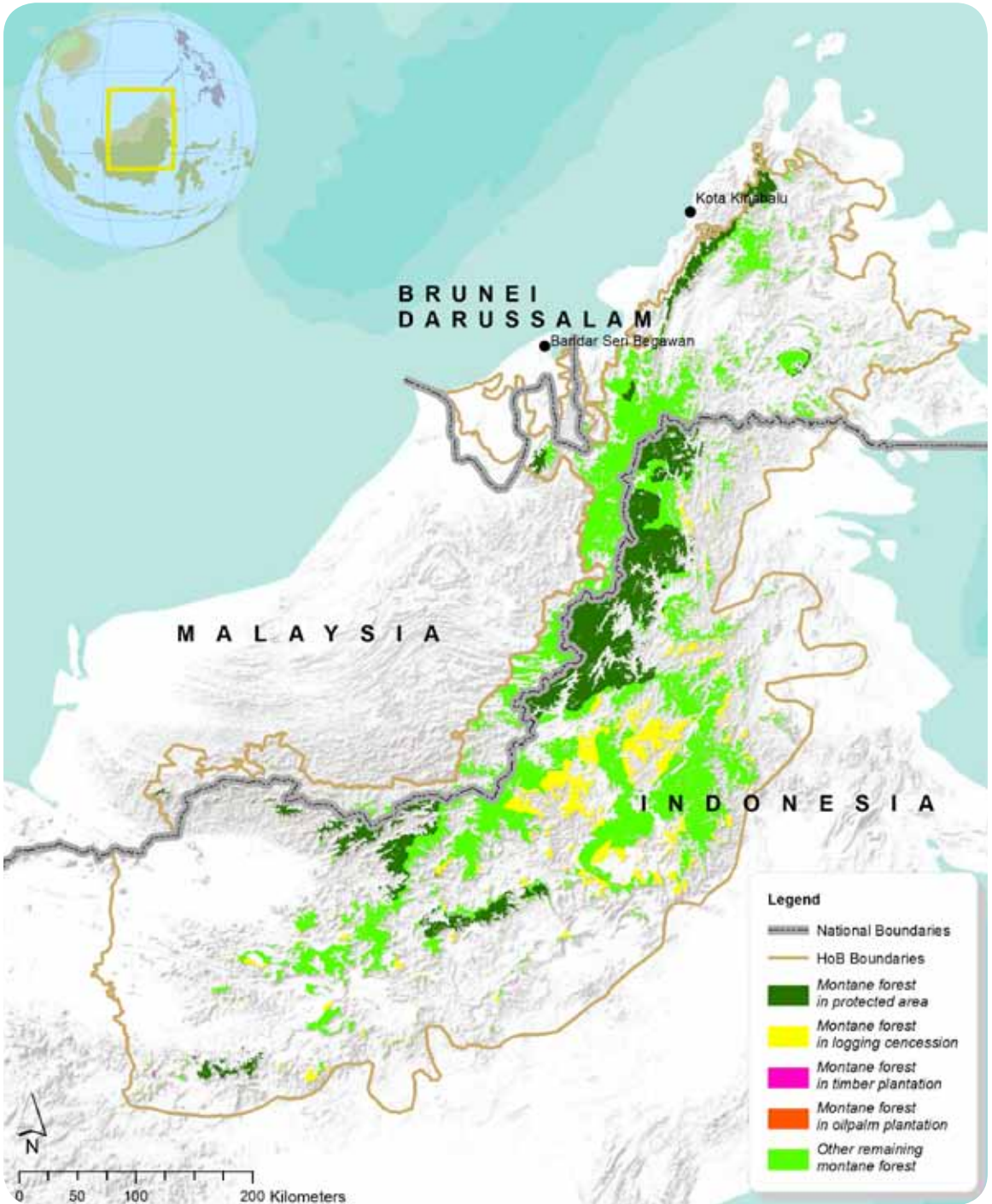
### **forest in plantations (thus will be converted):**

There no forests planned to be converted to timber plantations, as sufficient and much more suitable land is available in the lowlands and uplands.

### **remaining, with unclear status:**

Many of the montane forests that are currently not inside protected areas or concessions are allocated as protection forests, to safeguard the hydrological functions and erosion control.

A substantial total area is however allocated to limited production forest.





## Peat swamp forest in protected, logging and plantations

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Most of the peat swamp forests around the Mahakam lakes in the HoB part of East Kalimantan are inside logging concessions.

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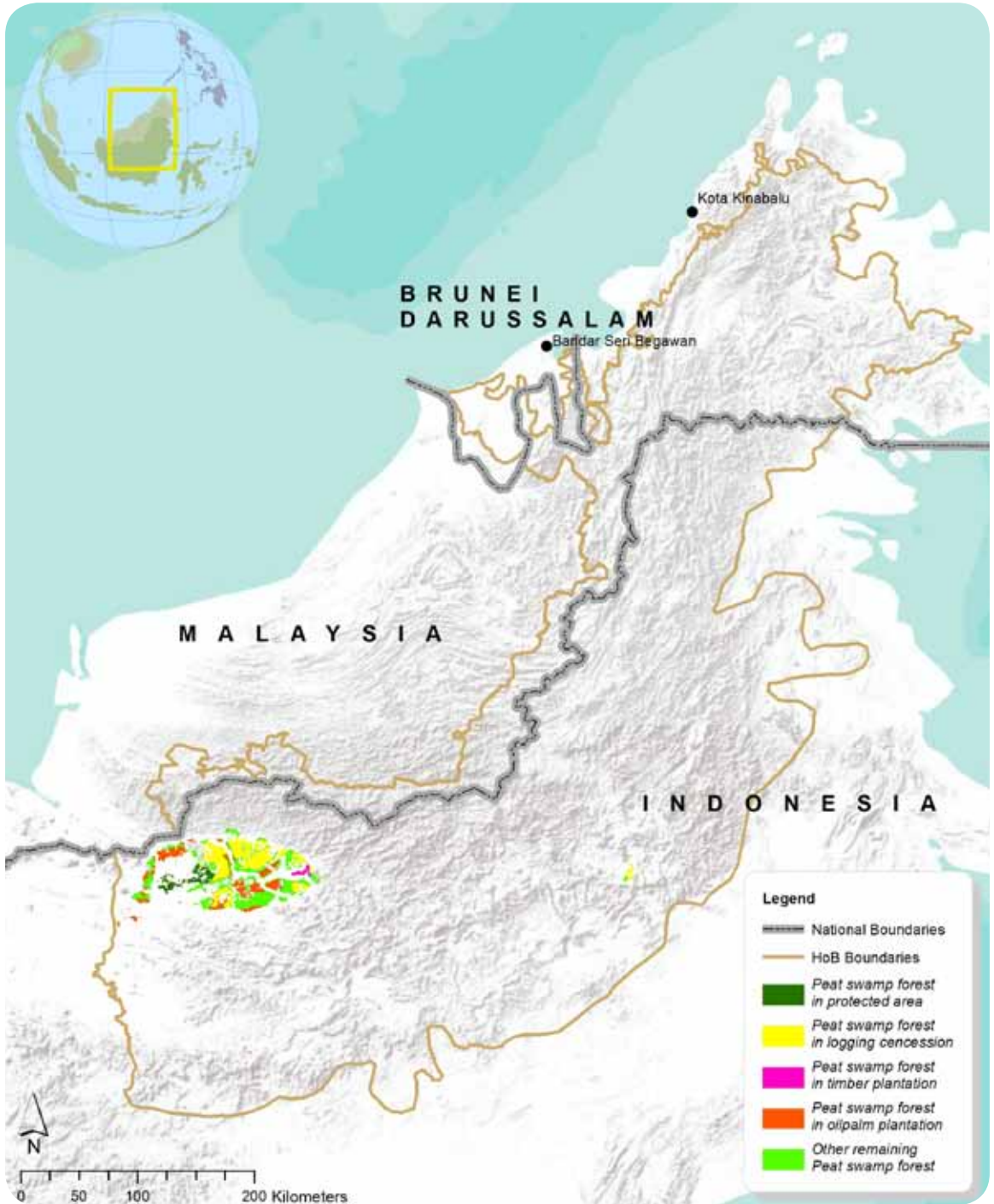
Not with standing the presence of wide stretches of peat swamp forests in the vicinity of the lakes of the middle Kapuas river in West Kalimantan, only a few of the core areas are inside the national park. Developments have expanding far into the peat swamp forests here and large areas are inside concessions.

Logging companies will find that the peat swamp forests of the interior provide much lower volumes of commercial timber than lowland rainforests. The coastal peat swamp forests have a number of commercial timber species that, although generally endowed with smaller diameters, can be abundant. This is not the case with the interior peat swamp forests, even though a number of valuable tree species are present. Logging of peat swamp forests and taking out the timber requires much efforts in terms of infrastructure. Heavy machinery can hardly be used and transportation is often by manual labor and by boat. This often implies the digging of canals, which has a very large impact on the hydrology of the peat swamps. Sustainability of timber harvest in these interior peat swamps is questionable and critics might even wonder whether this is a real goal of starting a logging concession here.

A relatively large total areas of these peat swamp forests is inside oil palm plantations concessions. The planting of the oil palm can only begin once the terrain is fully prepared, which includes the modification of the natural hydrology. This is usually done by digging extensive systems of small as well as some larger drainage canals during the dry season when machinery can enter the areas. Even then spots remain where the oil palms do not develop well. Some of the peat swamps at terrains with deep peat and long inundation periods might be preserved by the companies as green belts or high conservation values areas.

Most of the peat swamp forests around the Mahakam lakes in the HoB part of East Kalimantan are inside logging concessions. These peat swamps are however part of larger logging concessions that concentrate mainly on lowland rainforest. It is up to the whims of the company managers whether it is worth the efforts to log these swamp forests.


