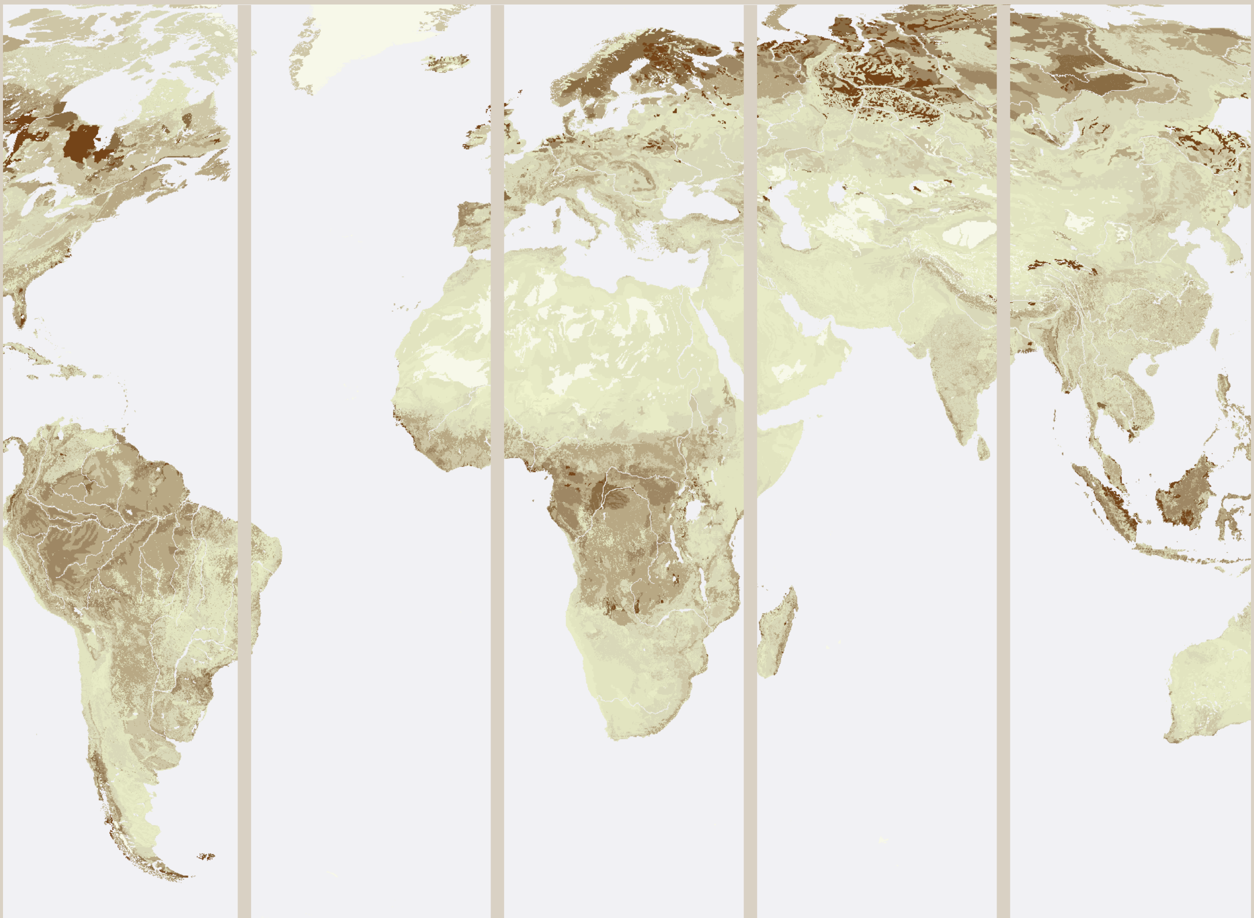
Carbon and **biodiversity**



A demonstration atlas

UNEP WCMC

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Contents

Introduction

This atlas demonstrates the potential for spatial analyses to identify areas that are high in both carbon and biodiversity. Such areas will be of interest to countries that wish to reduce greenhouse gas emissions from land use change and simultaneously conserve biodiversity.

BACKGROUND

Emissions from land use change, primarily deforestation, contribute to an estimated 20 per cent of total anthropogenic greenhouse gas emissions (IPCC 2007), equivalent to approximately 5.8 Gigatonnes (Gt) of carbon dioxide (CO_2) a year.

Recognition of the scale of CO_2 emissions from land use change has led to the decision that reduced emissions from deforestation and degradation (REDD) in developing countries should be considered for inclusion under the United Nations Framework Convention on Climate Change (UNFCCC). The Bali Action Plan, adopted by UNFCCC at the thirteenth session of its Conference of the Parties (COP 13) in December 2007, mandates Parties to negotiate a post-2012 instrument, including possible financial incentives for forest-based climate change mitigation actions in developing countries (Decision 1/CP.13). The Parties specified that the development of such an instrument should take into consideration 'the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries'. COP 13 also adopted a decision on 'Reducing emissions from deforestation in developing countries: approaches to stimulate action' (Decision 2/CP.13).

