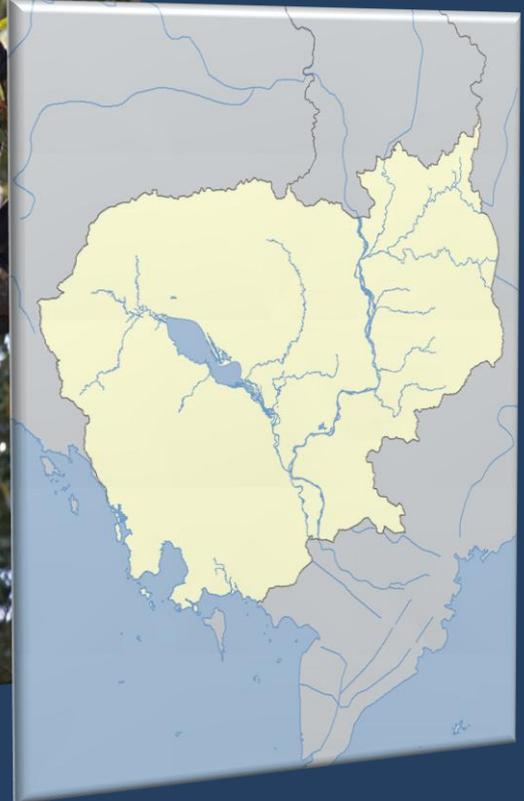




# Carbon, biodiversity & ecosystem services: exploring co-benefits

## Cambodia



UNEP



WCMC



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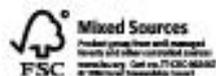
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## Introduction

Land-use change, primarily through tropical forest loss and degradation, is estimated to contribute between 6–17% of all anthropogenic greenhouse gas emissions (van der Werf *et al.* 2009). The maintenance and enhancement of natural carbon stocks are therefore considered key climate change mitigation measures, especially through the developing mechanism on Reducing Emissions from Deforestation and forest Degradation, forest conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+).

Well-planned and carefully implemented REDD+ actions can have positive outcomes that are additional to emissions reductions. Such ‘co-benefits’ include biodiversity conservation and maintenance of ecosystem services, as well as direct improvements to livelihoods and the rights and well-being of local people.

Spatial analyses relating to co-benefits can provide key information to support planning and decision-making on REDD+ at national and sub-national scales. To do so, they should be based on data developed at an appropriate scale and should address those benefits and challenges deemed most important by key stakeholders and practitioners.

This report presents results from an initial effort to produce such analyses for Cambodia. It includes new data on the distribution of terrestrial carbon stocks in Cambodia and analyses of its relation to areas of importance for biodiversity, Protected Areas and other land management units, and pressures (such as forest cover loss). It is expected that the study will be developed further in collaboration with other institutes and stakeholders.

## Cambodia

The Kingdom of Cambodia is located in Southeast Asia and spans 181 035 km<sup>2</sup> (Kingdom of Cambodia 2010). It is home to over 13 million people (National Institute of Statistics Cambodia 2009). Cambodia is bordered by Thailand, Vietnam, and Laos (Map 1). The climate of Cambodia is tropical, dominated by the annual monsoon cycle, which is accompanied by alternating wet and dry seasons. Cambodia is considered a high forest cover country: in 2006, 59% of the country was covered by forest (Technical Working Group on Forestry & Environment 2007). The country also contains the largest freshwater lake in Southeast Asia, the Tonle Sap Lake.

REDD+ and its potential co-benefits are widely relevant in Cambodia, where deforestation rates in recent years have been among the highest in the world (FAO 2007), and where

many people directly depend on forest resources. In 2008, 85% of the country’s population was dependent on fuelwood (CBD National Focal Point Cambodia 2009).



Map 1: Location of the Kingdom of Cambodia

The Government has made considerable efforts to address the issue of deforestation in recent years. Under Cambodia’s Millennium Development Goal 7, the country aims to attain forest cover of at least 60% of the country by 2015 (Kingdom of Cambodia 2003).

## Developing a carbon map

Generating a map of Cambodia's carbon stocks required combining information from several sources. The result is a new map showing the spatial distribution of carbon stocks in Cambodia's terrestrial ecosystems: in above- and below-ground biomass and soil organic carbon to 1 metre depth.

A map of forest cover in 2005/2006 was provided by the Forestry Administration (FA) of Cambodia (Kingdom of Cambodia 2007). This map is considered the most recent and accurate for forest extent in the country. For areas classified in the FA dataset as non-forest or as 'other forest', an earlier land cover map (JICA 2002) was used to provide more detailed information on vegetation type.<sup>1</sup>

Carbon stock values were assigned to the different land cover classes based on published estimates of biomass or carbon stocks in different vegetation types in Cambodia (Table 1, for more detail see Leng *et al.* in prep.). Where no estimates from Cambodia existed, estimates from similar vegetation types of neighbouring

countries were used. Where there were several published biomass or carbon values for a given vegetation type, we averaged the available estimates and applied the result. Most published biomass or carbon values provided information on above-ground biomass only; to determine below-ground biomass for a given land cover class, we used ecosystem-specific conversion factors (IPCC 2006), which provided ratios of below-ground biomass to above-ground biomass for different FAO ecological zones (FAO 2001). Bare soils and rocks, urban and built-up areas, as well as water features, were deemed to hold no above- or below-ground biomass carbon, and so were assigned 0 biomass carbon values. These classes cover about 3% of the country's total area.