A large part of the peat swamp forests of West Kalimantan that is currently not inside concessions is allocated in the land use planning to “other land use area” (areal penggunaan lain). This implies that these forests can be converted.



## Freshwater swamp ecosystems in protected, logging and plantations

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Only a few areas of the wide freshwater swamp forests of Brunei are strictly protected

A decorative graphic consisting of three horizontal, wavy lines in a light beige color, positioned below the sub-header text.

Only a few areas of the wide freshwater swamp forests of Brunei are strictly protected. Taking into consideration the explicit land status planning of Brunei which includes these freshwater swamps inside the HoB boundaries, it is likely that these areas will be preserved well.

The danau Sentarum national park of West Kalimantan encompasses a few tracts of freshwater swamps. Most areas of this ecosystem are however outside the protected area and are used by local communities. A few edges are inside plantation concessions.





## Heath forest in protected, logging and plantations

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The only very large areas of heath forests within the HoB are around the basin at the edges of the uplands of the Kapuas lakes in West Kalimantan.

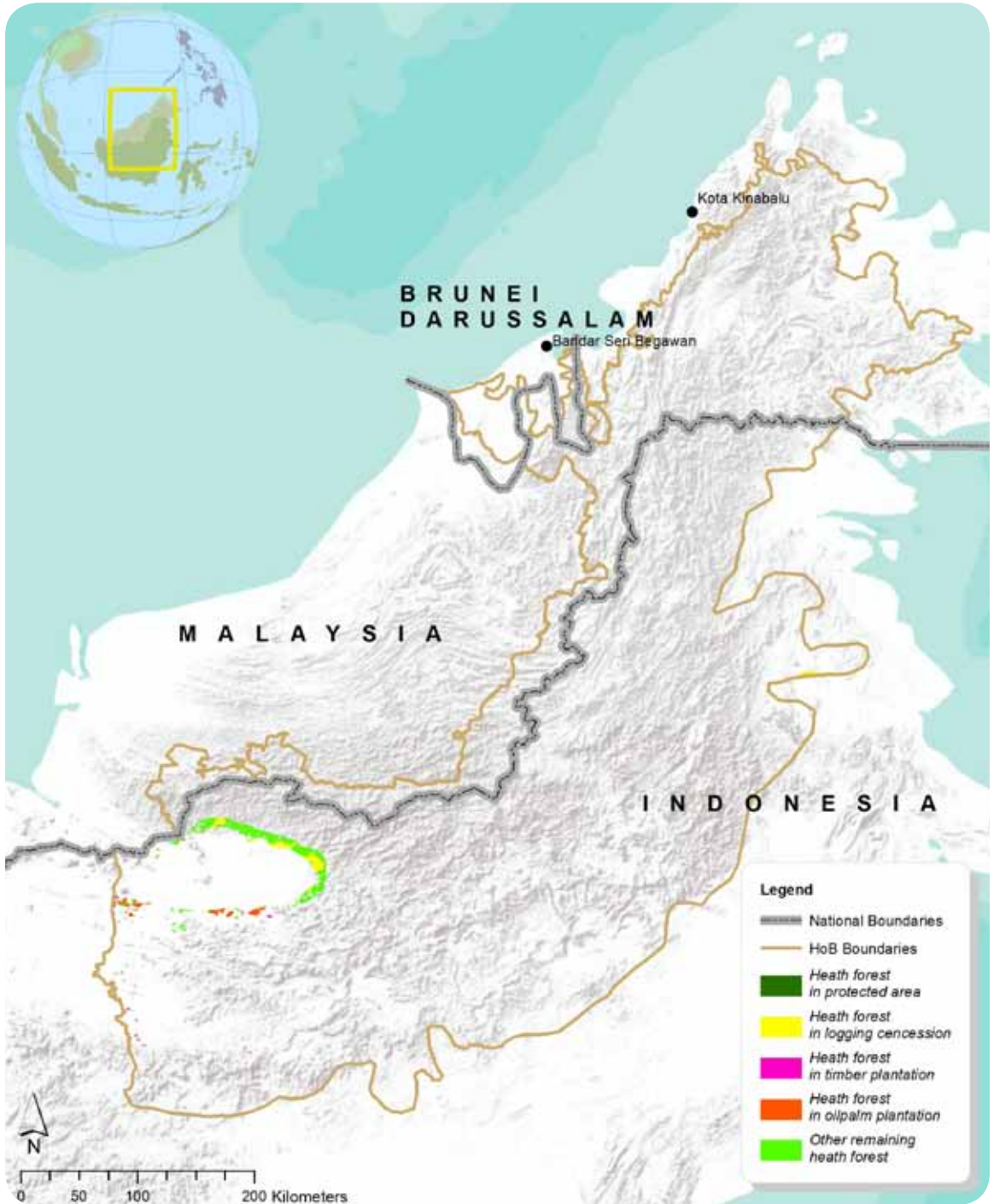
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None of these heath forests are inside a protected area, as the boundaries of Danau Sentarum national park are limited to the lakes and the swamps.

Parts of the heath forests are inside logging concessions that operate mainly in the surrounding lowland rainforests. The volume of commercial values timber is of the heath forests is limited which by default implies that harvest will be conducted through selective logging. Regeneration of large trees in logged-over forests on these extremely poor soils is naturally very slow.

Nearly all of the southern strip of heath forests is inside plantation concessions. The soils are actually not suitable for planting oil palms, but this problem will be solved by the companies by applying large amounts of fertilizers.

Conservation of parts of this unique ecosystem can still be ensure, 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.



## Limestone forest in protected, logging and plantations

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Although limestone outcrops can be found in many places of the national parks of the HoB, almost none of the larger limestone of the larger limestone



Although limestone outcrops can be found in many places of the national parks of the HoB, almost none of the larger limestone forest areas of the HoB are inside protected areas. The only large limestone area that is strictly protected is inside the Gunung Mulu national park in Sarawak.

Several logging concessions in West- but particularly in East Kalimantan have limestone forest tracts at the edges of their concession areas. These are mainly limestone ridges and hills with steep cliffs and very rugged terrain, and are hard to access. The

trees growing on limestone ridges are generally stunted and hardly any commercial timber can be harvested. Local communities might even object to disturbing limestone ridges because of cultural significance or because of the presence of bird nest caves.





## Forest fires by year

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Sarawak and Brunei appear to have their forest fire problems better under control, with only a few hotspots detected after 2008.

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The map shows all the hotspots recorded in the HoB between 2000-2012, in a cumulative way with the most recent hotspots on top.

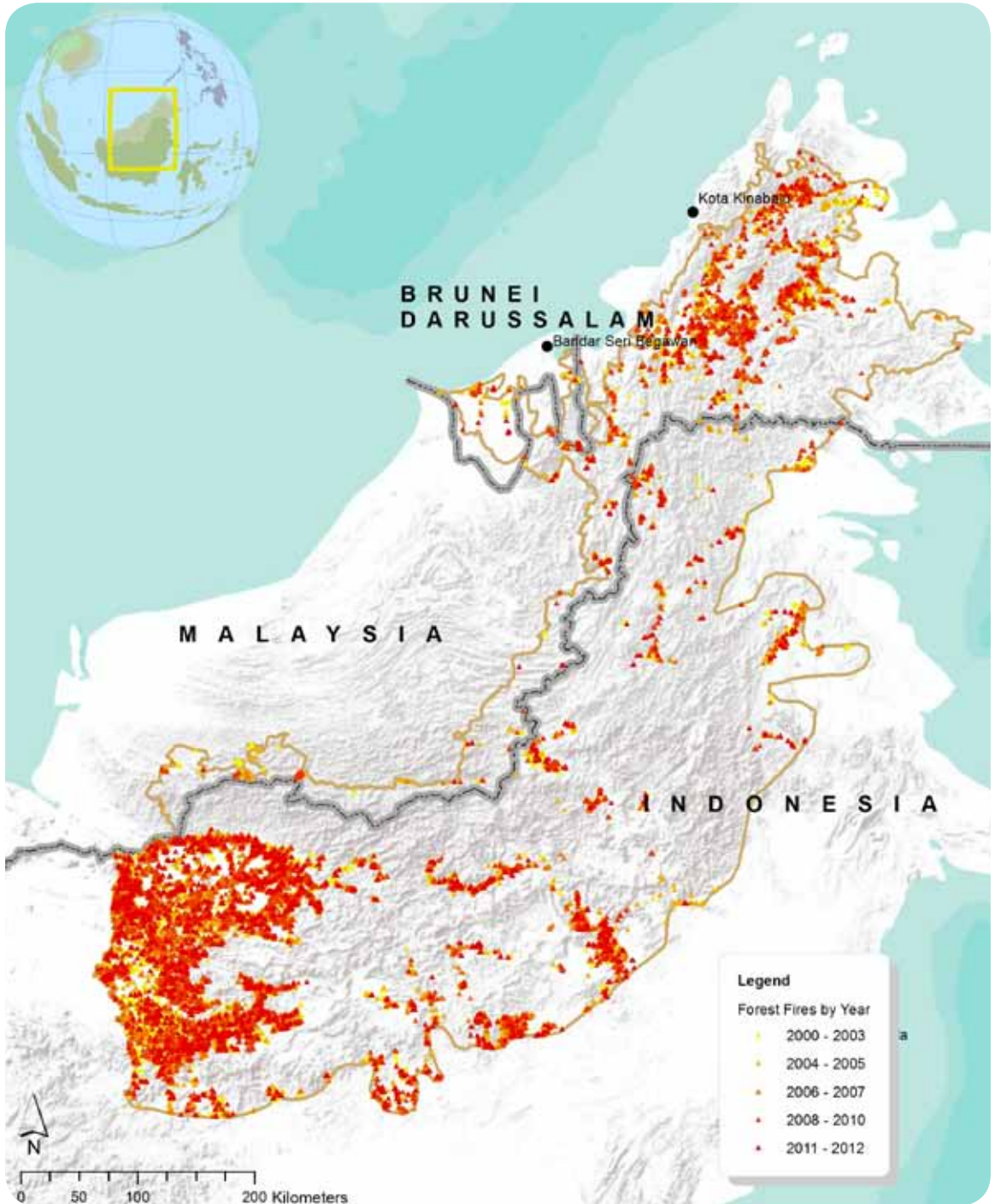
A very high number of forest fires still occurred in Borneo between 2008-2012. West Kalimantan was particularly strongly affected with forest fires in nearly all of the land below 200 m asl. Most of these fires were repetitions of previous fires but expansion of burnt areas also occurred, particularly before 2008.

