Report :

Where to focus our forest restoration efforts in Indonesia to maximize impacts ?

Application of a scientific approach to prioritising impact

Glossary

RL : Resilient Landscapes

CIFOR-ICRAF : Centre For International Forestry Research – International Centre for Research on Agroforestry

IUCN : International Union for the Conservation of Nature

KBA : Key Biodiversity Areas

IFL : Intact Forest Landscapes

UNEP: United Nations Environment Programme

PU : Planète Urgence

1. Index

2. Background and method

Planète Urgence is an international NGO for the protection and restoration of forest ecosystems, founded in 2000 and active today in the 3 major tropical basins (Amazonia, Congo Basin, Southeast Asia). The association gives priority to areas where the urgency is greatest: deforestation or risk of deforestation; exceptional biodiversity; human vulnerability. Planète Urgence is **a grassroots player that relies on nearly 80 local partners and local teams**. To ensure sustainability, its actions combine local community development, awareness-raising and education, and forest protection and restoration. **Planète Urgence is a member of the IUCN, the Global Mangrove Alliance and a participant in the UN Decade for Ecosystem Restoration.**

Faced with the urgent need to protect and restore forest ecosystems in the countries where it operates, the association decided to carry out in 2023-2024 a more in-depth study to identify priority areas for intervention. As well as being useful for its own operations, Planète Urgence is also keen for these studies to be shared and used by all players in the field**, in order to contribute to collective action within the framework of the United Nations Decade for Ecosystem Restoration.**

In response to the need expressed by the association Planète Urgence to identify priority areas for forest restoration, Resilient Landscapes has mobilized current public knowledge, as well as the tools and know-how resulting from 40 years of CIFOR-ICRAF research.

CIFOR-ICRAF is a world-class research institution providing evidence and actionable solutions to transform the way land and renewable resources are used, and the way food is produced. It is the result of a merger between CIFOR and ICRAF and has over 65 years of combined expertise.

While CIFOR-ICRAF is the world's leading organisation dedicated to research on terrestrial natural capital, its Resilient Landscapes initiative, is a 'gateway' to CIFOR-ICRAF science experts familiar with both scientific and operational language. Resilient Landscapes has proven its ability to unlock new types of cooperation and catalyse investment where it is most relevant for nature and people. **Resilient Landscapes is an impact-focused arm of CIFOR-ICRAF, translating science and data into operational solutions and nature-based project opportunities.**

To meet the needs of the study and consolidate this intermediate deliverable, we have drawn on:

- An in-depth bibliographical analysis at national with relevant datasets for the target geographies
- CIFOR-ICRAF's scientific and research data in relation to the different dimensions of the project, as well as information from the institution's collaborators with experience relevant to the geographies under consideration, at national, regional, and local level, and including the networks of local stakeholders who are partners and known to the institution.

The deliverable contains:

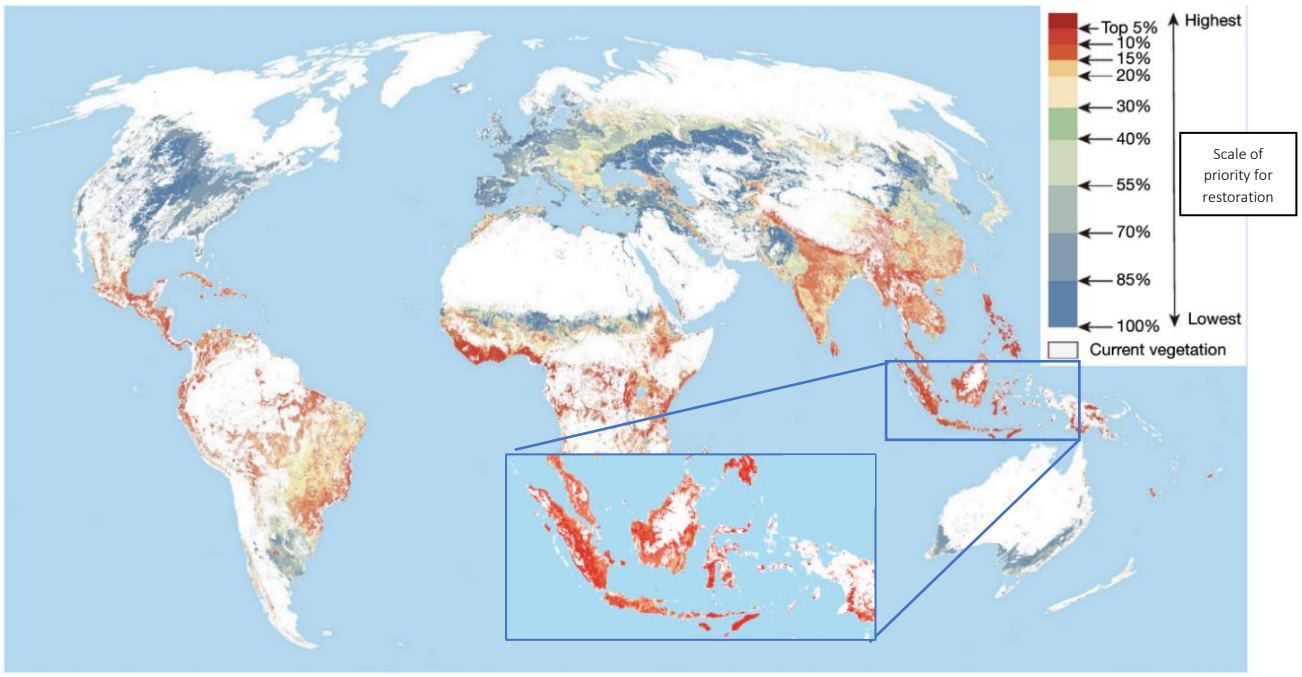
- A mapping of potential areas for conservation or restoration based on biophysical elements, in particular priority ecosystems, biodiversity hotspots, protected areas, terrestrial forest, and mangrove areas, as well as the pressure on ecosystems and their state of degradation.

- A presentation of the issues surrounding these areas, with the key characteristics of the main ecosystems identified, and the main pressures and degradation suffered by these ecosystems.
- Elements for prioritising actions from other sources, as well as an analysis of safety and accessibility in the areas.

3. The importance of Indonesia's Ecosystems

Global priority ecosystems for restauration:

Indonesia has degraded ecosystems that are in the top 5% to 10% of areas for restoration at global level according to *Strassburg et al. 2020*. This study classifies areas based on the importance of biodiversity, the potential for mitigating climate change and the cost of restoration opportunities and concludes that conservation and restoration of Indonesia's ecosystems is of the utmost importance.



Priorities for global restoration
Nature, Strassburg et al. 2020

However, because of its low level of granularity, this mapping on a global scale is insufficient to assess the challenges of restoring the various ecosystems present at national level. This more precise assessment is the subject of this study.

4. Factors for prioritising restoration areas

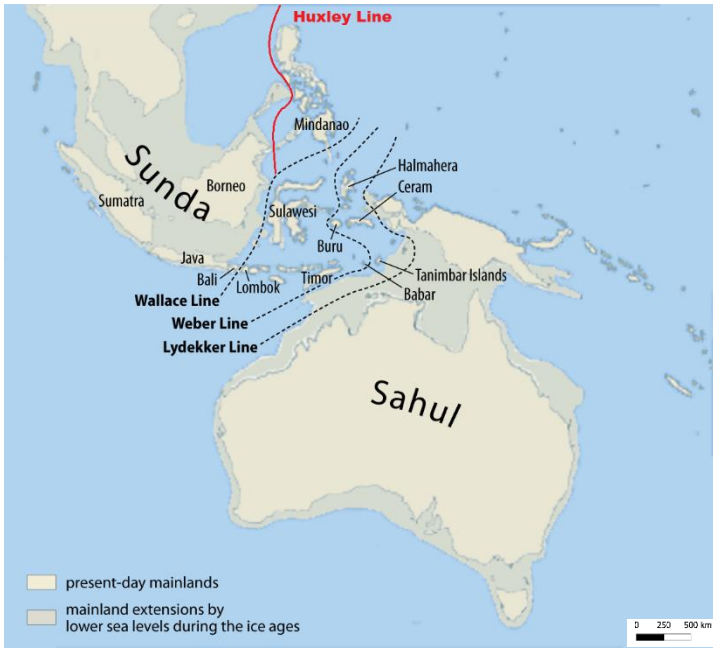
In this section we will review and analyse at national level several prioritisation factors for ecosystem restoration. The factors considered are outstanding ecoregions, key environmental features, historical and current pressures on ecosystems, safety aspects and medium-term climate risk. To identify priority areas of interest, each factor can be considered as a filter whose thresholds and importance must be determined according to the planned environmental restoration or protection project.