The resulting biomass carbon map was then combined with data on the spatial distribution of soil carbon, which were extracted from the Global Map of Terrestrial Soil Carbon Stocks (Scharlemann *et al.* in prep.) because no suitable national data were available.

**Table 1: Total carbon (C) stock (Gt) and total carbon density (t/ha) for different land cover classes in Cambodia**

Land cover	Area [km <sup>2</sup> ] (%)	Total C Stock [Mt] (%)	Biomass Carbon Density (t/ha)	Sources used for estimate
Evergreen forest	37228 (20)	1022 (34)	191-211	National
Deciduous forest	47070 (26)	880 (30)	114-126	National
Semi-deciduous forest	13617 (7)	324 (11)	161-178	National
Bamboo & secondary /regrowth forests	2998 (2)	36 (1)	25-92	National
Bamboo	357 (<1)	4 (<1)	49	Regional (China)
Grasslands	10774 (6)	99 (3)	10	Regional (Vietnam)
Shrubland & flooded shrubland	14851 (8)	134 (5)	11-13	National
Flooded forest	143 (<1)	3 (<1)	129	National
Evergreen wood- & shrubland	960 (1)	8 (<1)	14	Regional (Vietnam)
Mangrove forest	334 (<1)	8 (<1)	142	Regional
Mixed forest	169 (<1)	4 (<1)	161-178	National
Riparian forest	144 (<1)	4 (<1)	191-211	National
Dry wood- & shrubland	371 (<1)	3 (<1)	11	Regional (Vietnam)
Degraded mangrove forests	176 (<1)	3 (<1)	85	Regional
Dry deciduous (open) forest	3 (<1)	<1 (<1)	78	National
Plantation (rubber)	854 (<1)	15 (1)	102	Regional
Agricultural lands	46001 (25)	399 (13)	5	IPCC global average

<sup>1</sup> Non-forest areas in the FA dataset that had been classed as forest in the JICA dataset were assigned to the same land cover class as the nearest non-forest area in the JICA data.

The new map of terrestrial carbon stocks was used for all subsequent analyses and statistical summaries, but because the coarseness of the soil carbon data visually obscures the detail of the biomass carbon data, the biomass carbon map is used for display throughout. It shows the distribution of biomass carbon in five carbon density classes, each of which contains approximately 20% of the total carbon stock in the country (Map 2).

According to this analysis, a total of 2.97 Gt of carbon is stored in the biomass and soils of Cambodia’s terrestrial ecosystems. About one third of this carbon is stored in the country’s evergreen forest (see Table 1). The largest areas of very high carbon density are found in the wet evergreen forests of the Cardamom Mountains Rainforests Ecoregion in the southwest of the country. With over 100 mammal species and more than 450 bird species, this area holds some of the greatest species richness and intact

natural habitats in the region (Wikramanayake *et al.* 2001).

The highest carbon density class, which holds 20% of the country’s carbon, covers 12% of the country’s land area (Figure 1). Approximately 40% of Cambodia’s carbon stock is held in less than a quarter (23%) of its area.

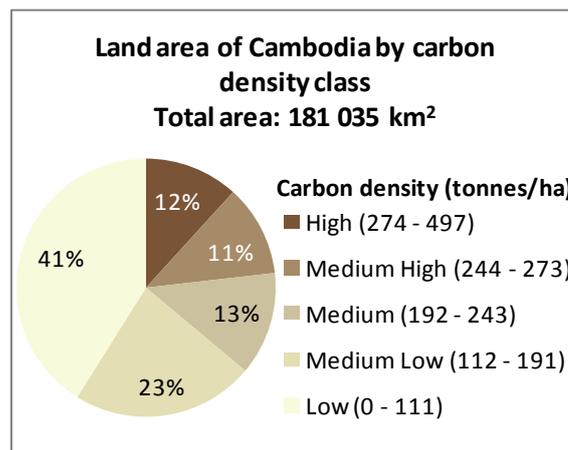
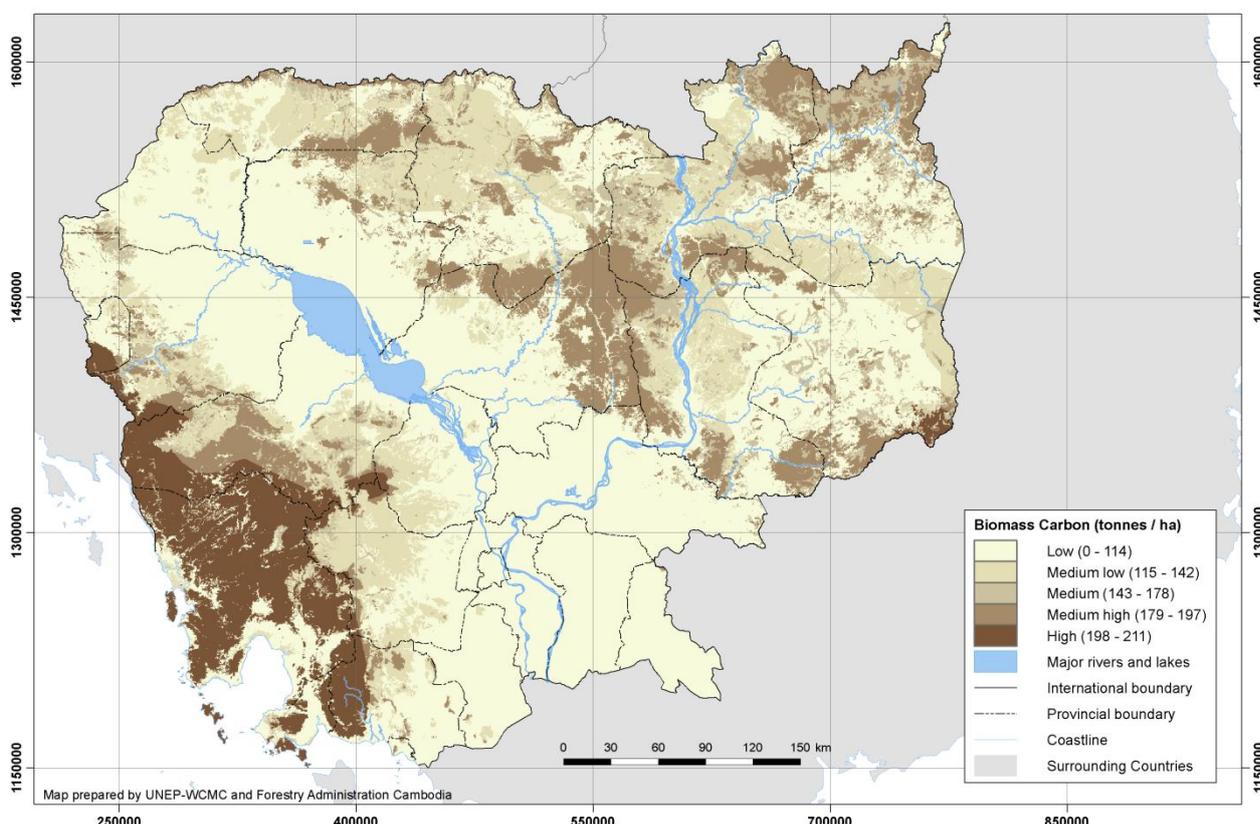