A surprisingly high number of hotspots were detected in Sabah especially in the eastern section of the Crocker range and the upper Kinabatangan. The areas burnt by forest fires have also expanded: many locations that got burnt between 2000-2006 were not affected anymore afterwards but new fires occurred in other locations.

Sarawak and Brunei appear to have their forest fire problems better under control, with only a few hotspots detected after 2008.

The forest fires in the HoB part of Central Kalimantan occurred mainly along the Barito and Murung rivers, and in the upper Seruyan and Katingan watersheds. Many of these fires are repetitions.

In East Kalimantan forest fires occurred particularly often along the Mahakam, where it is detected as a yearly phenomenon. In other areas of East Kalimantan, along the Kayan, Bahau, Kelai, Sesayap, Sebuku and other rivers, the forest fires occur in different places in most years.





## Forest fires in logging concessions

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Concessions with many forest fires inside of their forest areas can be considered suspicious and might have plans for later conversion of their forests

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Healthy rainforests and peat swamp forests are not very susceptible to forest fires as the lower storeys of the forest remain humid even during dry periods without much rainfall. Opening up the canopy by logging will let in more sunlight and drier air but even then the lower vegetation strata of smaller trees, shrubs and herbs will retain a certain humidity to the soil. Forest fires can usually only be devastating when getting into the forests from open edges.

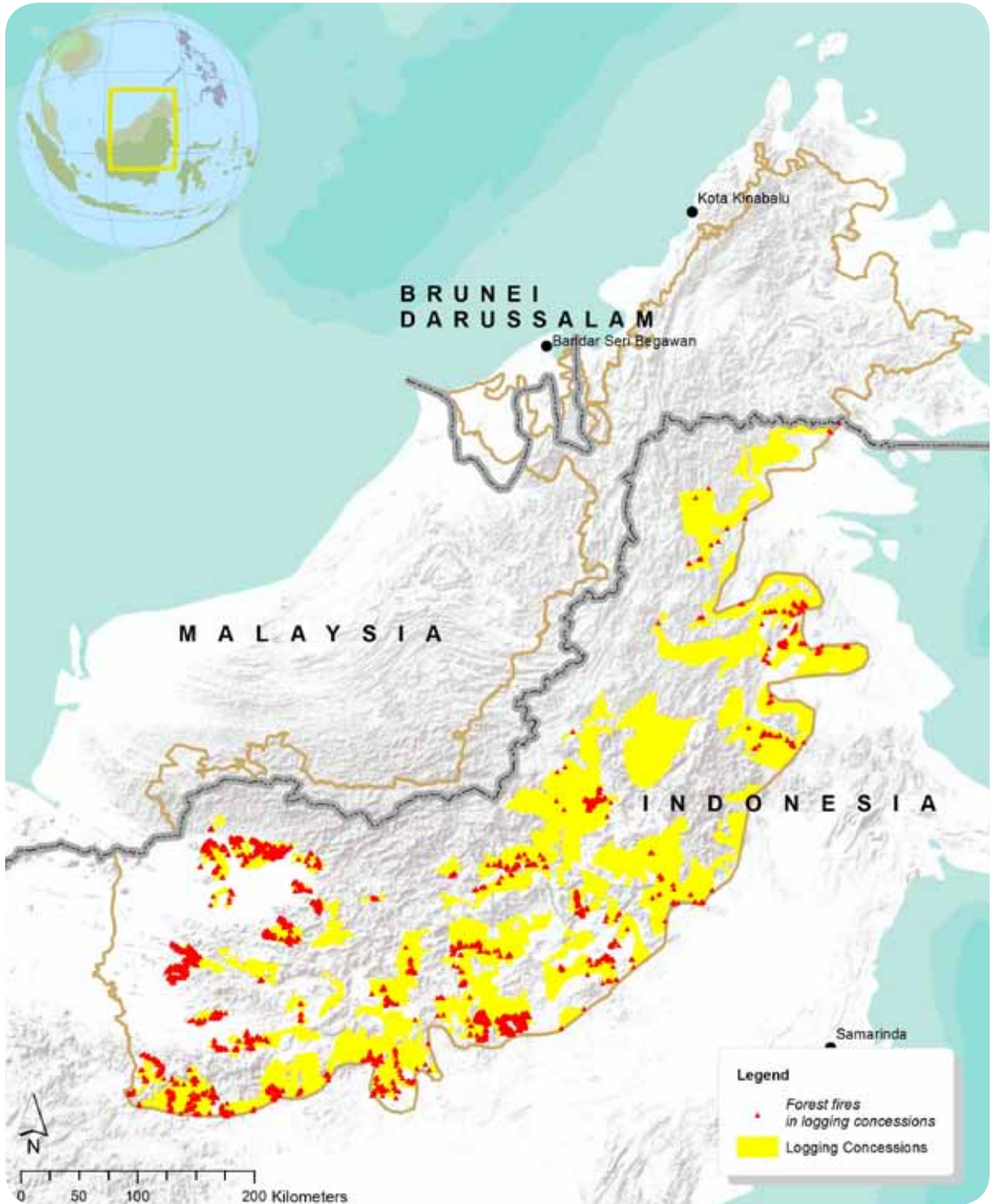
Logging companies should endeavor to prevent any forest fires as they need a healthy lower canopy for natural regeneration for their future timber stock.

Concessions with many forest fires inside of their forest areas can be considered suspicious and might have plans for later conversion of their forests.

The forest fires inside logging concessions are major issues in West and Central Kalimantan. Many of the concessions of the upper Kapuas area had hotspots that might be more than accidental. The areas south of Bukit Baka Bukit Raya, the upper Seruyan and the vicinity of MuaraTeweh have similar problems.

Forest fires in the logging concessions of East Kalimantan occurred mainly along these edges and are probably not intentional.

Since no official spatial data on logging concessions available for Sabah and Sarawak, the hotspot analysis in logging concessions could only be done for Kalimantan.



## Forest fires in plantation concessions

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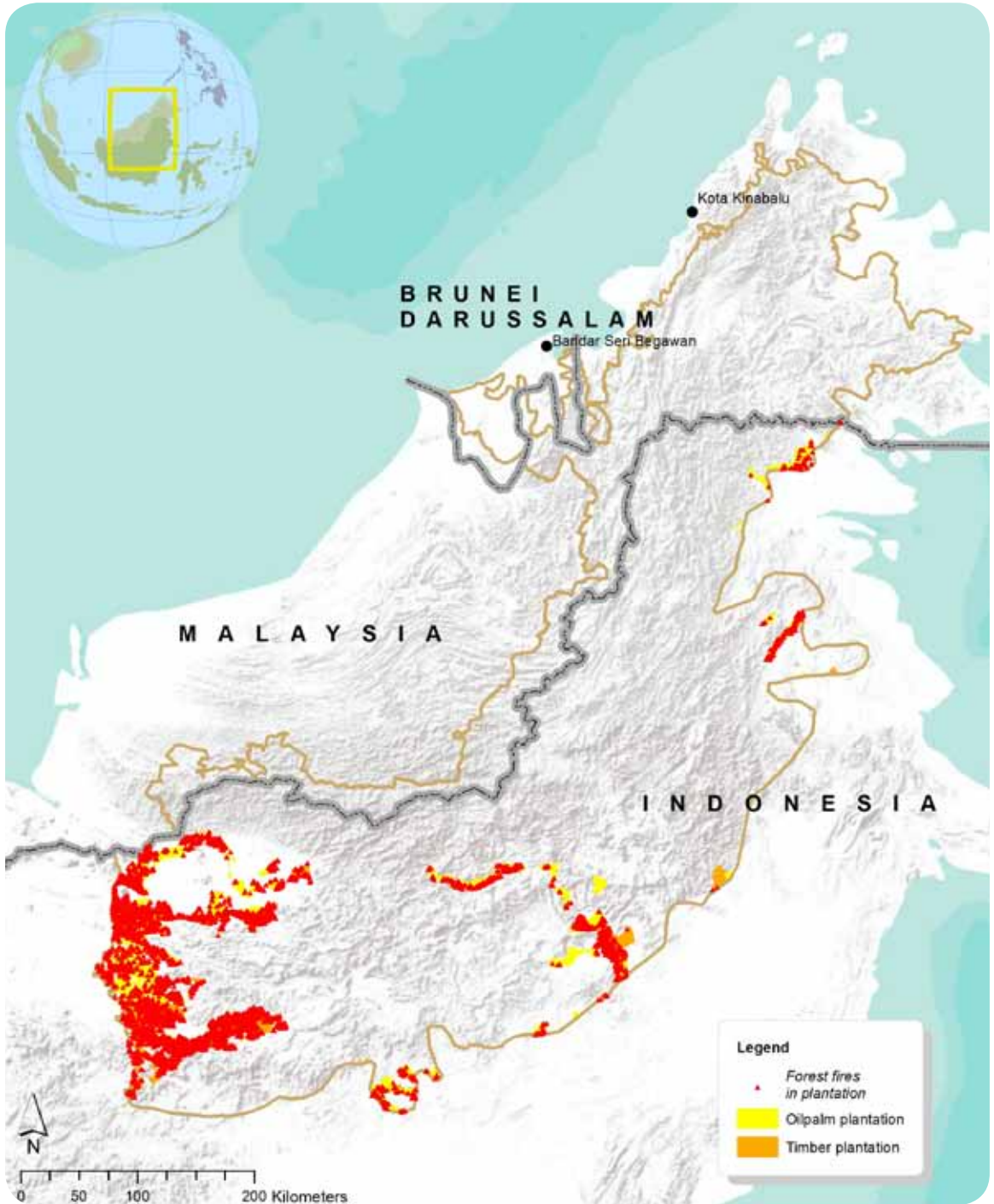
The practices of burning the forest occurred in the vast majority of the plantation areas

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Nearly all of the forests inside plantation areas in the HoB have had fires. About 60% of these fires occurred between 2000-2004, and about 40% between 2007-2012

Fire is considered a most convenient tool to clear forest and shrub areas before opening the land for plantations. Other companies that are more committed to the environment are against it and will apply a “zero burning” policy.