Although REDD is necessarily focussed on reducing carbon loss, the Bali Action Plan recognizes that actions to support REDD can also promote other benefits that may contribute to achieving the aims and objectives of other relevant international conventions such as the Convention on Biological Diversity (CBD). In addition to containing large amounts of carbon, many forests contain high levels of biodiversity and provide essential ecosystem services important for human wellbeing.

Policies and incentives for REDD are still under consideration. By reducing pressure on tropical forests, REDD in almost any form would be likely to have some biodiversity benefits. However, the magnitude of these benefits and the impacts of REDD on other forest values and services would depend on the precise nature of the mechanism adopted and how countries choose to implement it.

If countries wish to maximize biodiversity benefits from reducing emissions from land use change, they will need tools that help to identify the spatial overlap of high carbon and high biodiversity areas. They may further need to identify areas of high biodiversity value but lower carbon stocks, which may be at risk from displacement of land use pressures as a result of REDD interventions.

THE ROLE OF THIS ATLAS

This atlas demonstrates the potential value of spatial analyses as a tool to assist countries in maximising biodiversity benefits whilst reducing carbon emissions from land use change.

The atlas uses global datasets on carbon storage in terrestrial ecosystems and areas of high priority for biodiversity conservation to provide regional overviews of the spatial overlap of these important values in the tropics. National-scale maps for six tropical countries draw, where possible, on finer scale nationally developed biodiversity datasets, and show where existing protected areas coincide with high carbon and biodiversity areas. A variety of statistics are drawn from the national-scale maps to demonstrate the different types of information that these maps can provide.

These maps are intended solely as demonstrations of how combining spatial data can help to identify areas where the opportunities for carbon and biodiversity benefits coincide. REDD-related decision-making at the national scale will need to be based, if at all possible, on nationally developed data for both carbon stocks and biodiversity. In order to reduce emissions effectively, and realize other co-benefits of reducing deforestation, such decisions will also need to incorporate information on the country-specific pressures causing land use change.

Carbon and biodiversity

The global carbon store and biodiversity: global datasets

CARBON STORAGE IN TERRESTRIAL ECOSYSTEMS

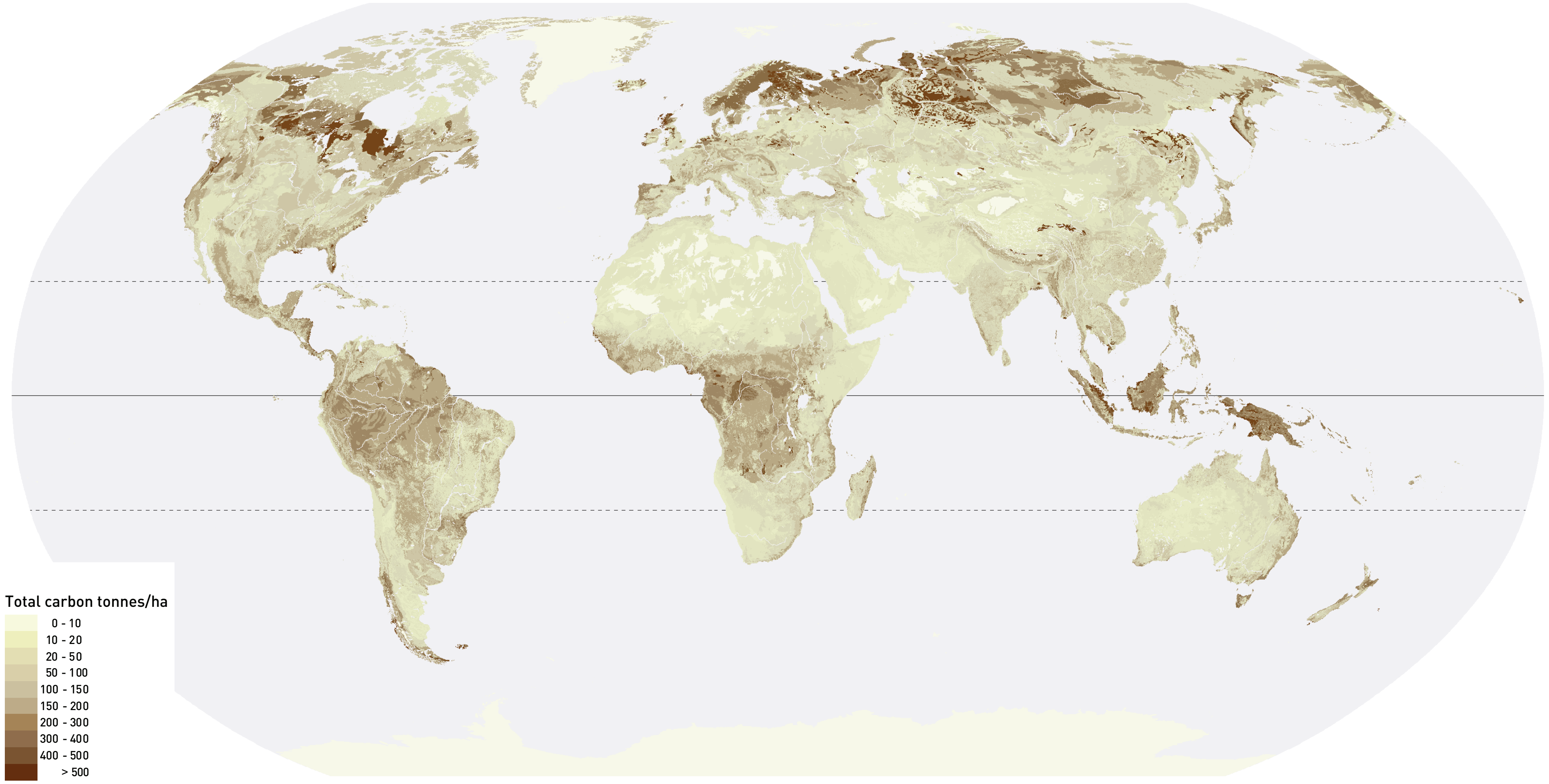
Earth's terrestrial ecosystems are estimated to store over 2,000 Gt of carbon (GtC) in their above- and below-ground biomass and in the soil (Campbell *et al.* 2008a). A significant proportion of this carbon is located within tropical ecosystems. The map of carbon storage in terrestrial ecosystems presented here was produced by combining the best available globally consistent datasets on carbon in live biomass (Ruesch and Gibbs, in review), estimated using the Intergovernmental Panel on Climate Change (IPCC) Tier-1 approach (IPCC 2006, Gibbs *et al.* 2007), and a dataset on soil carbon to 1m depth (IGBP-DIS 2000: this is likely to underestimate the carbon stored in peat soil).