Figure 1: Distribution of land area in Cambodia according to carbon density classes



Map 2: Distribution of biomass carbon in Cambodia (underlying data from Kingdom of Cambodia 2007, JICA 2002)

## Carbon and biodiversity

Cambodia is rich in biodiversity, and forms part of the Indo-Burma biodiversity hotspot (Myers *et al.* 2000). It is home to more than 2 000 known plant species, 500 birds, 100 mammals and 800 fish (Table 2).

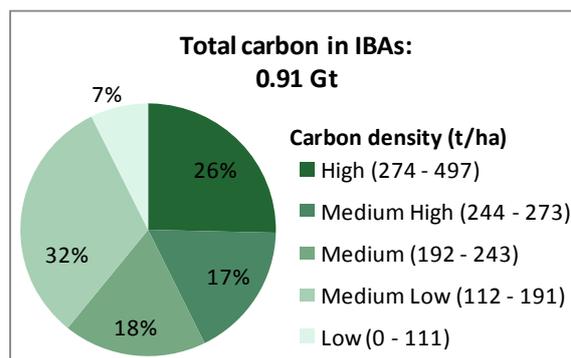
**Table 2: Number of known and threatened species by taxon (CBD National Focal Point Cambodia 2009; IUCN 2010, modified by Wildlife Conservation Society Cambodia)**

Taxon	Known species	Threatened species
Vascular plants	2 308	31
Mammals	123	37
Birds	545	24
Amphibians	63	3
Reptiles	88	13
Fish	874	28

The relationship between carbon distribution and areas of importance for biodiversity in Cambodia was investigated using datasets for Important Bird Areas (IBAs, BirdLife International 2010b). IBAs are identified nationally as areas of importance for bird species based on criteria relating to the conservation status of the bird species present and the importance of the site for their persistence (BirdLife International 2010a). Worldwide, there were almost 11 000 sites in 200 countries that had IBA status in 2009 (BirdLife International 2010a). There is evidence from several countries that IBAs encompass many of the areas that are important for taxa other than birds (BirdLife International 2010c). IBAs are not formally Protected Areas; however, some or all of an IBA may fall under other formal national and/or international protection regimes.

There are a total of 45 IBAs covering 45 954 km<sup>2</sup> of land across Cambodia (25% of the country's area). They are located mainly in the north-eastern and south-western regions of the country (Map 3). Additionally, there are some clusters of IBAs in the vicinity of the Tonle Sap Lake, and along river courses throughout the country.