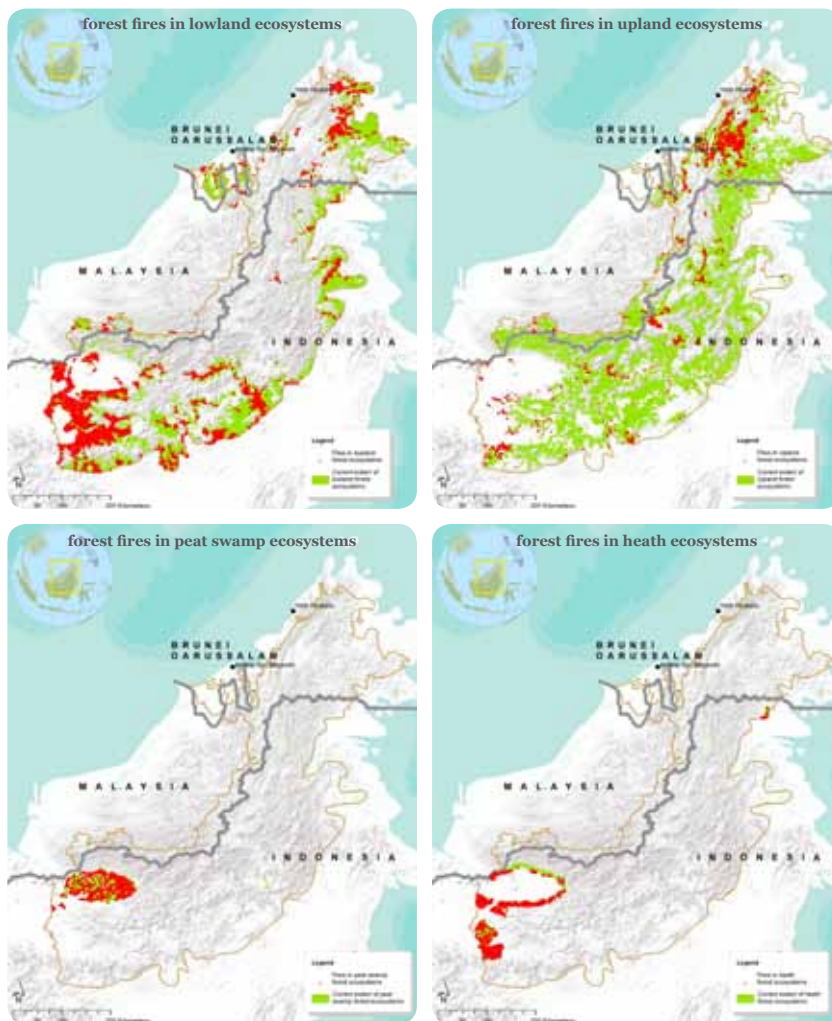
The practices of burning the forest occurred in the vast majority of the plantation areas. Nearly all the areas in West Kalimantan, the Seruyan area in Central Kalimantan and the Kelai and Sebuk watershed of East Kalimantan were affected. However in the Mahakam area of East Kalimantan it can be clearly distinguished which are the companies that do not apply burning for land clearing.



# Forest fires in forest types

The ecosystems most affected by forest fires were lowland rainforest, peat swamp forest and heath forest. Detection of single hotspots in forests does not have to imply

that an entire forest area got burnt, but unfortunately in many locations were already preceded by disturbances and are afterwards often followed by gradual conversion.







Most of the forest fires occurred in the lowlands and many of the remaining lowland rainforests throughout the HoB were affected. Many of the burnt areas were locations with land use planning for developments.

In Sabah most of the interior lowland forests have undergone forest fires. The fire situation in the Kinabatangan and Kalabakan areas were however much better under control and the few fires here could be extinguished rapidly.

In Brunei it were particularly the coastal edge areas that were affected by forest fires, but most of these sites will be retained as forest. In Sarawak many fires occurred in LanjakEntimau, but these spots were not followed by conversion and will gradually grow back.

Forest fires were particularly devastating in West Kalimantan, where nearly all of the lowland forests were affected, with the exception of the humid and undisturbed river valleys.

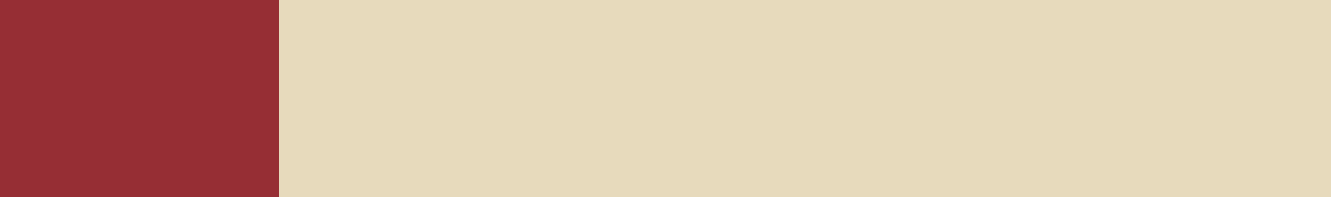
In Central Kalimantan not only most of the lowland forests at the edges but also in the interior along the major rivers had forest fires. In East Kalimantan it was particularly along the Mahakam and Kelai rivers where many forest fires occurred. In several of these burnt areas, plantations were established later on.

Most of the remaining peat swamp forests of the HoB were affected by fires. Fires in this ecosystem often have severe impacts, as the burning of peat can expand under the surface and can go on for many days. The peat swamp forests at the edges of the DanauSentarum are less as likely to fully recover than the peat swamps of the core area, where humidity remained rather high even during very dry periods.

Hotspots were detected in nearly all areas of the freshwater swamps of DanauSentarum, while only a few hotspots occurred in the swamps of Brunei.

The most severely affected ecosystem as a whole is heath forest, which has the highest hotspots to total area ratio. Many of the remaining larger heath forests of the HoB got burnt, with the remarkable exception of the heath forests north of the DanauSentarum area. These heath forests grow along the foot slopes of the BetungKerihun mountain range, and are more humid and less disturbed than the other heath forests further to the south. Once a heath forest got burnt, it is almost impossible for the forest to completely recover and the remaining vegetation is more like a bush land.

The number of forest fires in the upland rainforests of the HoB is much higher than one would expect in such a humid ecosys-



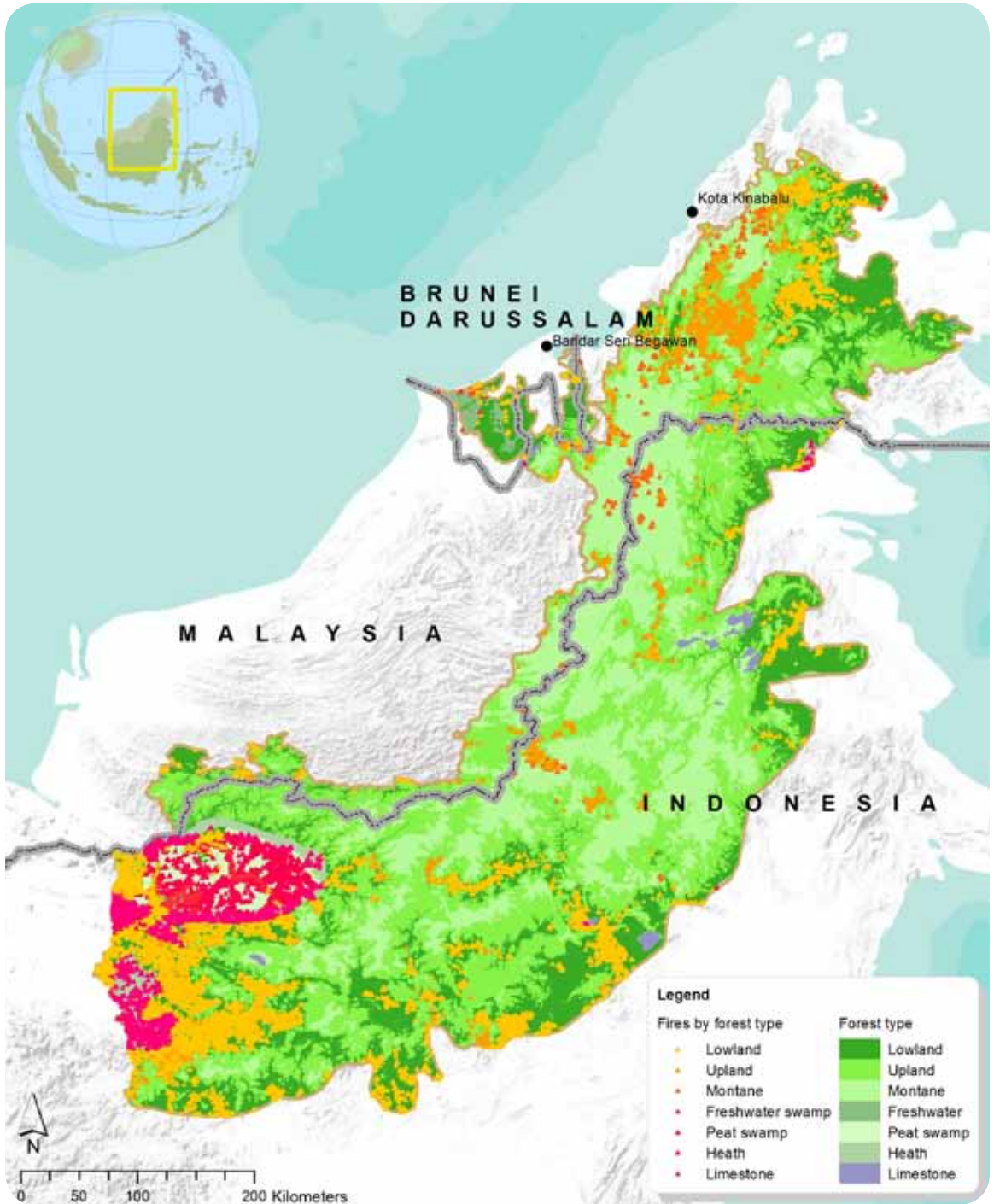
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tem. The extent of forest fires is particularly wide in Sabah, where most of the interior area east of the Crocker range was affected.