4.1. Biogeography, biodiversity, and ecoregions of Indonesia:

Indonesia's archipelago comprises approximately 17,000 islands, of which around 990 are permanently inhabited. It is part of the 17 megadiverse countries of the world, megadiverse countries being a group of countries in which most of the plant and animal species found on Earth are represented (UNEP 2020).

Biogeography:

Indonesia has a very specific geological history. There are 7 major biogeographic regions in Indonesia (areas of animal and plant distribution having similar or shared characteristics throughout), centred on the major islands and their surrounding seas. The Wallace line, Weber Line and Lydekker Line mark the limit between the principal biogeography areas. The zoogeography follows these limits quite closely – for example there are no orangutan, rhinoceros, or tiger populations east of the Wallace line.



Biogeography of indo-pacific continental shelves
NOAA 2019

Biodiversity:

Indonesia possesses 10% of the world's flora (estimated 25,000 flowering plants, 55% endemic). For fauna diversity, about 12% of the world's mammals (515 species) occur in Indonesia, ranking it second at the global level, after Brazil. About 16% of the world's reptiles (781 species) and 35 species of primate are found in Indonesia. 17% of the total species of birds (1,592 species) and 270 species of amphibians' place Indonesia in the fifth and sixth ranks in the world respectively. The list of species threatened by extinction includes 140 species of birds, 63 species of mammals and 21 species of reptiles.

The main factors affecting biodiversity loss and species extinction in Indonesia are habitat degradation and fragmentation, landscape changes, overexploitation, pollution, climate change, alien species, forest and land fires, and the economic and political crises occurring in the country.

Ecoregions of Indonesia:

An ecoregion is defined as a large unit of land or water containing a characteristic set of natural communities sharing a large majority of their species dynamics, and environmental conditions (WWF, *Olson et al. 2012*). The Global 200 is the list of ecoregions identified by the WWF as priorities for conservation based on their unique biodiversity and the threats they face. Indonesia has 18 Ecoregions that are part of the Global 200.

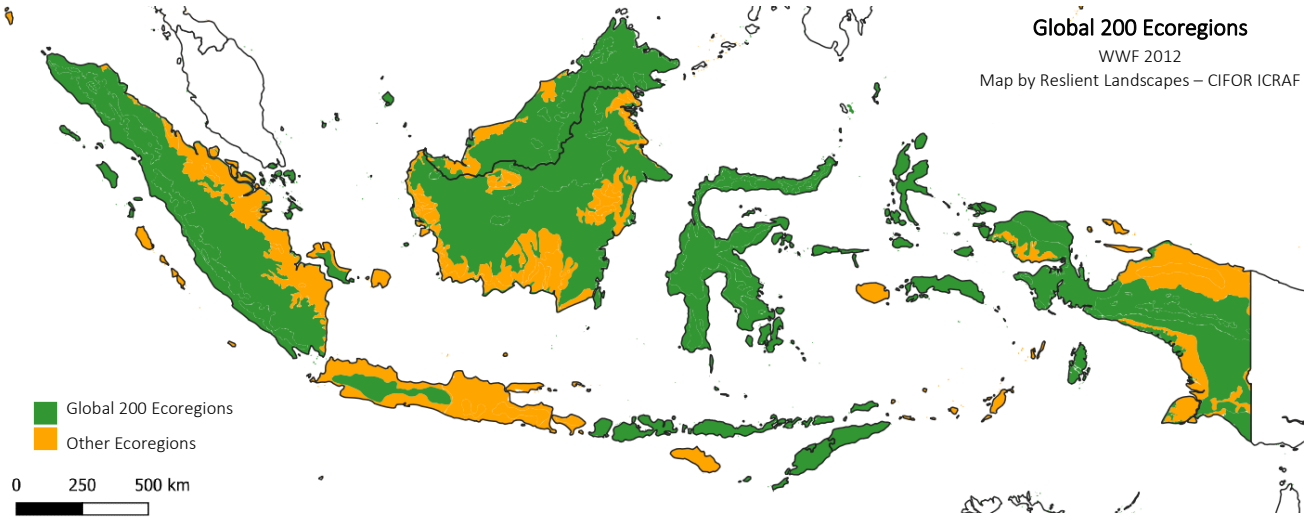
The table below shows 5 of Indonesia's islands and archipelagos that will be the focus of this study and their general characteristics, the ecoregions present and the main pressures leading to deforestation, deforestation being the main degradation of these ecosystems. The Papua and Maluku islands will not be covered by this study as they are considered as out of scope for Planète Urgence's activities.

Main Islands of Indonesia

Islands and archipeleagoes	Drivers of deforestation (*Source: WWF 2022, Nusantara Atlas 2023)*	Photo of ecosystems
Sumatra Covering 470,000 km2, Sumatra is the 6th largest island in the world. There are more than 15,000 known plants on the island. Sumatra is home to 201 mammal species and 580 bird species. There are 6 ecoregions present on the island, of which 4 are part of the Global 200: **Sumatran lowland rain forests, Sumatran montane rain forests, Sumatran tropical pine forests and Sunda Shelf mangroves**. The 2 other ecoregions are: Sumatran freshwater swamp forests and Sumatran peat swamp forests. This is the only place where Sumatran tigers, rhinoceros, orangutans, and elephants live in the same ecosystems. It is also home to the proboscis monkey (*Nasalis larvatus*).	About 12 million hectares of forest on Sumatra have been cleared in the past 22 years, a loss of over 50% of the original forest cover. Main drivers of deforestation are the expansion of palm plantations (9.8 Mha), Industrial pulpwood plantations (2 Mha), as well as other agricultural crops, mining, and fires. Forests on mineral soils are under the highest pressure (60 000ha deforested in 2022), but peat swamp forests and mangroves are also under threat.	 Leuser ecosystem in Aceh
Kalimantan/Borneo Borneo or Kalimantan is the 3rd largest island in the world and the Indonesian part of the Borneo Island covers 544 660 km^2. There are 230 species of mammals (44 of which are endemic), 420 resident birds (37 endemic), 100 amphibians, 394 fish (19 endemic), and 15,000 plants (6,000 endemic). Six terrestrial ecoregions are found on this island, of which 3 are part of the Global 200: **Borneo Lowland Rainforests, Borneo Montane Rainforests, and the Sunda Shelf Mangroves**. The other ecoregions present are Borneo Peat Swamp Forests, Southwest Borneo Freshwater Swamp Forests, and Sundaland Heath Forests. The island's isolation since over 12,000 years has resulted in the evolution of several endemic species and subspecies, including large species such as Bornean orangutan, Sunda clouded leopard, and Asian elephant.	About 23 million hectares of forests remain on Borneo, a loss of over 50% of the original forest cover. One of the biggest drivers of deforestation in Kalimantan is the growth of oil palm plantations, both industrial and smallholder plantations (6 Mha). Pulpwood plantations are also an important driver of deforestation (1 Mha) as well as agriculture, logging, fire, and mining. Of the 93 000 ha of deforestation identified in 2022 the majority was the conversion of forests on mineral soils (76 000 ha), then comes peatland forest and mangroves.	

Islands and archipeleagoes	Drivers of deforestation (*Source: WWF 2022, Nusantara Atlas 2023, OneEarth 2022)*	Photo of ecosystems
Java Island Java is the fifth largest island in Indonesia with about 138,800 km^2. It is also the most populated island in the world with a population of over 150 million people. Over 6,500 species of plants, 100 species of mammals, and 450 bird species are present in Java. Four terrestrial ecoregions are present on the island, of which one is part of the Global 200 which is the **western Java montane rain forests**. The other ecoregions present are Western Java rain forests, Eastern Java–Bali montane rain forests, Eastern Java–Bali rain forests. Several mammals are endemic to Java, these include the Javan slow loris and the Silvery Gibbon. It is also home to the critically endangered Javan Rhinoceros (*Rhinoceros sondaicus*).	The high population and extensive economic activities have significantly reduced the forest areas of the Island and have greatly increased the pressure on its ecosystems. Only about 700 000 ha of forest remain mostly found in protected areas. Anthropic pressure, agriculture and urbanisation has been a threat to forests in the past. In recent years deforestation has slowed down and only 260 ha of deforestation was identified in 2022.	 Gunung Halimun-Salak National Park, Java
Sulawesi Sulawesi is the world's eleventh-largest island with about 186,216 km^2. Over 1450 species of birds, 127 mammals and 5,972 plants (2,225 of which are endemic) are found on the island. Two terrestrial ecoregions are found on the island**,** and they are both part of the Global 200: **Sulawesi Montane Rainforests and Sulawesi Lowland Rainforests**. It is home to the Celebes crested macaque which is critically endangered and considered the most threatened primate on Sulawesi.	The tropical forests, which once covered the whole island, have been broadly deforested by agriculture, logging, and mining. Because most of Sulawesi's pristine lowland forests had been lost nearly two decades ago, its current rate of deforestation doesn't seem too high compared to Sumatra and Kalimantan. However, should the present rate of forest loss continue, it could be catastrophic for the island's remaining wildlife and natural ecosystems. The main drivers are agriculture for cash crops (cocoa and oil palm mostly), mining and logging.	 Lasolo Delta, Sulawesi

18 of the 38 ecoregions present in Indonesia are part of the Global 200. The Global 200 ecoregions can be considered as prioritisation criteria for restoration projects because of their exceptional nature in terms of biodiversity. The map below shows the Global 200 in Indonesia, they are present on almost all the islands in the scope of our study.