These data form the basis of each map presented in this atlas, which focuses on tropical regions. Although global scale data are likely to be less accurate than those produced at national or regional scales, they provide a globally consistent picture of carbon storage; suitable for the illustrative purposes intended here.

For the regional and national demonstration maps, carbon stocks are divided into 'high' 'medium' and 'low' carbon density categories. As decisions about priorities and actions for reducing emissions from deforestation will be made by countries, it may be helpful if the data are scaled appropriately for their own national contexts. Therefore, the categories of carbon density have been defined separately for each of the regional and national maps. The 'high' carbon category includes the carbon density values for the most carbon rich third of the total land area within that map. The medium and low categories similarly include the carbon density values for the relevant third of the land area.

GLOBAL BIODIVERSITY PRIORITY SCHEMES

Conservation scientists have used several different approaches to identify areas of global importance for biodiversity conservation. Each approach depends on measures of the distribution of particular components of biodiversity, and many incorporate measures of threat.



Carbon storage in terrestrial ecosystems.

The prioritization schemes included in this assessment are shown overleaf. **Conservation International's Hotspots** are areas of the world in which there are large numbers of endemic plant species, and where less than 30 per cent of the natural habitat remains (Mittermeier *et al.* 2004). **WWF Global 200 ecoregions** are the most biologically distinct terrestrial and freshwater ecoregions of the planet, selected for exceptional levels of biodiversity (Olson *et al.* 2001). **Birdlife International Endemic Bird Areas (EBAs)** are areas where two or more bird species with ranges smaller than 50,000 km^2 co-occur (Birdlife International 2008). **WWF/IUCN Centres of Plant Diversity (CPDs)** are areas of key significance for global plant biodiversity (WWF and IUCN 1994), and **Amphibian Diversity Areas** represent the areas significant for global amphibian diversity (Duellman 1999).

In the regional maps that follow, 'high' biodiversity areas are those identified by four or more of these global prioritisation schemes. These are areas with the greatest degree of consensus as to their importance (areas included in fewer prioritisation schemes are also important for biodiversity conservation). **Alliance for Zero Extinction (AZE)** sites, considered key sites for conservation to safeguard the last remaining refuges of Endangered or Critically Endangered species (Ricketts et al. 2005), are also shown.

The national-scale examples illustrate a variety of different approaches to identifying areas of high biodiversity value at a national level, as detailed for each map.