The many forest fires south of Bukit Baka Bukit Raya and around MuaraTeweh in Central Kalimantan might in certain cases be related to economic developments. The large cumulative number of hotspots in East Kalimantan is caused by the long history of shifting cultivation in these areas.

The hotspots in montane forests ecosystems are mainly related to shifting cultivation and a few forest fires caused by lightning strikes along exposed mountain ridges.





## Percentage forested land per watershed

The map displays the entire forest cover of each of the watersheds of Borneo.

Nearly all of the watersheds underwent strong losses of overall forest cover, outside but also inside of the HoB, between 2007-2012. Nowadays only five watersheds the Kayan, Sesayap, Belait, Temburong and Trusan still have a “very good” total forest cover of 70% or more. In 2007 there were still eleven watersheds with at least 70% forest cover, including the Sembakung, Sebuku, Berau, Rajang, Baram and Limbang. In 2007 not a single watershed had a forest cover below 30% and in 2012 there are already four of these highly deforested watershed with parts in the HoB. Given the situation in the HoB where nearly all of the rivers arise in mountainous areas with steep slopes as well as the overall heavy rainfall of Borneo, each of these watershed should ideally have a forest cover of at least 50%.

Forest cover decrease was strong in Sabah and most of Sabah's watersheds nowadays have a forest cover of less than 35%, while in 2007 nearly all watersheds had a forest cover of 45% or more.

- The Padas watershed underwent a forest cover decrease of almost 10% from 2007 to 2012 and deforestation was particularly strong in the uplands. The lowland were partly converted earlier.
- The Kinabatangan watershed, the largest in Sabah still had a 58% forest cover in 2007, but in 2012 only a 31% forest cover remained. Less than half of the remaining forest is un-fragmented.
- In 2007 almost half of the Kalabakan watershed was still under forest cover, but in 2012 less than 20% remaining and three-quarters of this forest area is fragmented. This is the most deforested watershed of the HoB.

- The Segama watershed had a forest cover of 29% in 2012, a reduction of 10% from 2007, and two-thirds of the remaining forests are fragmented.
- The Labuk watershed is only watershed in Sabah that is still half covered by forests.

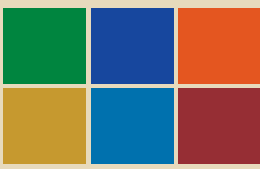
Brunei managed to preserve most of its forest cover, and all the watersheds of Brunei have a forest cover of at least 50%. Forest cover in the Brunei watersheds is decreasing but at a much lower rate than elsewhere in the HoB. Fragmentation of the forests is also much lower.

The hoB watersheds of the interior of Sarawak have still a good forest cover, although the northern watersheds lost much of their forest cover from 2007-2012.

The largest watershed of Sarawak, the Rajang, had a forest cover of 80% in 2007, which decreased to 62% in 2012. Half of the remaining forests are fragmented.

The Baram watershed, the other large watershed of Sarawak, underwent a 17% loss of forest cover from 2007-2012 but still has a good forest cover of 68%, and only a relatively small part of it is fragmented.

The Kapuas watershed is the only watershed in the HoB part of West Kalimantan. This is a very large drainage area, the largest watershed of Borneo, of which about 60% is inside the HoB boundaries, encompassing the upland and mountain ranges but also the Kapuas lakes basin. The western section of the northern mountain ranges is outside of the HoB. The total forest cover of the entire watershed was reduced by 6% between 2007-2012, but most of the conversions occurred outside and in the westernmost part of the HoB. In 2012, 41% of the Kapuas watershed was under forest cover, and about one-third of these forests were fragmented.



The watersheds of Central Kalimantan underwent more deforestation than expected. Most developments in this province occur in the lowlands, and a number of the watersheds of these coastal lowlands are entirely outside of the HoB boundaries.

The situation in the Seruyan watershed almost reached the point of becoming alarming, with only 26% forest cover left in 2012, down from 40% in 2007. Even worse is the fact that only 7% of the remaining forests are un-fragmented.

The Barito drainage area, by far the largest watershed of Central Kalimantan underwent a 10% forest cover reduction since 2007 but still had a 53% forest cover in 2012. Almost half of these forests are however fragmented.

The Kahayan watershed underwent strong deforestation between 2010-2012 and more than half of the remaining forests are fragmented.

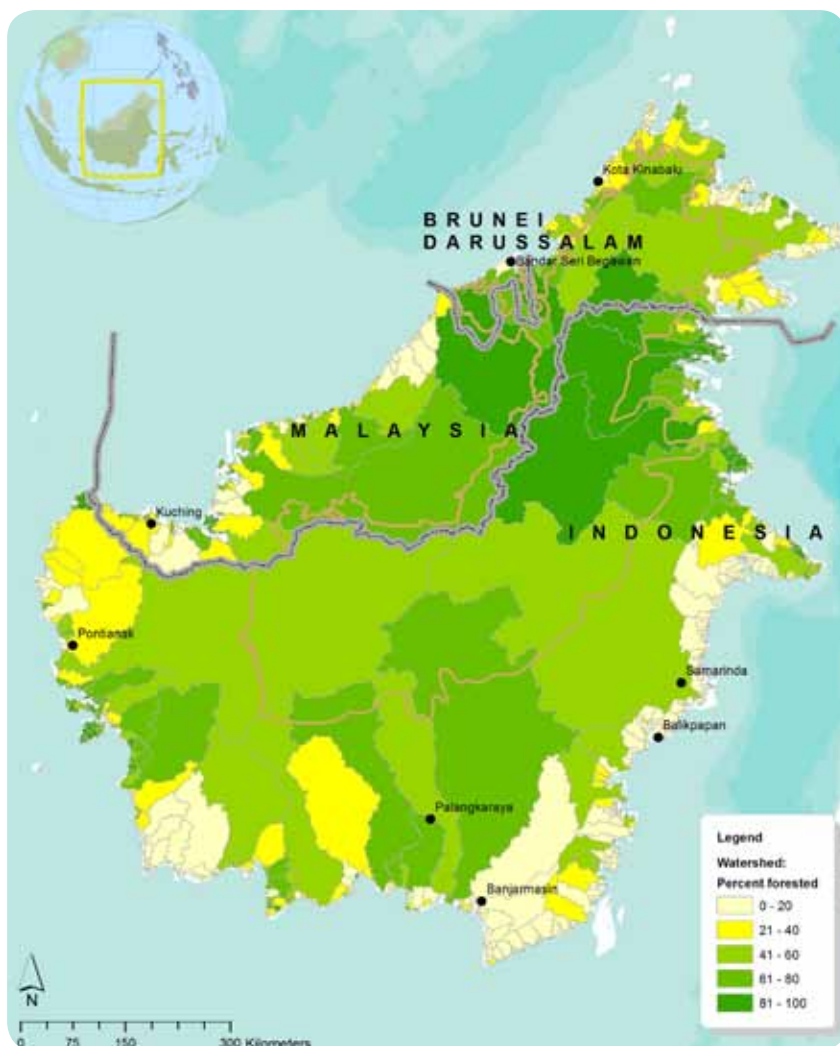
The Katingan watershed is notwithstanding a 12% forest cover reduction since 2007 doing reasonably well, with a forest cover of 56% in 2012. However half of these remaining forests are fragmented and this could indicate further deforestation in progress.

East Kalimantan generally still has a good forest cover of the large watersheds that arise from the interior.

- The Mahakam drainage area is the second largest watershed of Borneo. Still almost half of it was covered by forests in 2012, even though many plantation developments occurred in the lowlands and uplands. Deforestation between 2007-2012 was relatively low, about 3%, but one-quarter of the remaining forests are fragmented.
- Even though the Berau watershed is still for 60% covered by forests, it lost more than 16% of its forest cover between

2007-2012. Half of the remaining forests are fragmented.