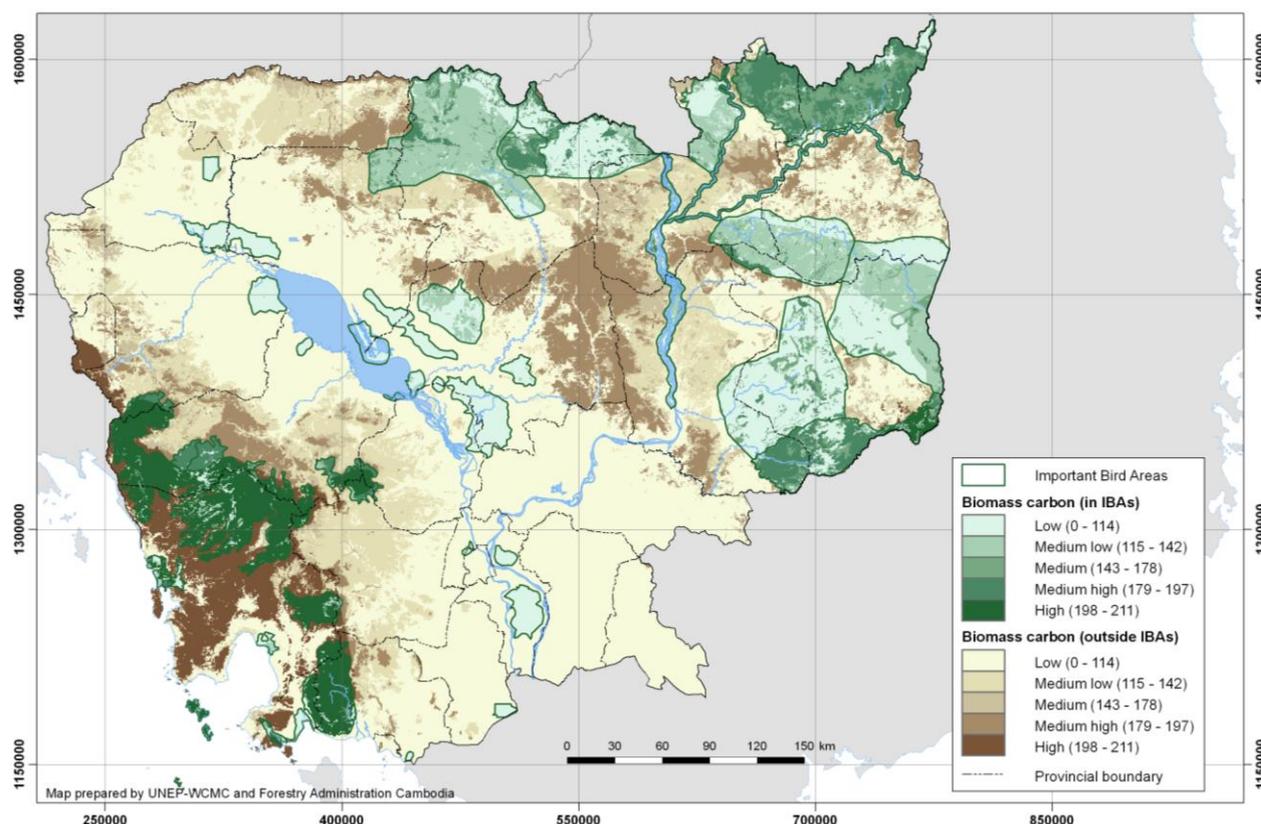
Overlaying the IBAs and the carbon data shows that almost one third (0.91 Gt) of Cambodia's terrestrial carbon stock falls within IBAs. Twenty six percent of the 0.91 Gt is in areas of high carbon density, whereas another 35% is in areas of medium or medium-high carbon density (Figure 2).



**Figure 2: Distribution of total carbon within IBAs across density classes**



**Photo: Sarus Crane (© Eleanor Briggs)**



Map 3: Distribution of biomass carbon and IBAs (data on IBAs from BirdLife International 2010b)

## Carbon, Protected Areas and Protection Forests

Protected Areas are nationally, and in some cases internationally, recognised areas that are managed to achieve long-term conservation of nature, in line with the areas' ecosystem services and cultural values (Dudley 2008). In Cambodia, Protected Areas were established by the 1993 Royal Decree on Creation and Determination of Nature Reserves and the 2001 Royal Decree on the Establishment and Management of the Tonle Sap Biosphere Reserve, and are managed by the Ministry of Environment. More recently, the Royal Government of Cambodia has declared a number of Protection Forests under the 2002 Forestry Law, whose primary function is to protect forests' ecosystems, which serve the public interests. Unlike Protected Areas, however, Protection Forests are managed by the Forestry Administration of the Ministry of

Agriculture, Forestry and Fisheries. There are currently 27 Protected Areas and 10 Protection Forests in Cambodia, representing about 24% of the country's total land area.

A new spatially explicit dataset for Protected Areas and Protection Forests was developed by combining current records held in the World Database on Protected Areas (WDPA) (IUCN and UNEP-WCMC 2010) with more recent records from the Forestry Administration and Ministry of Environment. Further updates to the layer were provided through expert input (Tom Clements, pers. comm.). The new layer was then overlaid with the carbon density map to calculate how much carbon is currently stored in Protected Areas and Protection Forests (Map 4, overleaf).

About 21% of Cambodia’s total carbon stock (0.62 Gt) is stored in its Protected Areas. An additional 11% (0.33 Gt) is stored within Protection Forests. More than one fifth of the area that is designated as Protected Area is of high carbon density. Within areas designated as Protection Forest, the share of high carbon density area amounts to 25%.

Analysis of the protection status of carbon stocks within IBAs shows that almost 0.6 Gt or 64% of their carbon is in either a Protected Area or a Protection Forest (Figure 3), that is, it has some degree of protection.



Photo: Forest in Cambodia flooded by light (© Edward Pollard / WCS)