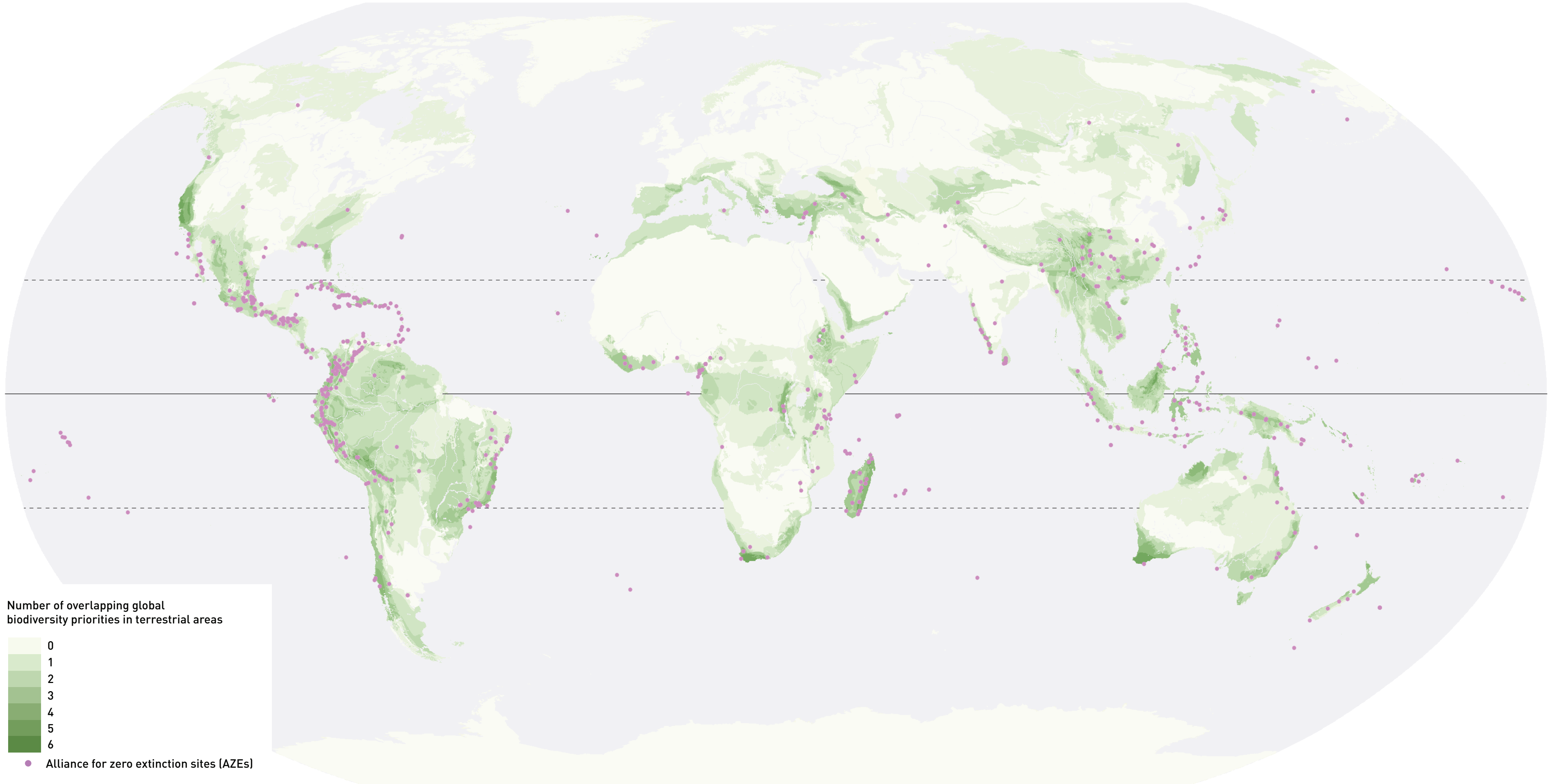
PROTECTED AREAS

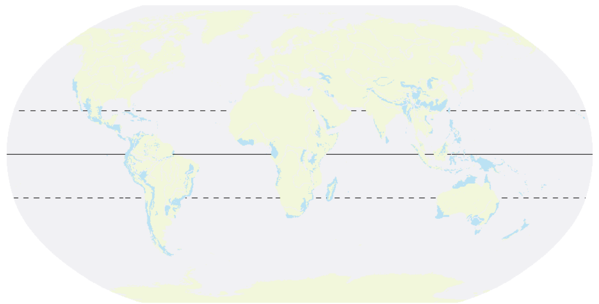
Although protected areas are designated for the purpose of biodiversity conservation, they also confer some level of protection on the carbon stocks contained within them. It has been estimated that globally, ecosystems within protected areas store over 312 GtC, or 15 per cent of the terrestrial carbon stock (Campbell *et al.* 2008a).

Protected areas are likely to make up just part of a national climate change mitigation strategy, and the role of protected areas in REDD is still up for debate. It may be useful for countries to know where protected areas lie in relation to the national carbon stocks. Protected area data from the World Database on Protected Areas (WDPA; UNEP-WCMC, IUCN 2007) are included on the national-scale maps.