- The Kayan drainage area has a very high forest cover of more than 90%, the highest forest cover of all the watersheds of Borneo. Deforestation occurred only in the lowland and some of the upland valleys and fragmentation is low. The Kayan is a very large, 3 million hectares watershed but population density is very low, with only one larger 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.
- The situation in the Sesayap watershed is similar to the Kayan watershed. The forest cover is still very good (86%) even though some 6% got became deforested between 2007-2012.
- The forest situation Sembakung is complicated. The international boundaries were drawn by the former colonial powers across the watershed and a large part of the upstream area is inside Sabah. The upland section in Sabah underwent quite some deforestation, while the upland section in east Kalimantan remaining more or less intact, but deforestation occurred here in the lowlands. Although the overall Sembakung watershed still has a forest cover of 66%, deforestation between 2007-2012 was high, almost 20%, and almost half of the remaining forests are fragmented.
- The Sebuk watershed, home of the only elephant population of Kalimantan, lost more than 20% of its forest cover between 2007-2012. Most of the lowlands are now deforested or fragmented; the uppermost section of this watershed in within the political boundaries of Sabah and here some tracts of deforestation occurred.

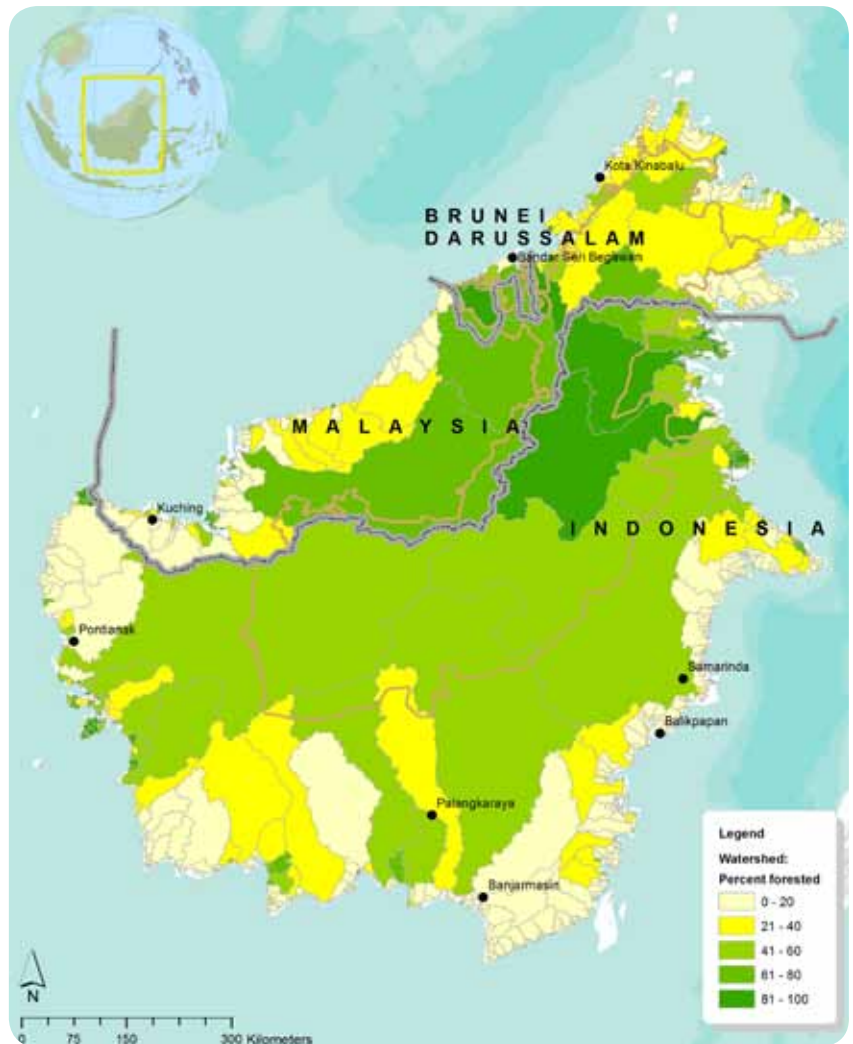


percentage forested watershed 2007



percentage forested watershed 2010





percentage forested watershed 2012

## Overall forest fragmentation

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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 automated choice for the number of pixels took into consideration landscape features such as water bodies and mountain ridges.

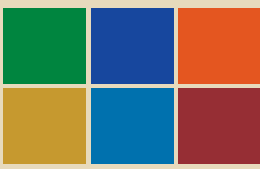
in 2007 large areas of the HoB were still almost completely un-fragmented; the interior in particular still many large areas of continuous forest. Along the large interior rivers fragmentation was common though mainly because of shifting cultivation agriculture and transportation sites for companies. In Sabah however most of the forest areas were already partly fragmented in 2007. In West Kalimantan most of the western lowland edges were fragmented while Central Kalimantan most of the southern edges were already strongly fragmented in 2007. The most fragmented ecosystem was lowland rainforest. Upland rainforest was generally intact in most areas. Montane forests were generally un-fragmented, except for the parts of the Crocker range and the upper Padas area.

in 2010 the forest areas of the interior start to become fragmented, while further fragmentation occurred in most of Sabah and the edges of West and Central Kalimantan.

in 2012 many of the interior forest areas also became fragmented. Not much un-fragmented forest was left in Sabah, mainly in the protected areas and parts of the eastern Crocker range. Most of the upland forests of Sarawak underwent strong fragmentation between 2007-2012. 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 forests of Central Kalimantan were fragmented in 2012, and fragmentation was also high along the Barioriver. Many edge areas of the forests of East Kalimantan, particularly in Berau and the northern part, became fragmented.

Most of the remaining lowland rainforest of the HoB was fragmented in 2012, the main exceptions being Brunei, the BulangJoloi area in Central Kalimantan and the Ratah area in East Kalimantan.

The upland rainforests of Sabah became highly fragmented in 2012. In Brunei only parts were fragmented. In Sarawak the western part in particular (Batang Ai LanjakEnti-



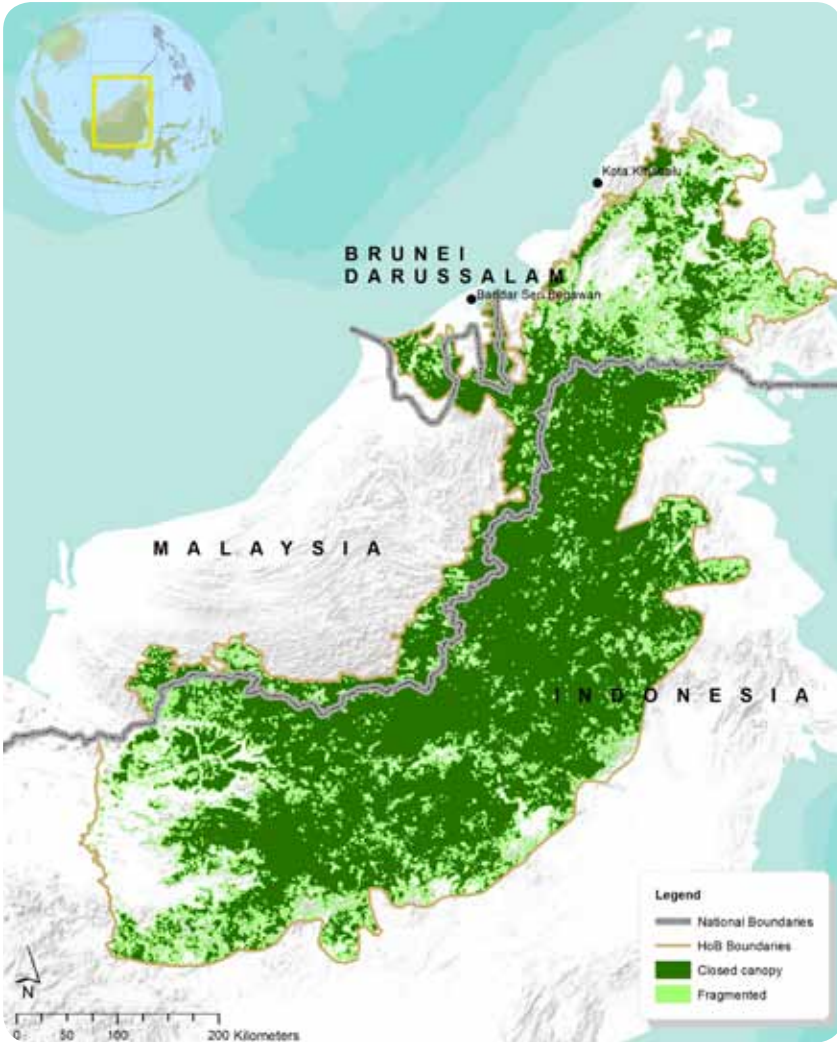
mauetcwasfragmented. In West Kalimantan the western part of the upland forest of BetungKerihun, the Melawi area, parts of upper Kapuas, and some northern slopes of Bukit Baka Bukit Raya were fragmented. Fragmentation of the upland forests of Central Kalimantan was strong along the HoB edges including the southern slopes of Bukit Baka Bukit Raya, the upper Kahayan, and along the large rivers. The upland forests of East Kalimantan remained mostly un-fragmented, except for parts along the middle Mahakam, Belayan, the Telen, the Senyur, Berau, lower Kayan and Sebuku rivers.

Most of the montane forest of the HoB were still un-fragmented in 2012. Exceptions are the Crocker range and upper Padas in Sabah; a wide coal mining areas in Central Kalimantan; and the Belayan upstream area in East Kalimantan.