The Global 200 was not created with for the purpose of excluding non-Global 200 areas. Therefore, we will not systematically exclude areas. They will be used as criteria for selecting restoration areas in certain scenarios at the end of this report. In the next sections we will go further in the analysis of additional environmental factors.

4.2. Environmental characteristics considered when assessing restoration projects.

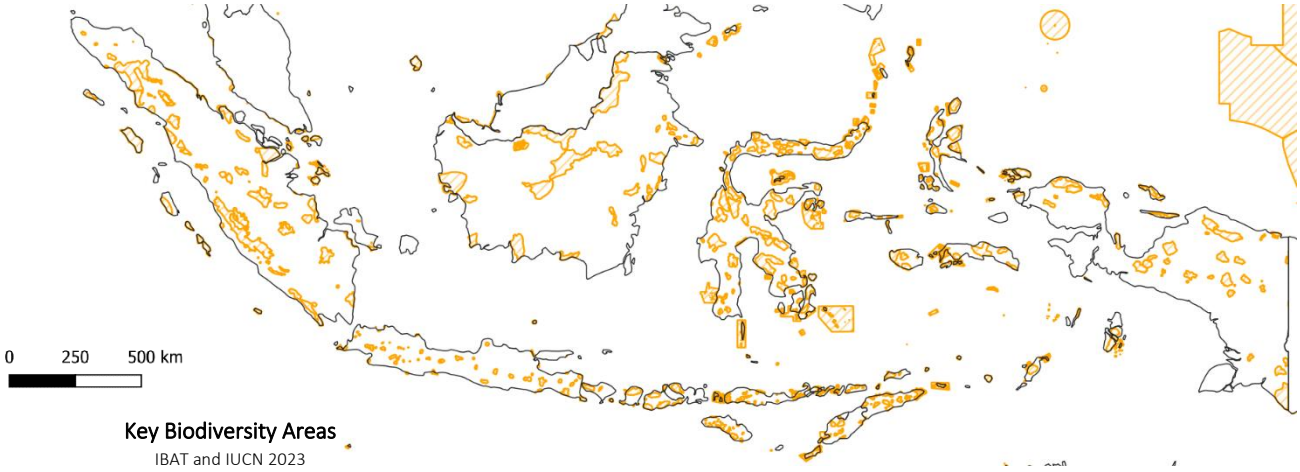
The various environmental elements we have considered for this analysis are biodiversity, presence of forests and mangroves, protected areas, and national parks, as well as the historical and current pressure on ecosystems.

4.2.1.The importance of Biodiversity

Key Biodiversity Areas:

The Key Biodiversity Areas (KBA) dataset, produced by IUCN, helps to identify, and designate areas of international importance in terms of biodiversity conservation using globally standardised criteria. Endangered species include those identified on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species: species whose populations are very small, geographically restricted or in rapid decline. The criteria used to identify KBAs also consider vital sites for species whose populations are confined to small areas or form large aggregations at certain times of the year to breed, feed or migrate - as these species all depend on a limited number of key habitats. The identification of KBAs makes it possible to focus protection efforts on sites that are important for nature. This data is used by various stakeholders to ensure that their negative impacts on biodiversity are avoided or reduced, and to ensure that conservation efforts are concentrated where they will have the greatest positive impact on biodiversity. KBAs are based on datasets produced by various expert organisations such as Birdlife International, and depending on the sources and countries may sometimes be limited in their representation of the complexity of local biodiversity. They can be used in combination with other indicators to identify the importance of ecosystems when assessing restoration projects.

In Indonesia there are 509 KBAs that have been identified from 42 different sources, publications, and organisations. They cover many different habitat types and biodiversity ranging from flora, mammals, birds, and amphibians.

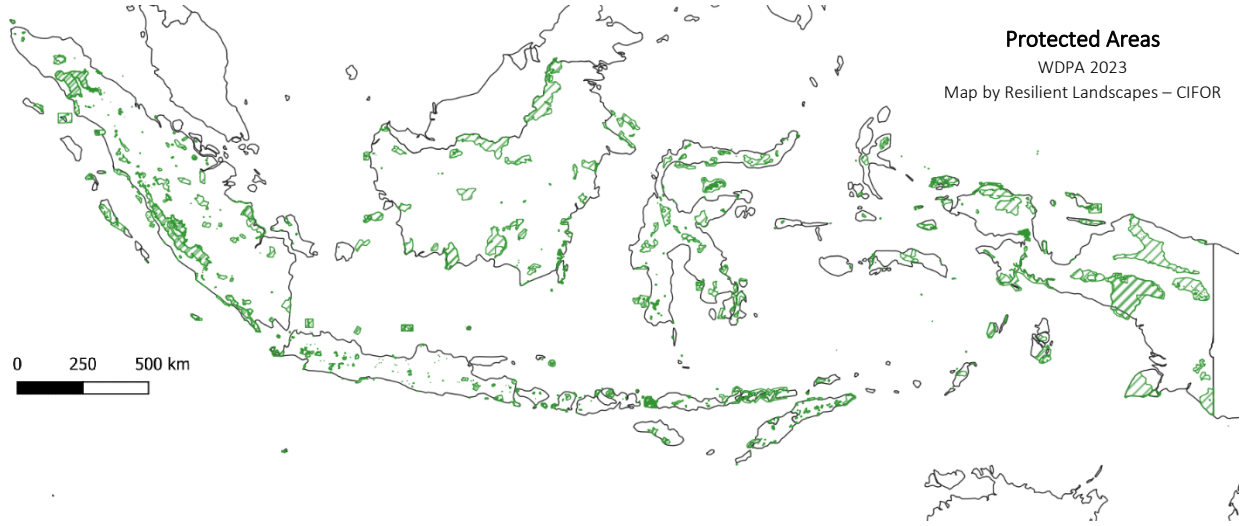


Key Biodiversity Areas
IBAT and IUCN 2023
Map by Resilient Landscapes CIFOR-ICRAF

Protected Areas:

Protected areas in Indonesia have been created to preserve natural habitat and biodiversity. However, there are often conflicts between local people and the conservation objectives. For instance, in Tesso Nilo National Park in Riau province, which has one of the strongest levels of protected area. The park was established in 2004 to preserve Indonesia's charismatic endangered species, Sumatran elephant (*Elephas maximus sumatranus*) and Sumatran tiger (*Panthera tigris sumatrae*). Yet it continues to be entangled in land conflicts. Today people continue to build illegal settlements, clear forests for agriculture and palm oil plantations in areas where human activities are supposedly banned. The remaining forest cover is approximately 10 000 ha down from the original 70 000 ha when it was created. Furthermore, areas in conservation forests were divided into different zones in 2015 to try and resolve land conflicts. For instance, in utilisation zones people are allowed to continue their traditional farming activities. In religion zones, people are allowed to use the area for worship. In the core areas human activities are prohibited.

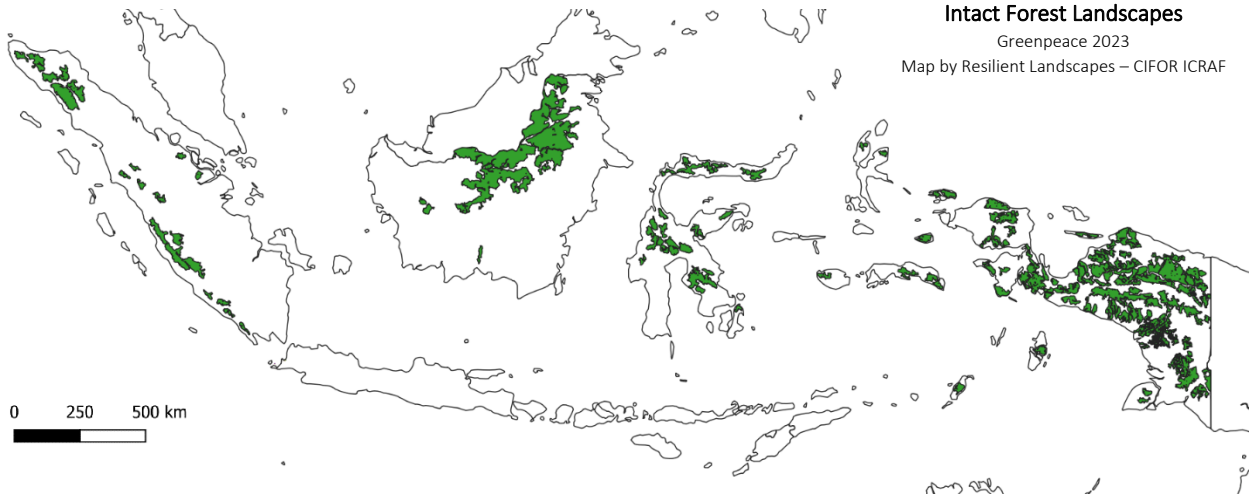
In total we have identified 702 Protected areas of 12 different categories from the highest degree of protection (National Park) to natural areas where sustainable management of the area is authorised (such as nature parks or game reserves). These protected areas are illustrated in the map below.