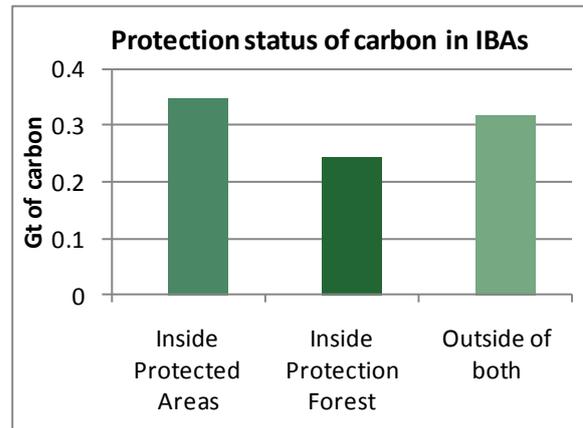
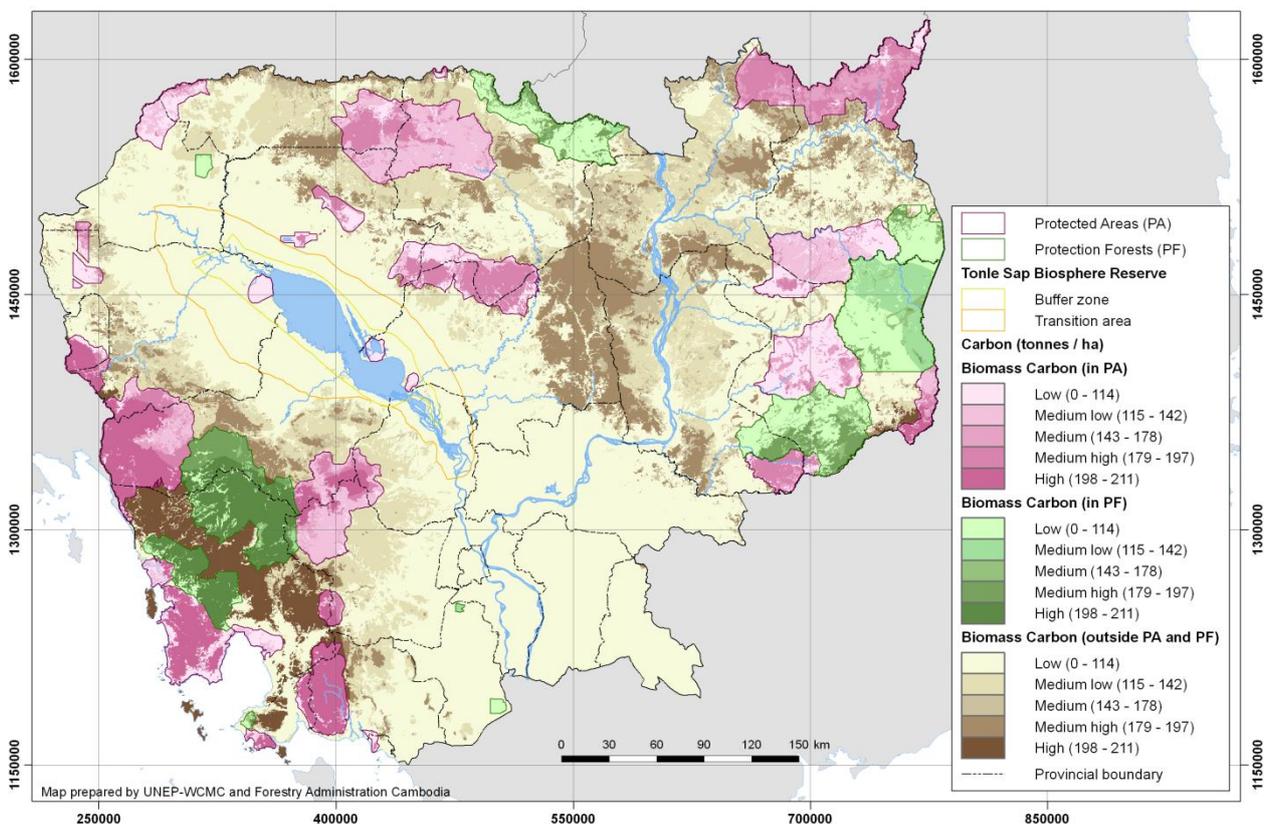


Figure 3: Protection status of carbon stocks within IBAs



Map 4: Biomass carbon, Protected Areas and Protection Forests (data on Protected Areas and Protection Forests from IUCN and UNEP-WCMC 2010, with amendments from the Forestry Administration Cambodia)

## Carbon and other land management categories

Land management, or the use and development of land resources, comes in many forms and can include practices as varied as habitat conservation, agriculture and farming, and timber production. In Cambodia, the government has formally allocated land to particular management categories, including Protected Areas, Protection Forests, Community Forestry Areas, Forest Concessions, Community Fisheries Areas, Fishing Lots (fisheries areas managed by concessionaires), and Economic Land Concessions. In some cases, a given area may be allocated to more than one of these categories. Understanding how carbon stocks

are distributed in relation to different land management categories can indicate whether carbon is likely to be protected or be exposed to pressure, and can help identify the products and services from that land that are considered most important. In addition, this analysis gives an understanding of the 'players' that are likely to be involved in REDD+ and other decision-making, since the land management categories reflect both formal government plans and designation, as well as the authorities and other stakeholders who have jurisdiction and interest in the use of the land.

## Carbon, Community Forestry Areas, and Forest Concessions

Community Forestry Areas are places where state forest has been allocated under a management agreement between the state and a local community living within or nearby the forest area. In Cambodia, Community Forestry Areas can only be located in production forests, and are regulated by the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries.

The Community Forestry scheme is considered a key part of efforts to reduce rates of forest loss in Cambodia. Presently, there are more than 400 Community Forests, covering about 3 646 km<sup>2</sup> (2% of total land area) (Map 5, overleaf). The country's National Forest Programme intends to approve a further 20 000 km<sup>2</sup> of Community Forests in the near future, increasing the total more than eight-fold.