The large areas of heath forests inside the HoB, around DanauSentarum were mainly un-fragmented in the eastern parts, but the half of the area of the western section was fragmented.

Analysis of the 2007, 2010 and 2012 time series indicate that fragmentation is frequently followed by deforestation

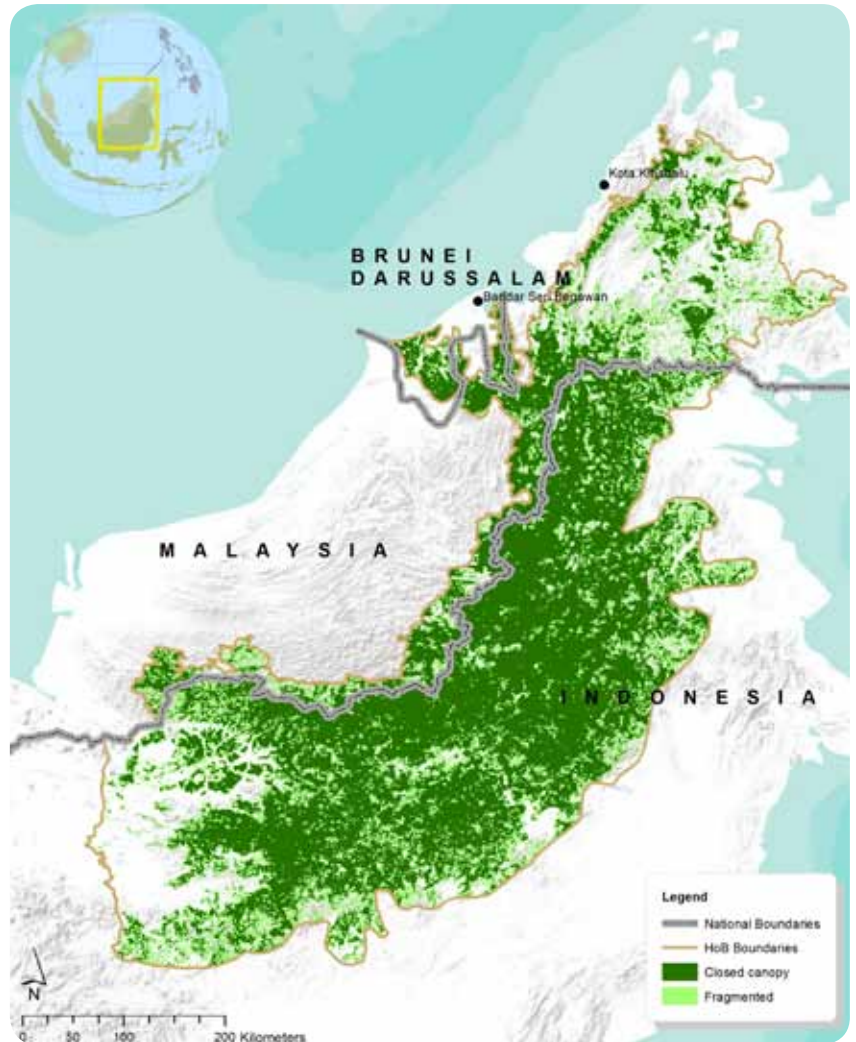




forest fragmentation 2007



forest fragmentation 2010



forest fragmentation 2012

# Mining concessions

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The delineations on the map show all the mining concession allocations of 2012; this includes exploitation as well as exploration concessions.

The area where a company is permitted to conduct surveys and sampling for commercially valuable geological deposits is often very large. These exploration concessions can overlap with any other land use allocation status, even certain protected 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 before exploitation can begin. The preparation of infrastructure is essential and the larger mining companies usually develop an excellent road network. These roads as well as any other infrastructure such as harbors are generally much better developed than in logging concessions.

The mined area, mainly through open pit mining, is relatively small but the environmental impacts of the infrastructure to otherwise remote and inaccessible locations should not be underestimated. The largest mining companies endeavor to conduct responsible mining with a minimal environmental impact. The smaller mining companies and fortune seekers are often less committed to the environment.

No mining data was available for Malaysia and Brunei, and the data from Indonesia is only sparsely available.

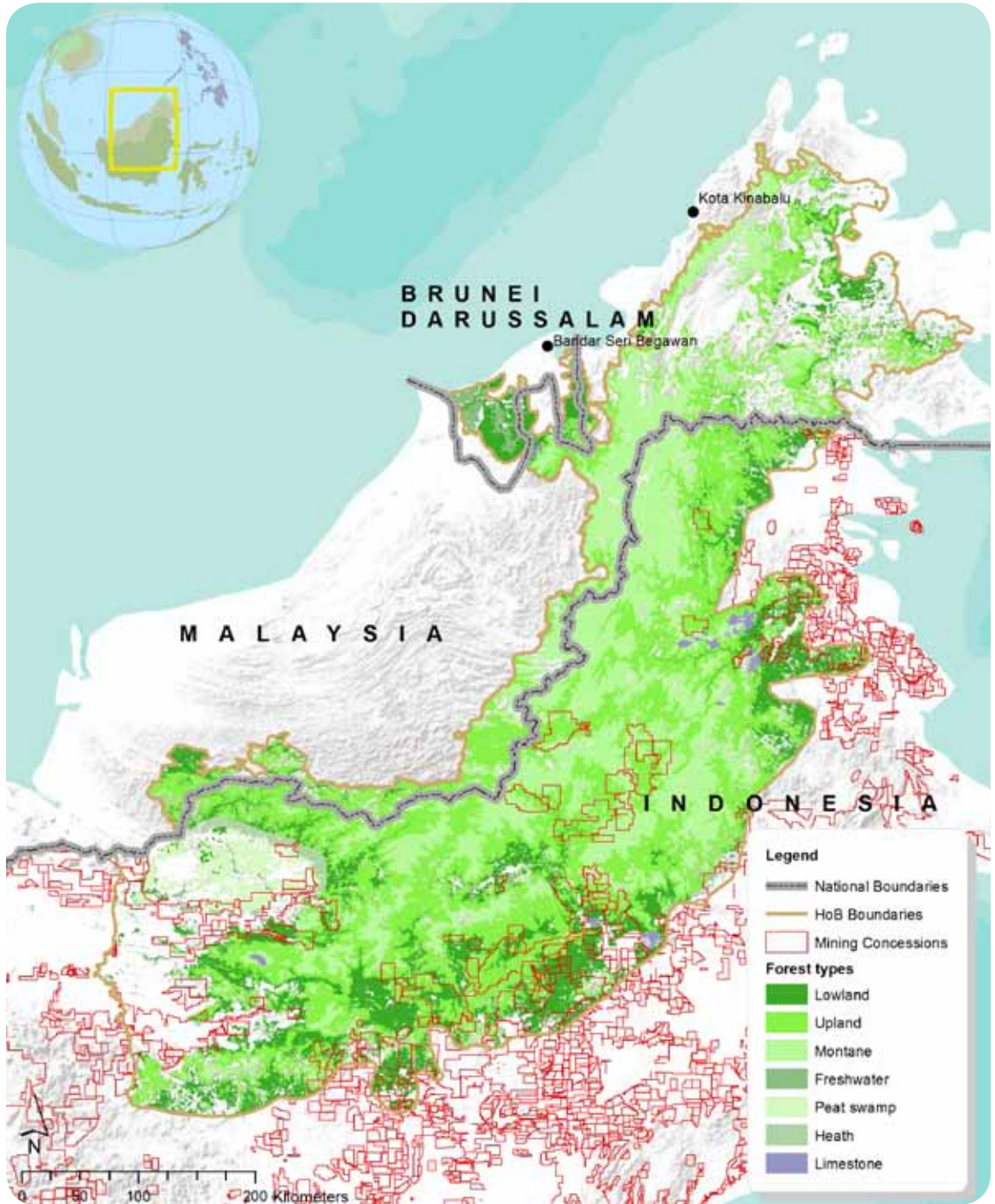
The mining concessions of the HoB part of West Kalimantan are concentrated along the edges of the uplands and the Kapuas basin. Mining concessions inside the peat swamp forest areas and some are even in the freshwater swamps. Exploitation of these concessions and particularly the required infrastructure will likely have a large impact on the environmental status. The southern

and most degraded strip of heath forest has several mining concessions but the northern strip is left alone. Many of the remaining lowland forests are in concessions and these are generally the lowland forests that border cultivated or deforested areas. New infrastructure can potentially make these forests very accessible. A few bordering mining concessions are even in upland forests.

The HoB part of Central Kalimantan has mining concessions virtually throughout the area, except for the highest mountain ridges in the north. Many mining concessions are in the lowland forests at the edges but also in the interior wide valleys. In the upland forests are many very large mining concessions. Some of these even go all the way in to the montane forests. These remote concessions will be explored very critically to ensure that exploitation will be economical feasible. In the case of coal mining, surveys to these locations are usually done by helicopter with a small team of experts and their drills. If the coal deposits are too thin then no further steps will be taken.

The mining concessions of the HoB part of East Kalimantan are fewer than in the other HoB parts, but several of them have been established for a long time and particularly coal mining is done at a large scale. These major mining areas are in the upper Mahakam, Berau and to a smaller extent Malinau. The concessions at the edges are mainly inside lowland rainforest but often extend to smaller areas of heath forest. Some of the concessions even include limestone ridges. The large concession areas of the interior are mainly inside upland rainforest and montane forests. It seems to be unlikely that the exploration concessions in the remote interior above the large rapids will ever be actually exploited, but one never knows to where human covetousness can lead.





# Certified logging versus non-certified logging

In 2012 about 20% of all logging concessions within the HoB were certified. Half of them lowland rainforest, half of them upland and some montane forest.