Protected areas are important to consider when assessing restauration and protection potential as studies have showed that they are effective in protecting forests and slowing deforestation in most cases (Santoro 2017), remaining landcover and degradation should also be considered.

Intact Forest Landscapes (IFL):

An Intact Forest Landscape (IFL) is a seamless mosaic of forest and natural ecosystems, which shows no signs of human activity or habitat fragmentation and is large enough to maintain all native biological diversity, including viable populations of wide-ranging species. IFLs have high conservation value and are critical for stabilizing terrestrial carbon storage, harbouring biodiversity, regulating hydrological regimes, and providing other ecosystem functions. The latest mapping of intact forest landscapes in 2020 was carried out at global level by a coalition of organisations led by Greenpeace. In Indonesia the majority of IFLs are in Papua, with important areas of IFLs present in Kalimantan, Sulawesi, and Sumatra.



Mapping areas of importance for biodiversity:

By compiling and superimposing these different maps and adding up the areas of intact forest, it is possible to identify the most important areas of the country in terms of biodiversity, endemic and threatened species. The result is the map below, which shows that there are areas of high biodiversity present on all the main islands of Indonesia. Some have larger areas of importance for biodiversity such as the central part of Kalimantan Island (also known as the heart of Borneo) and Papua's intact rainforests. The areas with the fewest remaining areas of high biodiversity are areas that are densely populated such as Java or that have been degraded for agriculture such as parts of Kalimantan and Sumatra.

4.2.2. Environmental threats

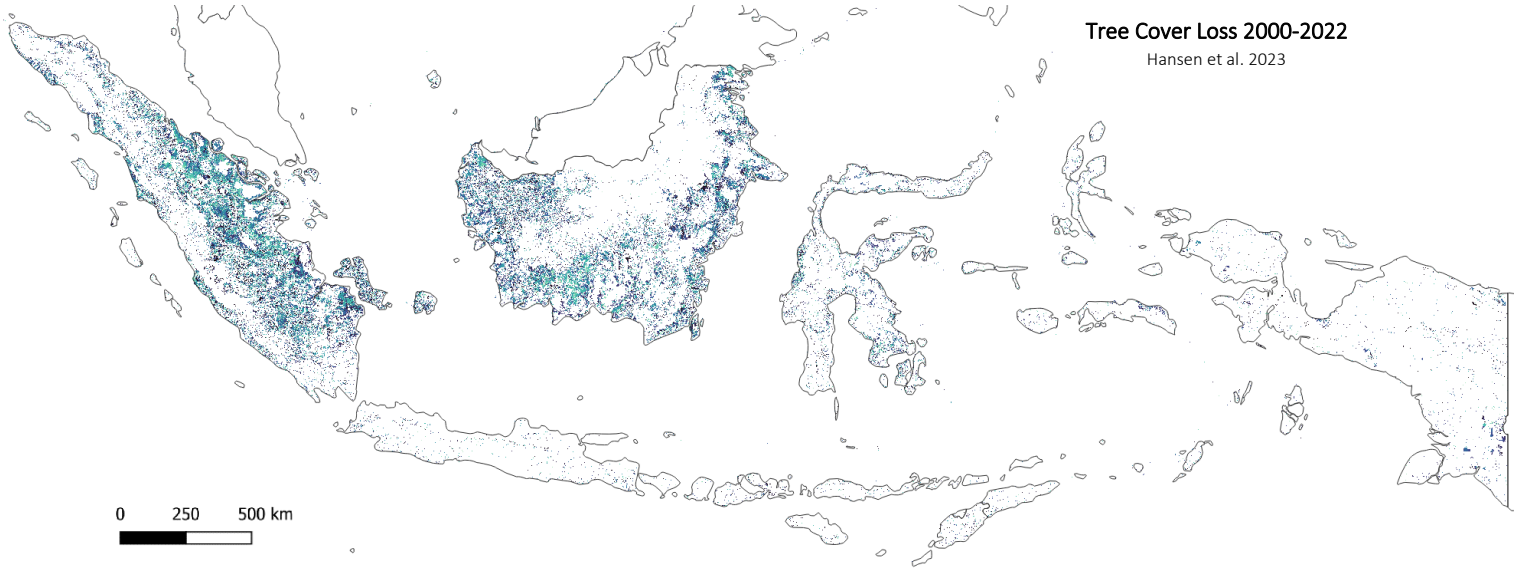
To map environmental pressures precisely, we have chosen to study two important aspects: deforestation and mangrove degradation.

Deforestation:

Several datasets are available to assess deforestation. To have an overview of recent deforestation and a precise granularity, we have chosen to use maps from *High-Resolution Global Maps of 21st-Century Forest Cover Change* (Hansen et al. 2023).

This mapping, which can be seen on the map below, identifies the loss of tree cover between 2000 and 2022, with each pixel representing a deforested area measuring 30m x 30m.

Most of the deforestation in recent years has taken place in the forests of Kalimantan and Sumatra, Sulawesi has also seen significant tree cover loss albeit less intense.



Mangrove degradation:

About 3 million hectares of mangrove forest grow along Indonesia's 95,000 km coastline. This is 23 percent of all mangrove ecosystems in the world (Giri et al., 2011). Over the past three decades, Indonesia has lost 40 percent of its mangroves. This means Indonesia has the fastest rate of mangrove destruction in the world (Campbell & Brown, 2015). Mangrove deforestation accounts for 6 percent of total annual forest loss in Indonesia, despite covering less than 2 percent of the country's total forest area.

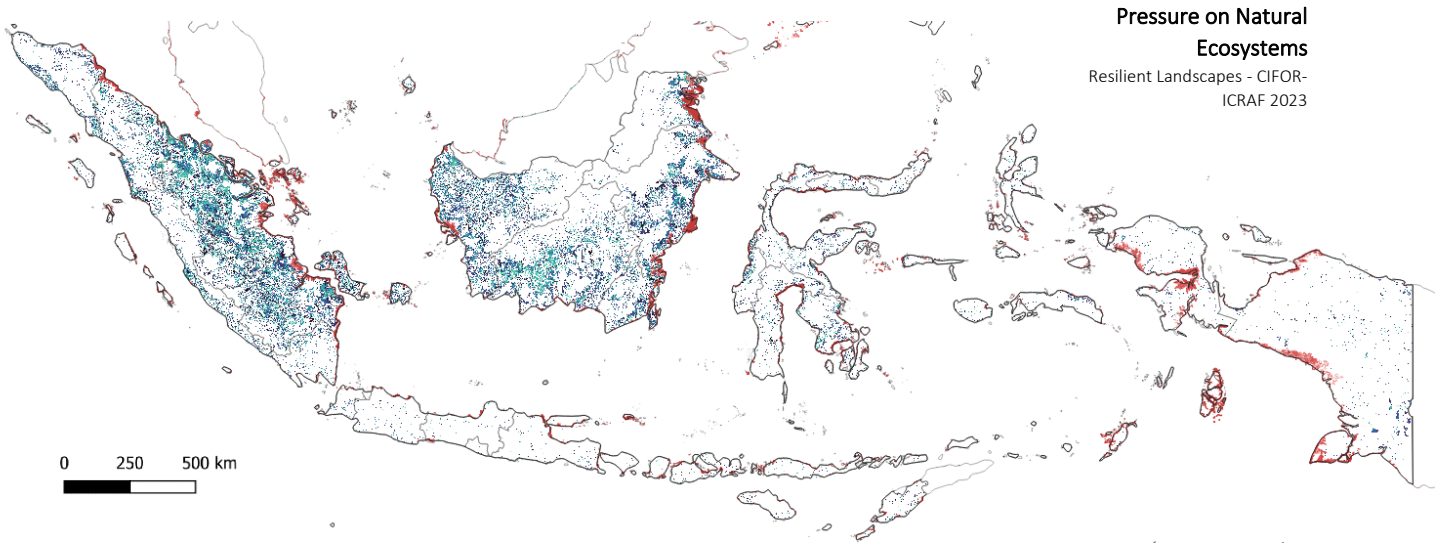
To map the situation of mangroves we used the dataset called *Global Mangrove Watch: yearly habitat change* (Bunting et al. 2023). This dataset allows us to identify the degradation and loss of mangroves between 2000 and 2020. Three main areas of heavy mangrove loss appear, the Mahakam Delta in East Kalimantan, the coastal areas of North Kalimantan and the coasts of Aceh in Sumatra.