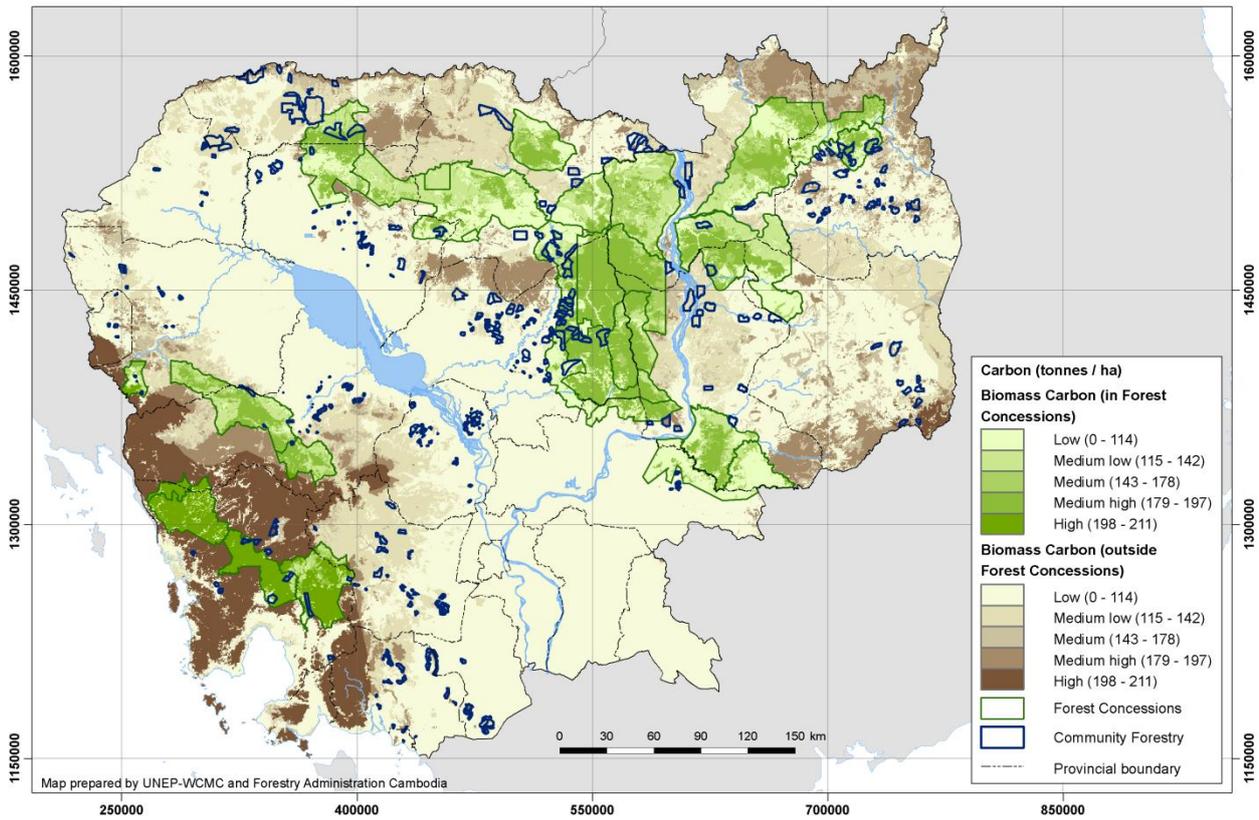
Forest Concessions, on the other hand, are leased to other third parties, such as private and state timber companies, for the purposes of sustainable management and harvest of forest products and by-products. In Cambodia, Forest Concessions, according to the Forest

Administration's data, cover 34 391 km<sup>2</sup>, which is about 19% of Cambodia's total land area. It should be noted, however, that following the 2002 Forestry Law, which declared a logging moratorium, activity within Forest Concessions has been suspended, and all concessions are currently under state review.

Spatial analysis shows that Community Forests currently store 0.07 Gt of carbon, which represents approximately 2.4% of Cambodia's total carbon stock. By contrast, Forest Concessions store 0.73 Gt of carbon, which accounts for 24% of Cambodia's total carbon stock.



Photo: Children in Pu Char village, Monduliri  
(© Edward Pollard / WCS)



Map 5: Biomass carbon, Community Forestry Areas, and Forest Concessions (data on Forest Concessions and Community Forestry Areas from the Forestry Administration Cambodia)

### Carbon, Fishing Lots and Community Fisheries Areas

In Cambodia, Fishing Lots are areas of the freshwater fisheries domain which supply fish production, and are leased to a third party (the lot concessionaire). They are regulated by the Fisheries Administration of the Ministry of Agriculture, Forestry and Fisheries. Community Fisheries Areas, on the other hand, are areas of the fisheries domain of the state, which have been handed over to local community management under an agreement between the Fisheries Administration and the communities living inside or around the domain. Fishing Lots and Community Fisheries Areas in Cambodia cover a combined area of 12 434 km<sup>2</sup> (7% of total land area). They are mostly situated in the floodplains along Tonle Sap Lake and in the Southeast region along the Mekong River. Fishing Lots and Community Fisheries Areas hold 0.09 and 0.02 Gt of carbon respectively.

Together, this represents approximately 3.7% of the total carbon within Cambodia. None of the carbon in Fishing Lots or Community Fisheries Areas is in areas of high carbon density. As can be seen in Figure 4, more than 86% of the area within Fishing Lots is of low carbon density.