Most of the other 80% are considered potential candidates for certification.

The HoB part of West Kalimantan had two certified logging concessions (PT Sari Bumi-Kusuma & PT Barito Putera). Both are located along the northern edges of Bukit Baka Bukit Raya national park and thus provide a continuation of the forest areas to include the lowland foot slopes. These concessions at the edges of deforested areas can also serve to prevent further conversion of forest land. The orangutan population of this area should be able to survive.

Several potential candidates exist in West Kalimantan and there is one company with several logging concessions in the Danau Sentarum - Betung Kerihun corridor that can play a key role in connecting these areas.

In the interior upland forests of Central Kalimantan are two large logging concessions in the upper Barito area managed by PT Sarang Sapta Putra. The area also encompasses several lowland valleys and there is a small population of orangutan adding to the high biodiversity. These concessions connect the mountain range to the lowlands in the south.

Along the southern foot slopes of Bukit Baka Bukit Raya are a number of certified logging concessions. None of the logging concessions of the upper Seruyan are currently certified, though there is one certified company in the vicinity (PT Carus Indonesia) with also has a orangutan population. The Seruyan area was identified as one of the areas with a high level of forest conversion and fragmentation, and engagement and certification of logging concessions here could be crucial for the preservation of the remaining forests. Important candidates include PT Bumimas Permata Abadi, PT Gunung Meranti and others.

The majority of certified logging companies are in East Kalimantan and many of these are along the edges of the HoB, which might

ensure the preservation of these lowland and lower upland forest areas.

In the northernmost area, along the international border with Sabah, is the logging concession of PT Adimitra Lestari. This concession encompasses most of the habitats of the only elephant population of Kalimantan and two very important trans-boundary corridors are present here. The area connects directly to a protection forest and is also connected to other forests that still connect to Kayan Mentarang and area even further to the west.

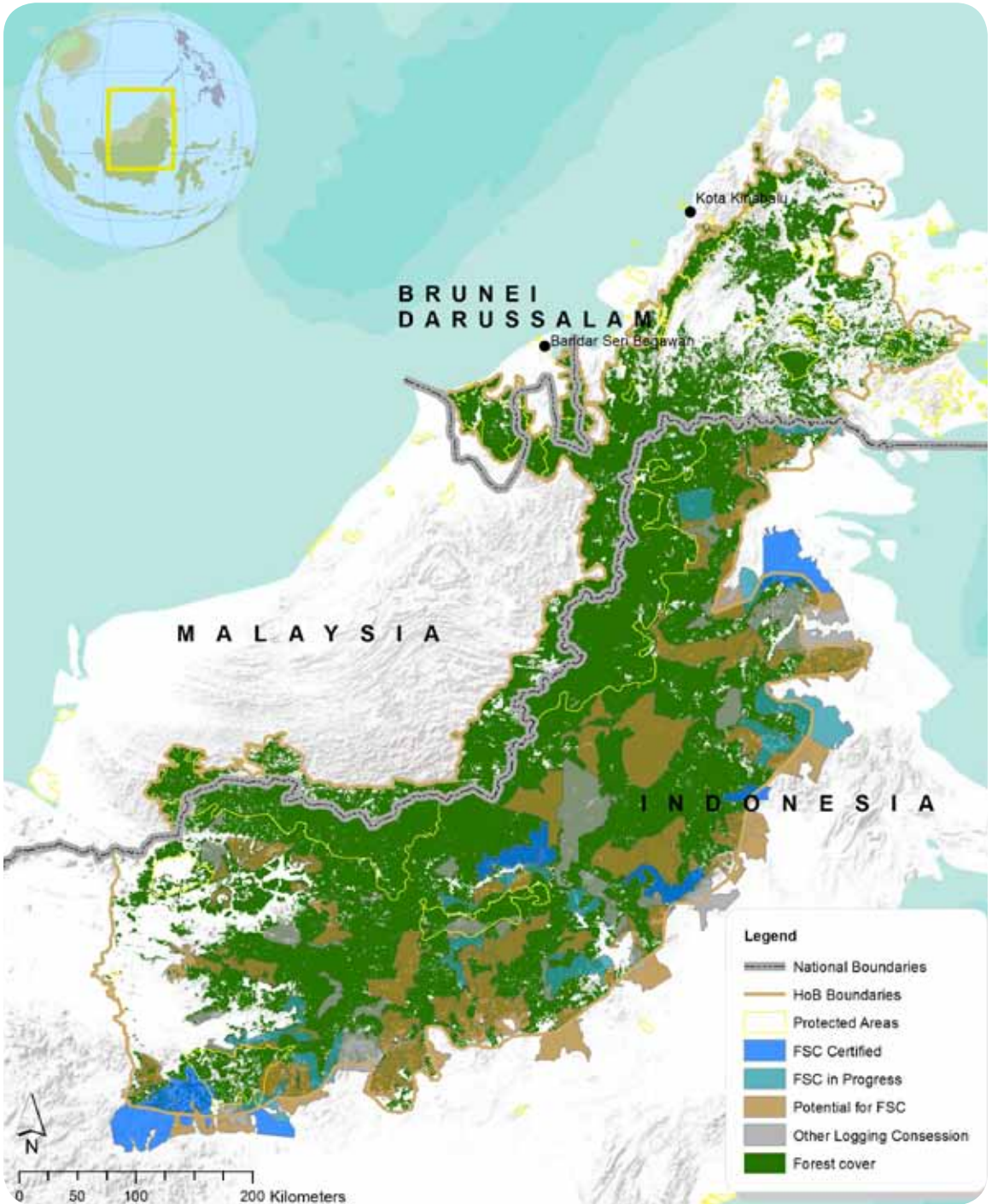
Another large concession (PT Inhutani II) almost connects directly to the Tubu area of Kayan Mentarang and has important lowland forests hardly present in the national park.

A very large area encompassing a large part of the remaining lowlands of north Kalimantan is inside the certified logging concessions of PT Intraca wood and PT Inhutani II, unit Malinau.

In Berau are five certified logging concessions in the lowland edges of the HoB with important orangutan habitats.

In the middle Mahakam area there are PT Belayan River Timber, Hulu Mahakam and three concessions of PT Sumalindo Lestari Jaya V. These areas can ensure the connectivity of lowland and upland forests from the upper to the lower Mahakam basin and might ensure the survival of the orangutan population here, of which the habitats are gradually reduced to smaller strips surrounded by the many oil palm plantations here. In the upper Mahakam, the most interior area below the mountain ranges are four large certified logging concessions of PT Kemakmuran Berkah Timber and PT Rodamas Tbr Kalimantan. Further to the south are the two large certified concessions of PT Ratah Timber. These form a very large area that connects to the mountains of East and Central Kalimantan.

There are several important candidates for certification in the interior of East Kalimantan. The largest areas are the logging concessions of PT Essam Timber and PT Rimba Karya Rayatama and it will become crucial to keep these core areas covered by forest.





## Protected area intactness

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The low resolution of the satellite images used for the analyses implies that only the largest areas of fragmentation are detected. When these tracts appear inside protected areas, it often means that illegal activities were carried out here.

Fragmentation causes the remaining forest areas in having more edges which are subject to direct sunlight and wind. Invading species have easier access and vegetation structure changes.

The Crocker range State Park in Sabah underwent fragmentation not only along the edges but also in the entral part. This is partly caused by encroaching agriculture and construction of infrastructure.

In Mt. Kinabalu state park is a large fragmented area along the north-western slope of the mountain. This could partly be the result of storm damage and encroachment. It should be noted however that the fragmentation analysis is based on forest canopy cover, and the areas of shrub land and even bare rock commonly found at the higher elevations of mount Kinabalu would thus appear as being fragmented, even though this is a natural condition.

The UluTemburong national park of Brunei does not show signs of serious fragmentation and the other smaller protected areas of this green country are also mainly un-fragmented.

In Sarawak the largest protected area is LanjakEntimau wildlife sanctuary. This area is partly fragmented at more than half of its edges but even more serious fragmentation occurred in a large area of the central part. Further investigation could reveal whether this is partly caused by logging. The connecting Batang Ai national park is strongly fragmented.

The northern part of the Pulong Tau national park is fragmented but the southern part is mainly intact. This fragmentation could be temporary if it is caused by shifting cultivation with a long recovery period for secondary forest.

The GunungMulu national park is mainly un-fragmented, except for some edges. This appears to be caused by construction of infrastructure and might partly recover.

DanauSentarum national park in West Kalimantan appears to be strongly fragmented. This is not only caused by the many areas of open water and marshland. According to the official RAPPAM assessment there are indeed issues of encroachment threats, logging threats and forest fire impacts. Land use conflicts increasing might be partly solved through further engagement with the local communities.

The western part of BetungKerihun is fragmented for often more than 50% throughout the area, but the eastern part is mainly un-fragmented except river valleys. The areas that suffered illegal logging can still partly recover with adequate protection. The assessment mentions that encroachment threats and logging threats are decreasing.

The Bukit Baka Bukit Raya national park is shared by West and Central Kalimantan. Most parts of the national park are strongly fragmented, and only some northern and eastern sections remain un-fragmented. The major threats mentioned are from logging and mining but encroachment is also an issue.

The SapatHawung nature reserve in Central Kalimantan has several large fragmented areas along the western edges but the eastern section is mainly un-fragmented. The area is rarely surveyed and logging could be uncontrolled here.

KayanMentarang national park in East Kalimantan is the largest protected area of Borneo and the landscape ecology of the area is relatively well-known after many years of activities in collaboration with the local communities. Most of the fragmentation present in Kayan-Mentarang can be explained by the occurrence of shifting cultivation agriculture, which has been the major means of subsistence of the people for hundreds of years.