The main causes of mangrove loss in Indonesia include conversion to shrimp ponds known as the “blue revolution” (Sumatra, Sulawesi, and East Java), logging and conversion of land to agriculture or salt pans (Java and Sulawesi) and degradation due to oil spills and pollution (East Kalimantan).

Identification of areas under historical and current pressure

Linking maps of deforestation, degradation of mangroves allows us to identify natural areas that are under historical and current deforestation and degradation pressure.

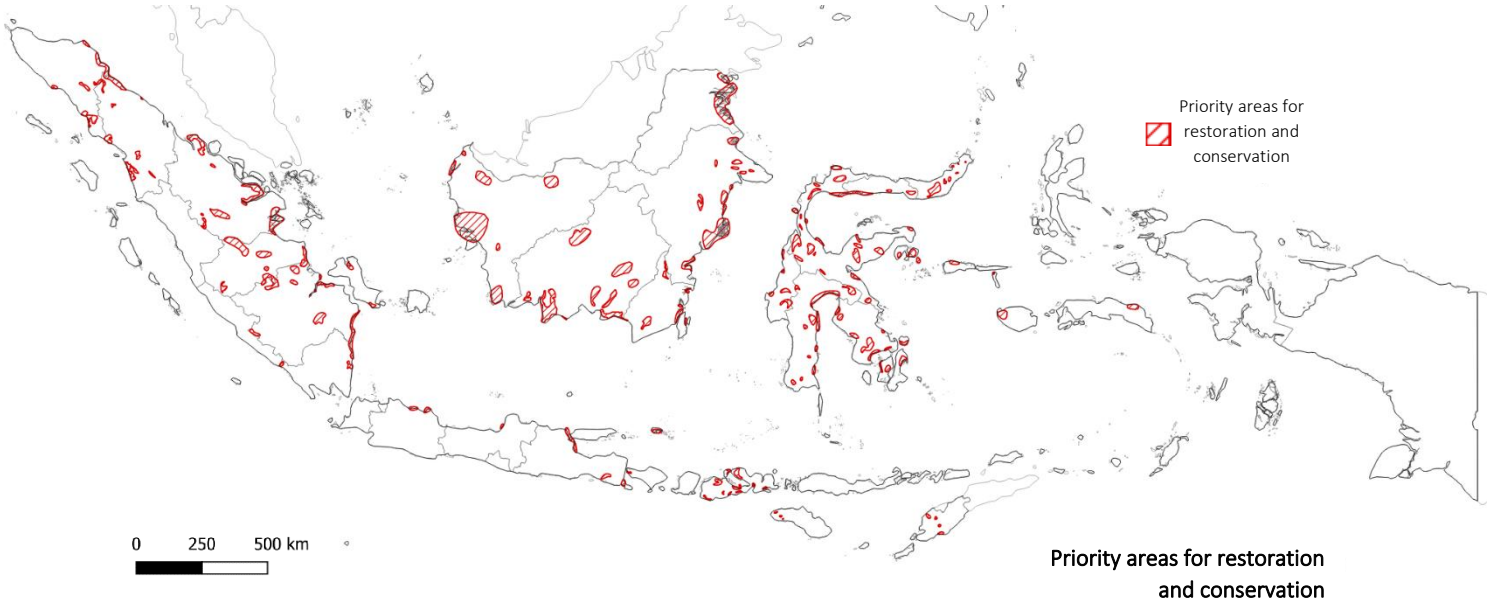
The map below illustrates the fact that almost all islands in Indonesia are facing degradation and environmental pressure. Kalimantan and Sumatra are the two regions that have the highest level of degradation, followed by Sulawesi.



Priority areas for restoration

By cross-referencing the analyses of areas of importance for biodiversity and natural areas under pressure, it is possible to identify priority areas for restoration. The areas identified on the map below are concentrated around protected areas and KBAs, as well as in the mangrove forests on the coast.

These areas are considered priorities for restoration and conservation projects (Papua is out of scope). They are present in all the regions of Indonesia. In total they cover approximately 94 000 km^2. The majority of areas are situated in Kalimantan, Sumatra as well as Sulawesi.

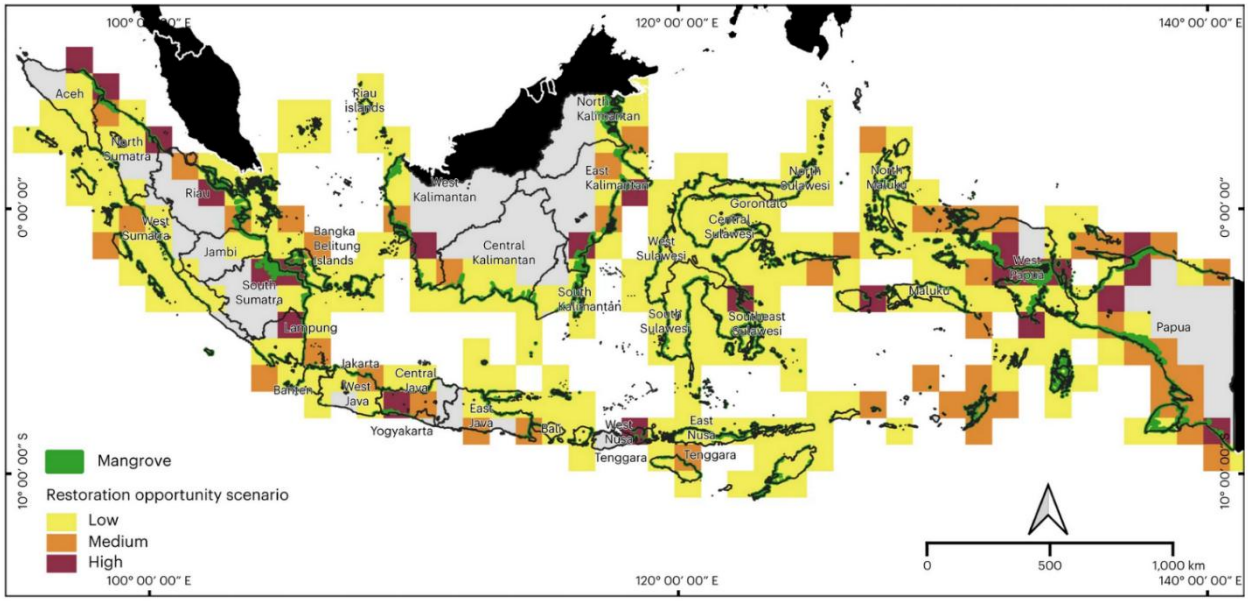


Priority areas for restoration and conservation

Resilient Landscapes - CIFOR-ICRAF 2023

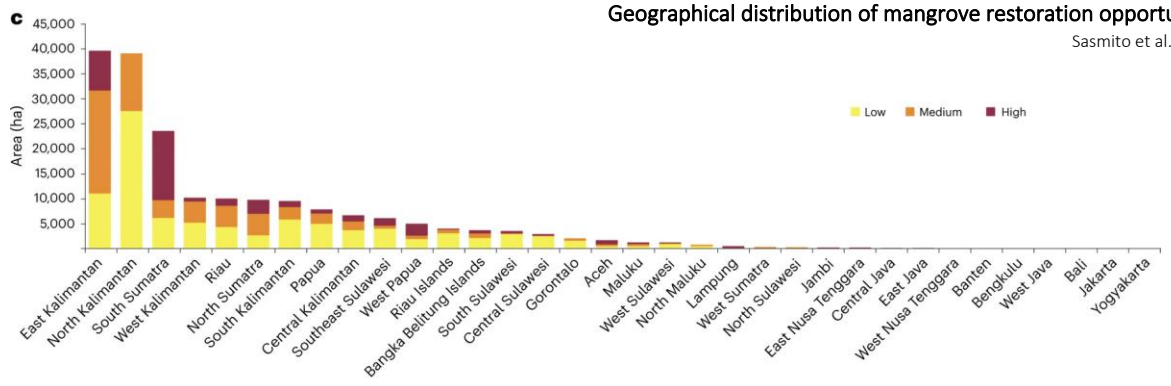
4.3. Contextualising the study with other studies

Below are presented the results of a study called *Challenges and opportunities for achieving Sustainable Development Goals through restoration of Indonesia's mangroves* (Sasmito et al. 2023) that identifies the priority areas for mangrove restauration. These results are coherent with our study and identify East Kalimantan, North Kalimantan, and South Sumatra as the 3 main provinces that have the highest area for mangrove restoration. The maps and graphics below are extracted from the study.