Carbon and biodiversity

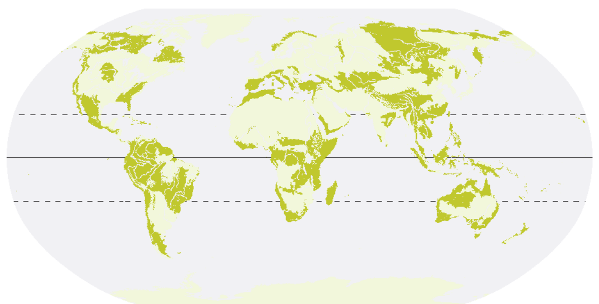
The spatial overlap of the global terrestrial biodiversity priority areas used for the regional maps, and the original priority schemes from which this map was derived. Areas where 4 or more priority schemes overlap are considered here to be 'high biodiversity'. Alliance for Zero Extinction sites (AZEs) are also shown.



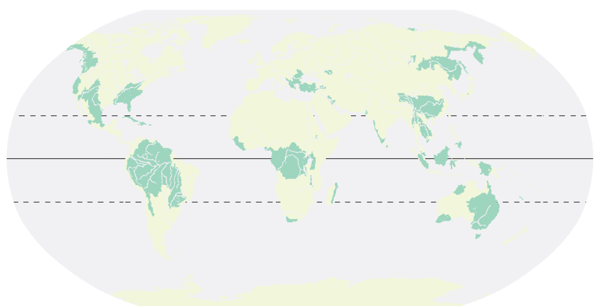


Endemic bird areas (EBAs) (BirdLife International)

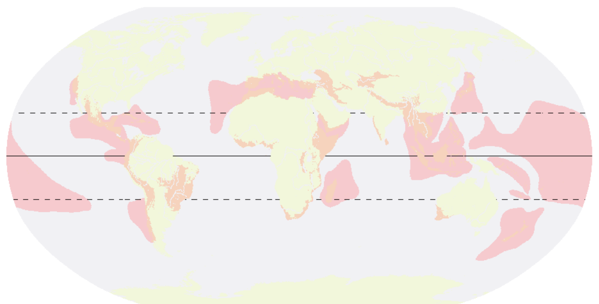
Amphibiam diversity (Duellman 1999)



Global 200 terrestrial ecoregions (WWF)



Global 200 freshwater ecoregions (WWF)



Biodiversity hotspots (Conservation International)

Centres of plat diversity (WWF/IUCN)

The Neotropics

The terrestrial ecosystems of the Neotropics cover 15.8 million km^2 of land and contain 321 Gt of carbon (GtC). The vast majority of this store is in the humid tropical forests, where high deforestation rates accounted for approximately 60 per cent of deforestation across the whole humid tropical forest biome between 2000 and 2005 (Hansen *et al.* 2008). The high deforestation in this region reflects both the large total remaining forest area and the high land use pressures acting upon it.

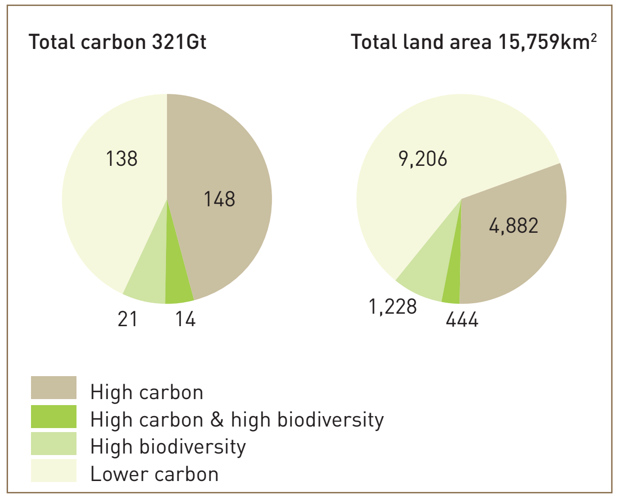
Both the high carbon stocks and the biodiversity values of the Neotropics are threatened by this deforestation, which is largely driven by pasture expansion (Chomitz *et al.* 2006, Nepstad *et al.* 2008). Recently, large scale soybean production has also become a very important contributor to deforestation in the Brazilian Amazon (Cerri et al. 2007).