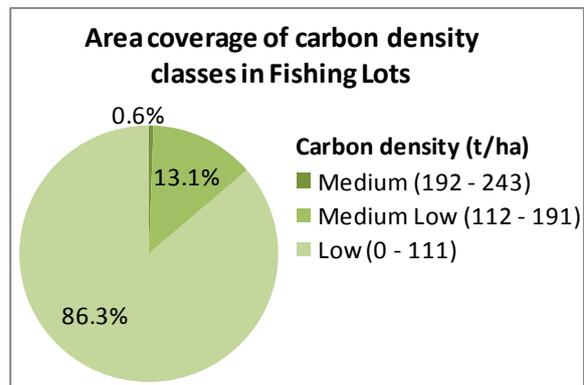


Figure 4: Area coverage of carbon density classes within Fishing Lots

## Carbon and Economic Land Concessions

Economic Land Concessions are blocks of land designated by the state and leased to third parties (concessionaires) for the purposes of agri-industrial development. According to the data received, Cambodia has over 160 Economic Land Concessions, located mostly in the Northeast and Southwest regions, covering an area of 17 770 km<sup>2</sup> and representing 10% of total land area (Map 6).

Carbon overlay results show that 0.32 Gt of carbon is stored within Economic Land Concessions, representing 10.7% of total carbon within Cambodia. However, only 4% of the area of Economic Land Concessions is of high carbon density (see Figure 5). Two thirds of the area

covered by Economic Land Concessions is of medium low and low carbon density.

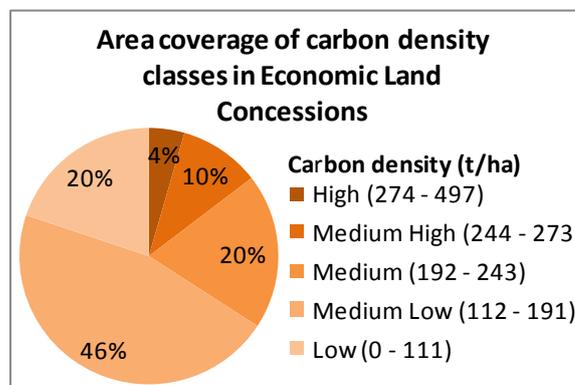
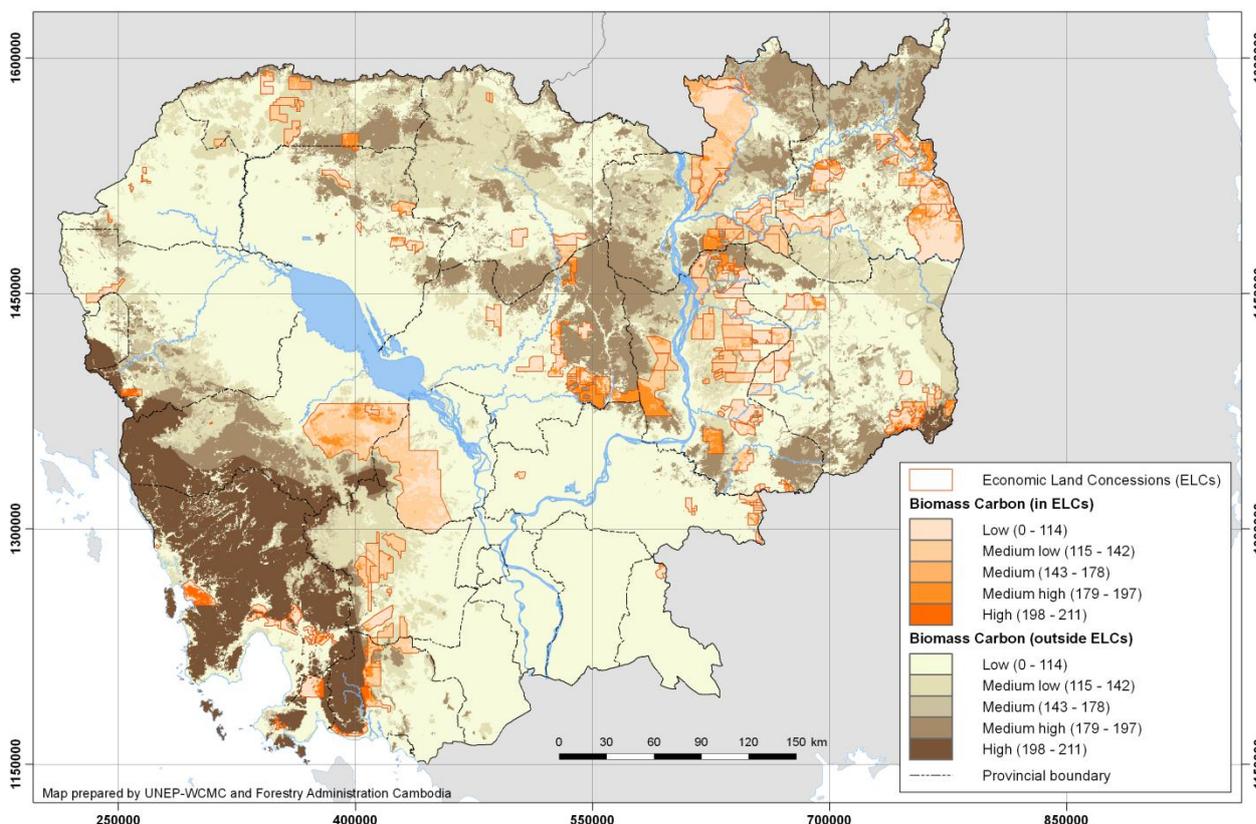


Figure 5: Area coverage of carbon density classes in Economic Land Concessions



Map 6: Biomass carbon and Economic Land Concessions (data on Economic Land Concessions from the Forestry Administration Cambodia)

## Carbon in land management categories: an aggregate picture

The distribution of carbon across different land management categories in Cambodia is not uniform (Figure 6). In most cases, the proportion of national carbon stock stored in a given land management category corresponds roughly to the proportion of the land area it occupies, which means that land management categories with larger areas will tend to store more total carbon than land management categories with smaller areas. For example, Forest Concessions, which cover the greatest area of all land management categories, also store the greatest amount of carbon (0.73 Gt). This is more than 30 times that stored in Community Fisheries Areas (0.02 Gt), the land management category with the smallest area.