Geographical distribution of mangrove restoration opportunity

Sasmito et al. 2023



Mangrove restoration opportunity scenarios area at provincial level

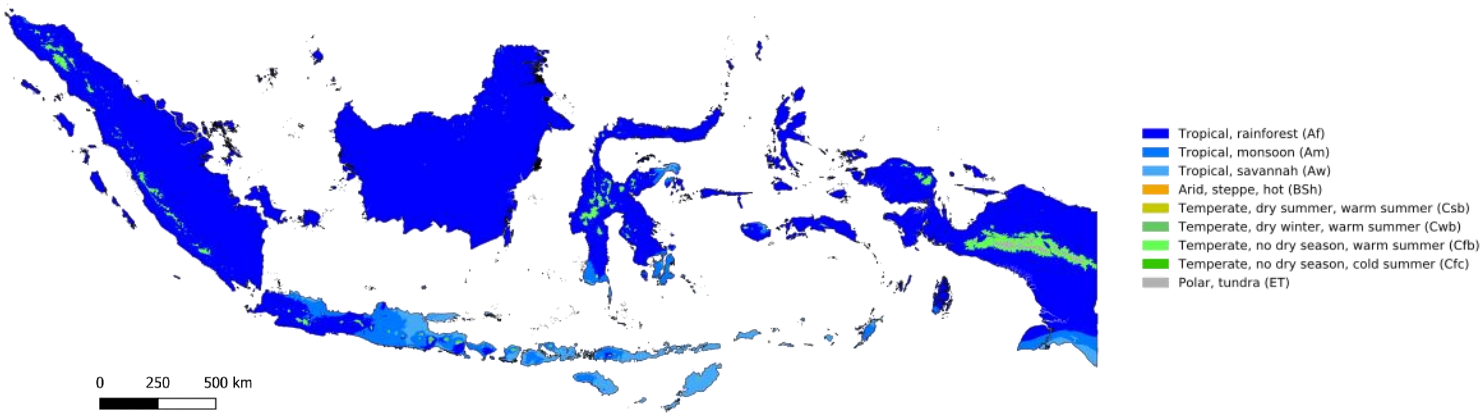
Sasmito et al. 2023

4.4. The main impacts of climate change by 2100

Depending on the type of project, the risks associated with long-term climate change may be considered a relevant factor to consider. It is important to bear in mind that the future impacts of climate change are based on constantly evolving predictive models.

The two maps below are taken from the study *Present and future Köppen-Geiger climate classification maps at 1-km resolution* (Beck et al. 2018) and illustrate the current climate zones and the estimated evolution of these climate zones between now and 2100.

Köppen-Geiger climate classification map for 1980-2016

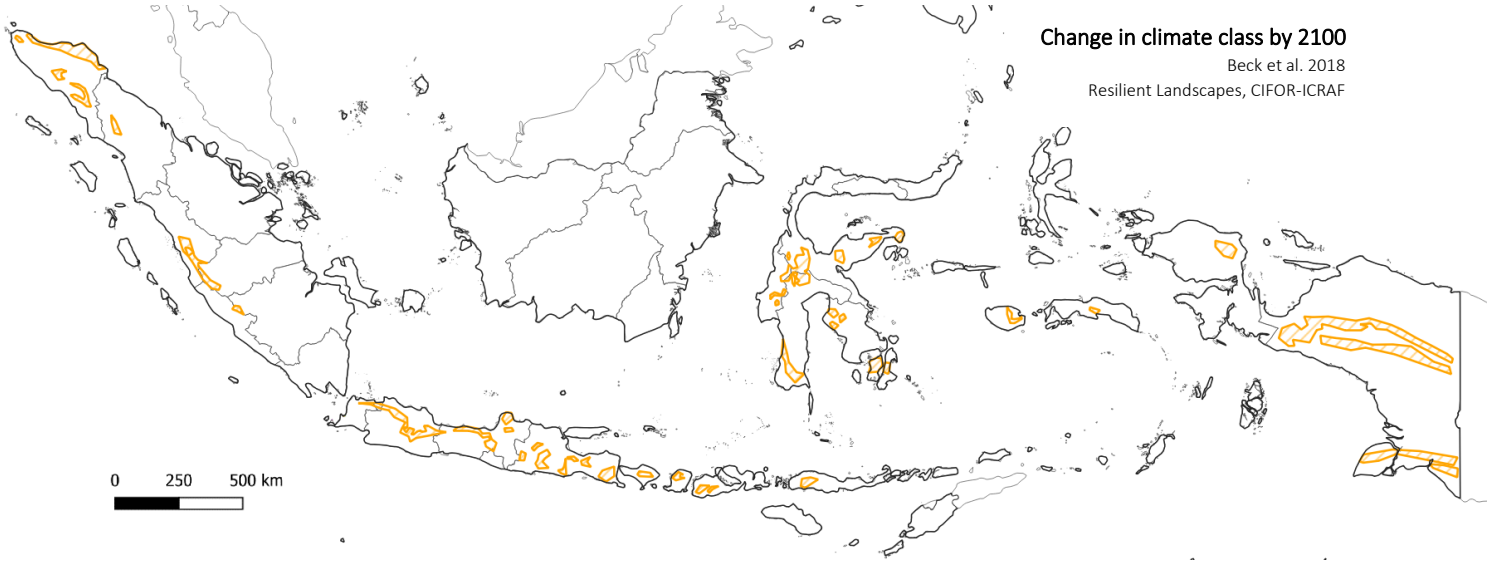


Köppen-Geiger climate classification map for 2071-2100

Present and future Köppen-Geiger climate classification maps at 1-km resolution

Beck et al. 2018

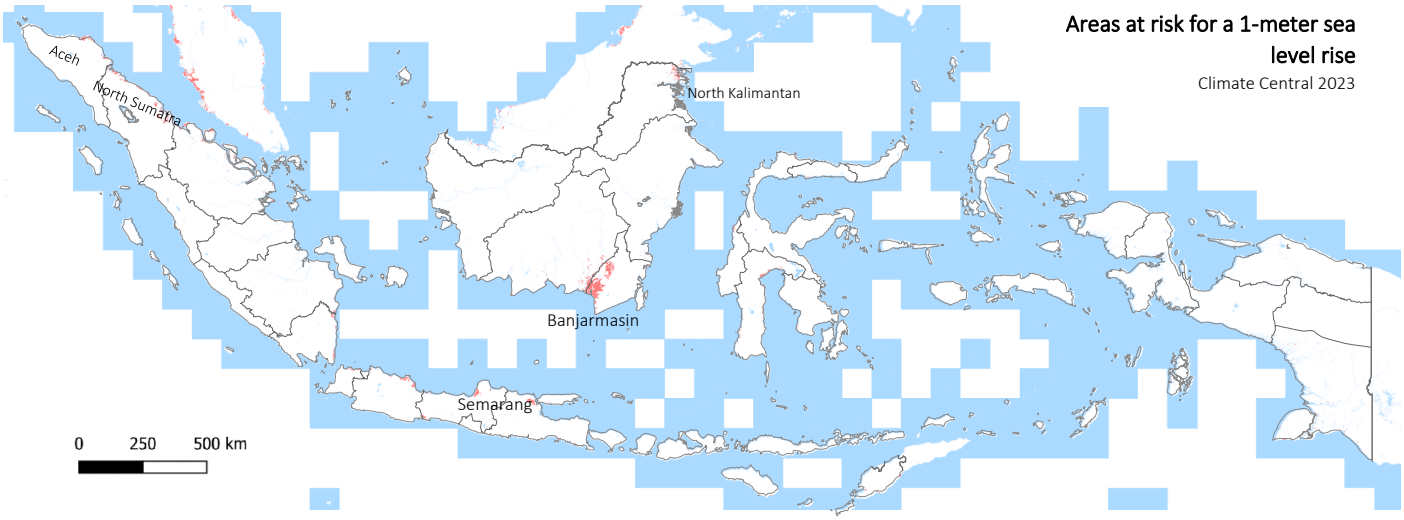
The map below is a consolidated summary of the results of this publication and models the areas of Indonesia that are expected to change climate class by 2100. According to the study, there should be few impacted areas, and they are mainly concentrated on Java, Sumatra, Sulawesi, and Papua. These areas should see a wetter and warmer climate by the end of the century.