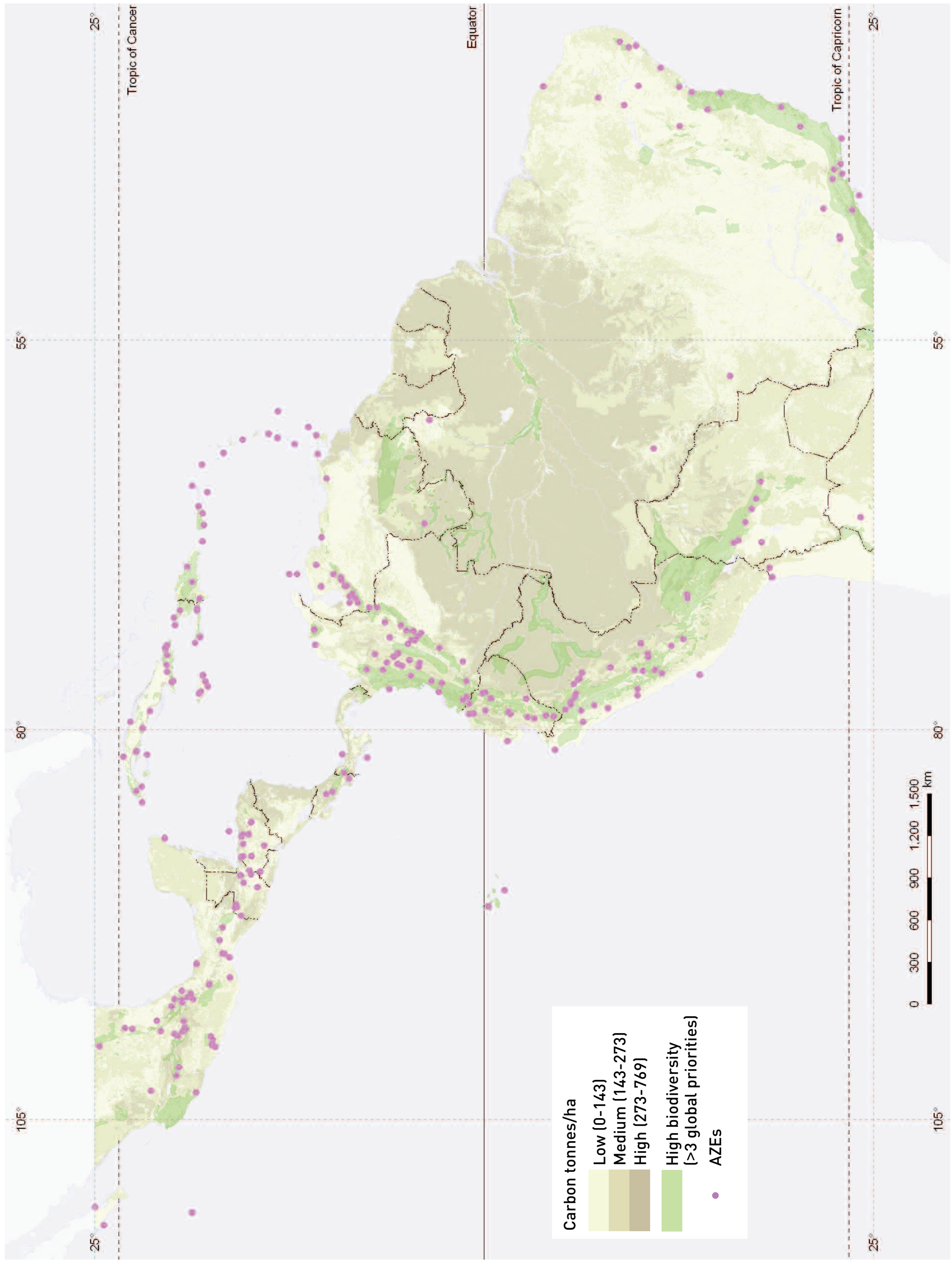
In addition to containing a large carbon store, the Neotropics are extremely high in biodiversity. The tropical Andes is the richest and most diverse biodiversity hotspot in the world (Mittermeier *et al.* 2004); and the Amazon rainforest, the world's largest continuous rainforest area, is estimated to host a quarter of the world's terrestrial species. Six of the world's 17 'megadiversity' countries (Mittermeier *et al.* 1997) are in the Neotropics.

Areas of high biodiversity value, where at least four global biodiversity priority schemes overlap, are shown on the map in green. These areas, which are largely concentrated over the tropical Andes and Amazon River, cover 1.6 million km^2 and contain an estimated 35 GtC, accounting for 11 per cent of the total regional carbon stock. The Alliance for Zero Extinction sites (AZEs) shown on the map are the last refuges for endangered and critically endangered species, and also highlight areas in which biodiversity benefits could be gained through conservation of carbon stocks.

The areas of the map in darkest green, those where high biodiversity value overlaps areas of high carbon density (more than 273 t/ha; represented by dark brown), cover more than 0.4 million km^2 or 3 per cent of the total land area of the region. These high carbon and high biodiversity areas contain 14 Gt of carbon, or 4 per cent of the total regional carbon stock (see diagram, left). In such areas REDD-related interventions could also produce significant biodiversity conservation benefits. However, the precise locations of such 'priority areas' would be far better determined by finer scale analysis than derived from global scale data. It would also be useful to identify a sliding scale of biodiversity value in relation to the carbon stock, including those areas that are low in carbon but high in biodiversity.

Christian Ziegler





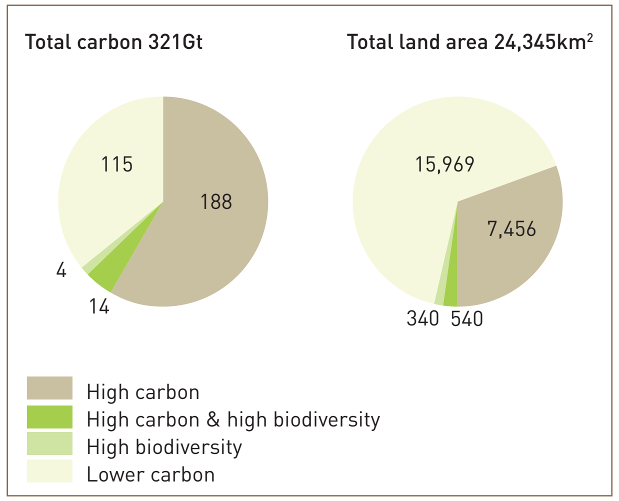
Carbon and biodiversity

Tropical Africa

The varied ecosystems of the African Tropics cover 24.3 million km² and store 321 GtC, the bulk of which is held in the humid tropical forests. The areas with the highest carbon stocks, which account for 63 per cent of the total carbon stock, store 202 GtC.

Lower rates of deforestation have been reported in Africa than for other tropical regions, accounting for only 5 per cent of total global humid tropical forest loss between 2000 and 2005 (Hansen *et al.* 2008). This could in part be due to lower levels of large scale deforestation in this region, and the difficulty of detecting small scale, patchy deforestation and forest degradation with relatively coarse resolution remote sensing. The land use pressures in tropical Africa are a combination of agricultural expansion and subsistence scale resource use; both of which lead to forest degradation. This is exacerbated by the growing commercial logging operations. The carbon implications of forest degradation are less well known than those of deforestation, but it is clear that degradation can cause significant levels of carbon loss (Asner *et al.* 2005) and can have major negative impacts on forest biodiversity.

The large number of habitat types in the African tropics represent most of the world's tropical biomes and support varying levels of unique biodiversity. The land cover ranges from dry and wet Miombo woodlands and tropical savanna to the Congo Basin rainforests, the second largest expanse of continuous rainforest in the world. High levels of biodiversity are found in the Congo, which is particularly rich in primates, and in the Eastern Arc mountains.