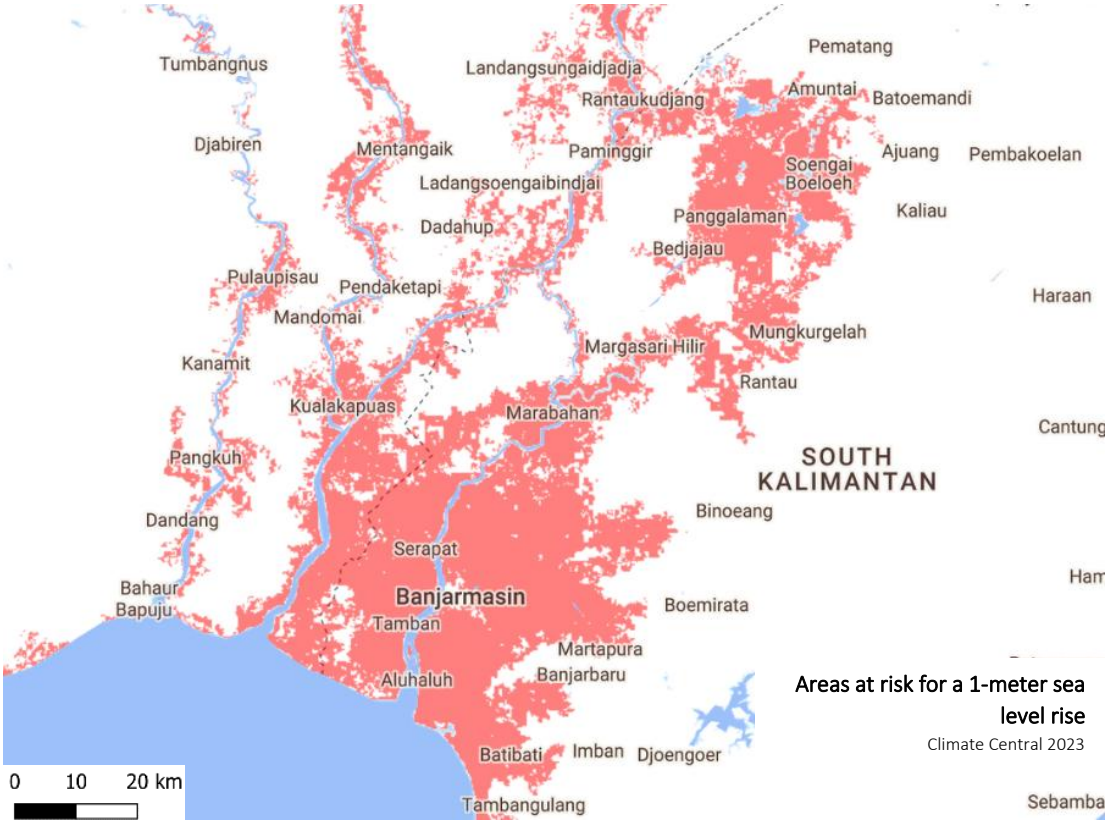
Rising sea levels

For coastal projects, considering the risk of rising sea levels may also be relevant. The map below shows a model of a one metre rise in sea levels (Climate Central 2023), combining sea-level rise, tides, and storm surges.

Several coastal areas are at risk in Indonesia, the biggest one being the area around Banjarmasin in South Kalimantan. Other large areas are at risk, the coastal areas of North Sumatra, North Kalimantan, and Aceh as well as areas around Semarang on the island of Java.



The impact of this factor is difficult to visualise on a national scale, but it may be relevant on a very local scale and should therefore be studied in greater detail for projects in coastal areas. The map below shows the areas at risk around Banjarmasin.



4.5. Security and accessibility issues for restoration operations in Indonesia

There are few security issues in Indonesia. The French ministry of foreign affairs does not recommend on going to the Papua province.

Security map
French Ministry of Foreign Affairs 2023

The accessibility of projects depends on several factors, including the location of the centre of operations in relation to the field sites. The current and future road network must be considered, as well as potential travel outside the road network (by plane, boat, etc.). In Indonesia many of the smaller or more isolated islands are difficult or expensive to access, and seasonal climate characteristics can have significant consequences on time allocated to travel.

5. Conclusions

Based on robust data available to date, this study presents priority areas for ecosystem restoration in Indonesia. The methodology used and the relevance of the sources used justify the conclusions presented, which may change over time as the context evolves.

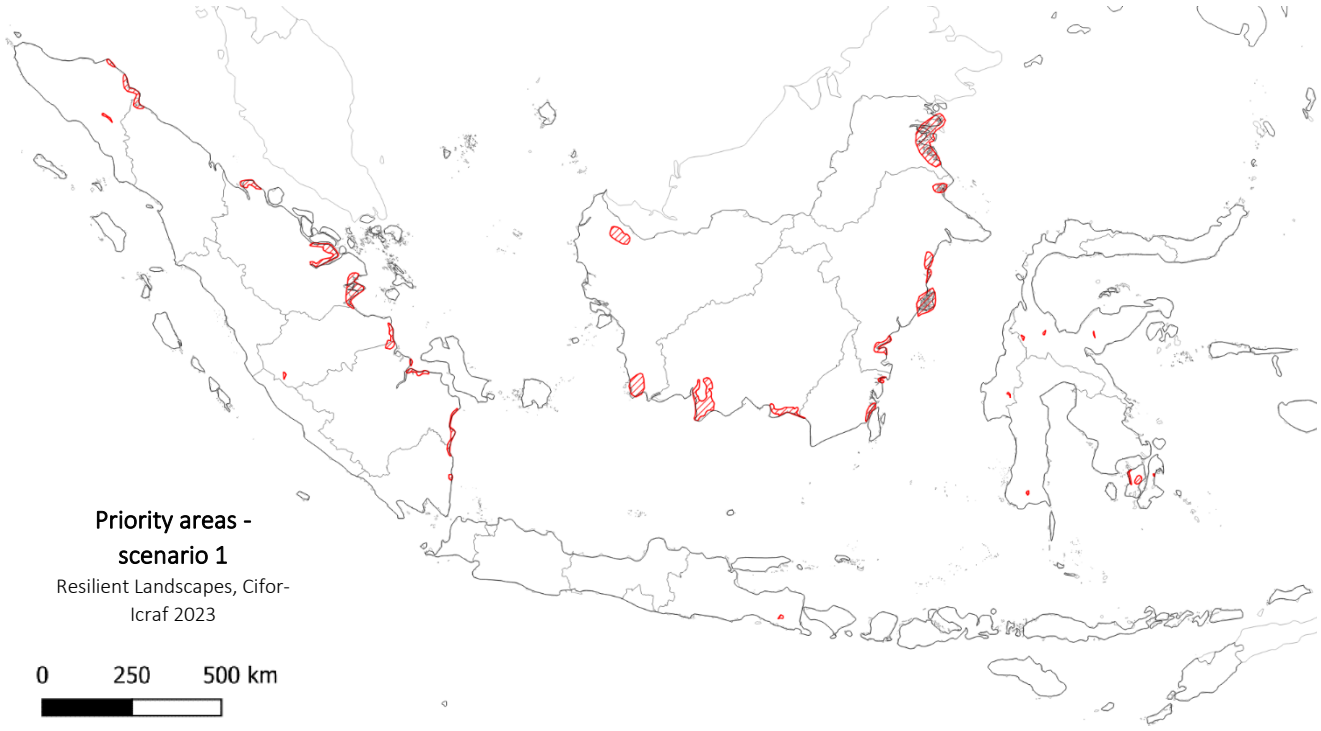
The degree of relevance, importance and thresholds of each factor presented must be assessed according to the type of project being considered. Below are some examples of scenarios for prioritising intervention areas, to illustrate the importance of the project developer's decisions in applying the prioritisation factors.

5.1. Scenario 1: Priority to areas that present little security risks and where the climatic impact would be significant.

In this scenario, we have chosen to use the following filters:

- Areas with little security risk
- Priority areas for biodiversity
- Presence of pressure on ecosystems
- Significant impact of climate change

It is quite a restrictive scenario and only identifies 33 areas that cover approximately 29 000 km^2. A lot of areas are along the coast and are areas for potential mangrove restoration. The largest area (5000km^2) is on the coast of North Kalimantan, an area that has seen significant mangrove degradation. Another large area is the coastal area between South Sumatra and Lampung, also for mangrove restoration. Some areas have also been identified within National parks (Tanjun Putting NP in Central Kalimantan and Way Kambas NP in Lampung for example) and in KBAs (Muna Timur on Pulau Muna Island).