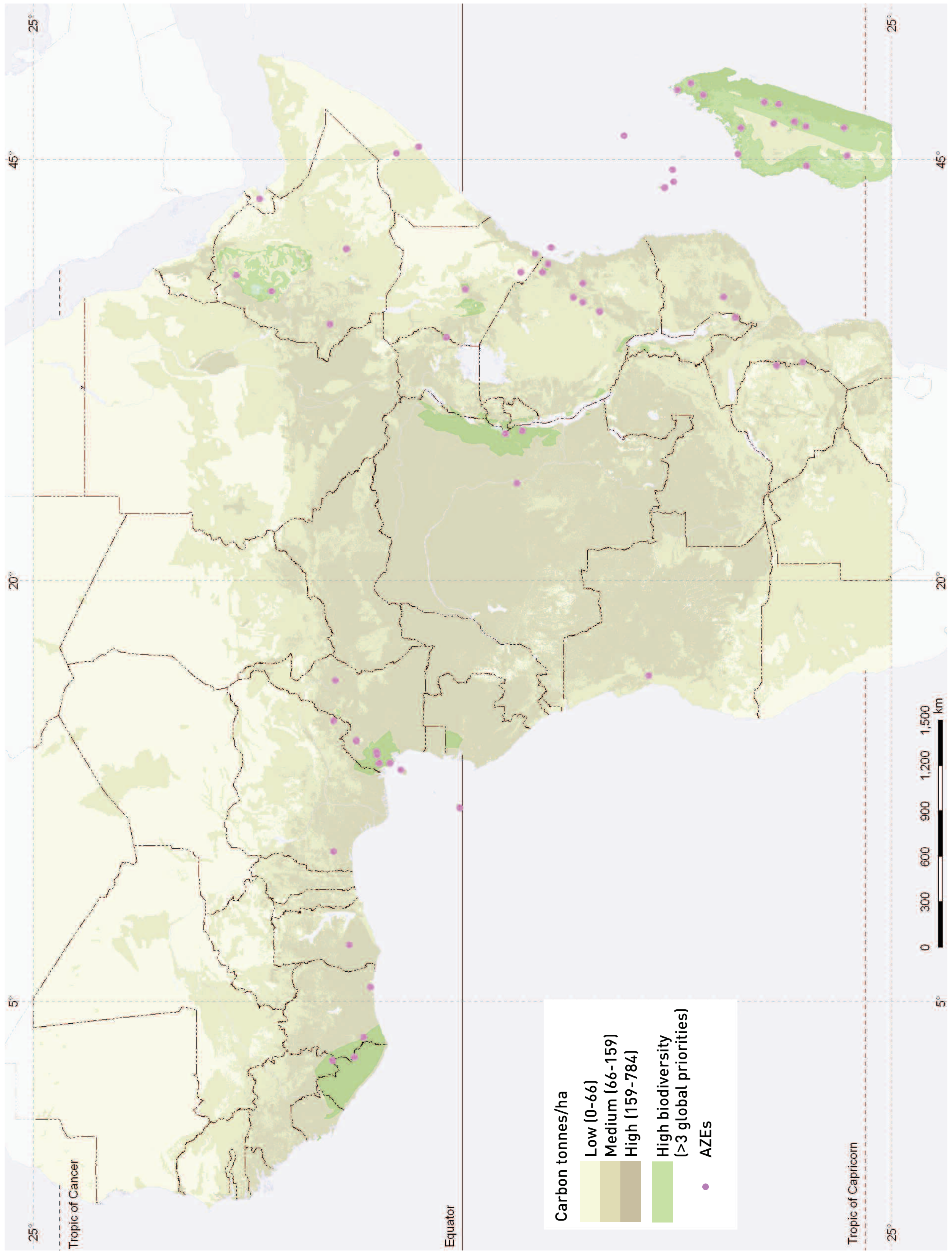


Charles Besançon

The areas of high carbon stocks (shown in dark brown) and the areas in which they overlap with high biodiversity (shown here in dark green) can clearly be seen. The eastern edge of Madagascar is one such area of overlap, as are the hotspot areas of the Eastern Afromontane and the Guinean Forests. The small area of Africa identified by the global priority schemes used here may not reflect the regional biodiversity priorities. This highlights the need to scale data relative to regional or national circumstances and to identify clear sets of priorities accordingly.

The high biodiversity areas shown here contain a total of 18 GtC, accounting for 6 per cent of the total carbon stock in tropical Africa. The areas with highest carbon and high biodiversity hold 14 Gt of carbon, accounting for 4 per cent of the total regional carbon stock. High biodiversity lands cover 7% of the high carbon land areas. This suggests that the high biodiversity areas of Africa in general have a high carbon density, and that significant biodiversity benefits could be gained from reducing carbon loss in these areas (see diagram, left). This is further supported by the overlap between high carbon areas and a number of the AZE sites (shown in purple on the map), which indicates that REDD actions could be targeted to benefit endangered and critically endangered species.

Although the global data used here may not fully represent regional priorities for tropical Africa, these simple mapping tools could be applied to improve biodiversity benefits in a number of ways. For example, areas of high carbon density and high density of great apes could be identified if the aim was to identify where REDD implementation could potentially have the added benefit of conserving great apes of the Congo Basin.



Carbon and biodiversity

Tropical Asia and Oceania

FAO/Masakazu Kashio

The tropical regions of Asia and Oceania cover a large geographical area, from the continental land mass of south Asia to the Pacific Islands in the east, with a total land area of 11 million km². They store approximately 206 GtC, 60 per cent of which is contained within high carbon areas. Malaysia, Indonesia, and Papua New Guinea are particularly notable for their high carbon density land.

This region has a large total area of tropical forest, second only to the Neotropics, and a high rate of deforestation. Approximately one third of global humid tropical forest loss between 2000 and 2005 occurred in Asia (Hansen *et al.* 2008). This high deforestation rate reflects the extremely high land use pressures acting in this region (Laurance 2007). The expansion of oil palm plantations has already replaced a large area of carbon rich and high biodiversity tropical peat forest, resulting in significant greenhouse gas emissions (Hooijer *et al.* 2006).

Tropical Asia and Oceania include seven 'megadiverse' countries (Mittermeier *et al.* 1997) and a number of biodiversity 'hotspots', including the Sundaland area of the Indo-Malayan realm, which has an estimated 25,000 species of vascular plants and a high number of endemics. High species richness and endemism are found across the lowland forests of the island archipelagos and in mountainous areas of the islands and continental land masses.

The areas of high biodiversity value, shown by the green areas of the regional map (defined as in the other regional maps), cover 9 per cent of the land area and contain 12 per cent (25 Gt) of the regional carbon stock. The high carbon density areas show particularly high levels of coincidence with the high biodiversity areas in this region, with 20 Gt, or 10 per cent of the total carbon stock contained within high carbon,

Total carbon 206Gt	Total land area 11,382km²