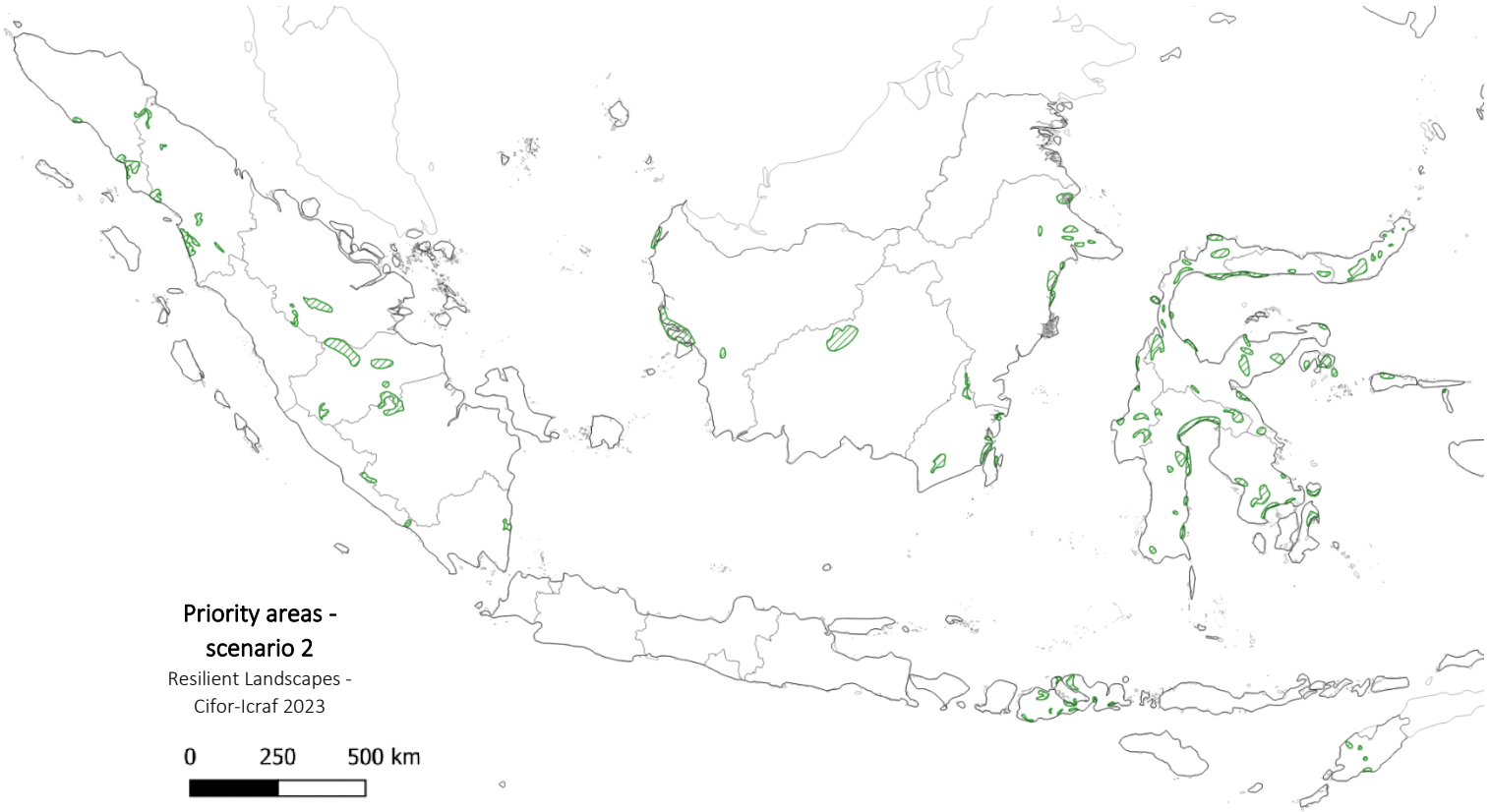


5.2. Scenario 2: Priority to areas in Global 200 Ecoregions that present little security risks and where the climatic impact would not be significant.

In this scenario, we have chosen to use the following filters:

- Areas with little security risk
- Priority areas for biodiversity
- Presence of pressure on ecosystems
- Low impact of climate change
- Global 200 Ecoregions

This scenario targets areas that are in Global 200 Ecoregions and where climate change would not have a significant impact. It is a wider scope scenario and identifies 107 areas that cover approximately 42 000 km^2. There is a variety of areas identified on many islands of the country. The largest area (2900km^2) is Rawa di Pesisir Kapuas on the coast of West Kalimantan, an area of swamp, peatlands, and mangroves. Another large area is the Bukit Baka – Bukit Raya National Park in West Kalimantan, that has seen small scale degradation. There are also many smaller areas identified in Sulawesi and Sumatra,



The choice of factors to be used by the project implementer can be decided on their priorities and certain reflections around the strategy, for example:

- Prioritising areas that will suffer less from the impact of climate change may help to ensure the sustainability of restoration actions, but it means ruling out projects in areas where local populations will be most affected in the short and medium term by changes to their environment and livelihoods.

Depending on the objectives of Planète Urgence and its priorities, it is possible to carry out several iterations of filters and to refine scenarios which would identify different priority areas. The purpose of this intermediary study, and the description of the prioritisation factors, is to initiate discussion with the Planète Urgence teams to define the prioritisation factors best adapted to the organisation's strategy, and thus to make progress in the definition of prioritisation zones for future projects, these more precise local zones being the subject of the final deliverable.

Sources :

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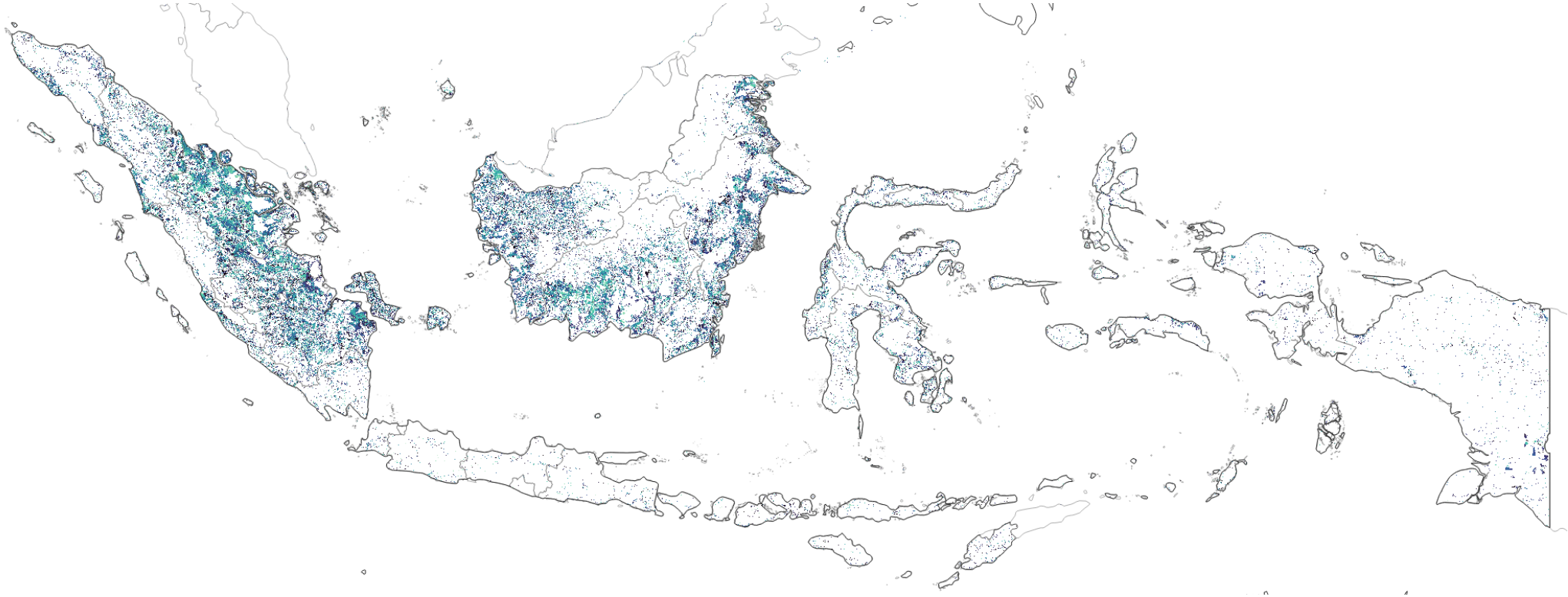
Annex – Map of tree cover loss in Indonesia



Tree cover loss 2000-2022

Hansen et al. 2023

2000 2022