Approximately one third of Cambodia's terrestrial carbon stock (0.95 Gt) is in land management categories that aim specifically to maintain forest cover (Protected Areas and

Protection Forests). For carbon in other land management categories, the picture is less clear; whether carbon is at risk will highly depend on the policy decisions and management practices adopted for each category.

Narrowing the scope of our analyses to consider land management categories in areas that are high in carbon and also important for birds (defined as overlapping with IBAs), we find that more than three quarters (78%) of these areas are located in Protected Areas and Protection Forests (Figure 7). Less than one fifth (18%) of areas that are high in carbon and at the same time important for birds are located in Forest Concessions, Economic Land Concessions and Community Forestry Areas. Fishing Lots and Community Fisheries Areas contained none of this land.

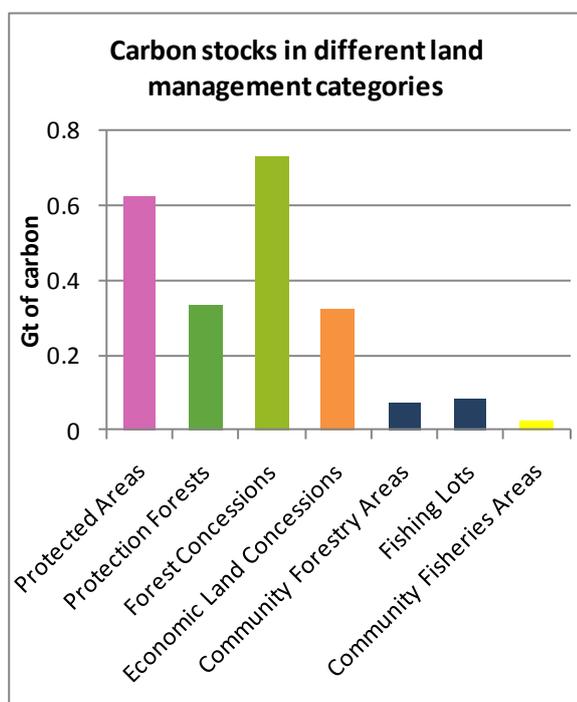


Figure 6: Variation in the storage of carbon across different land management categories

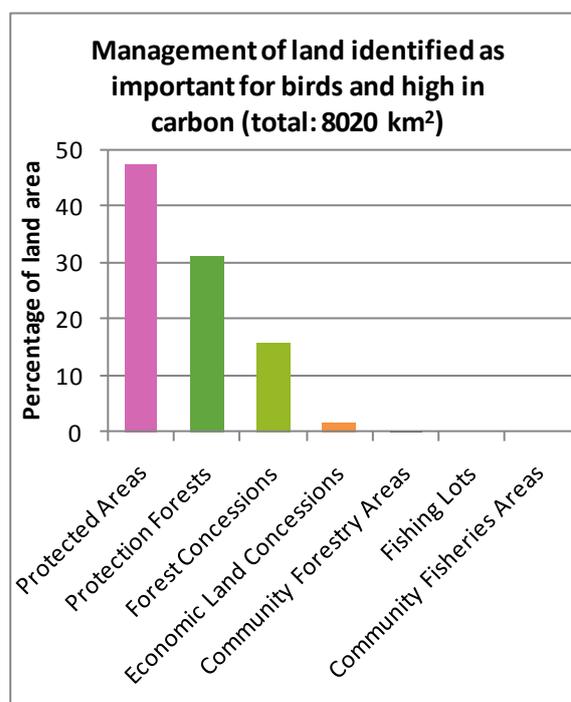


Figure 7: Management of areas of high carbon density that also fall within important bird areas

## Pressures on carbon: forest cover loss

Forest cover loss represents a major challenge for Cambodia. Between 2002 and 2006, Cambodia lost approximately 3 735 km<sup>2</sup> of forest, reducing the country's total forest cover from 61% to 59% of land area (Map 7; Technical Working Group on Forestry & Environment 2007). This places the country slightly below its Millennium Development Goal (MDG) target of 60% forest cover.

To understand how Cambodia's terrestrial carbon stocks might be affected by proximity to recent forest cover loss, the carbon data were overlaid with 1, 2 and 5 km buffers around the areas of forest cover loss between 2002 and 2006 (Kingdom of Cambodia 2007). The resulting analyses indicate that the amount of carbon within 1 km of forest cover loss (0.65 Gt) represents 22% of Cambodia's total carbon stock (Figure 8). Of this carbon, 16% (or 0.11 Gt)

is in high carbon density areas. Approximately two-thirds of Cambodia's terrestrial carbon stock (1.9 Gt) is within 5 km of forest cover loss. These data provide important information on the potential pressures on carbon stocks, though further work is needed to determine whether proximity to recent forest over loss in fact suggests a higher risk of subsequent loss.

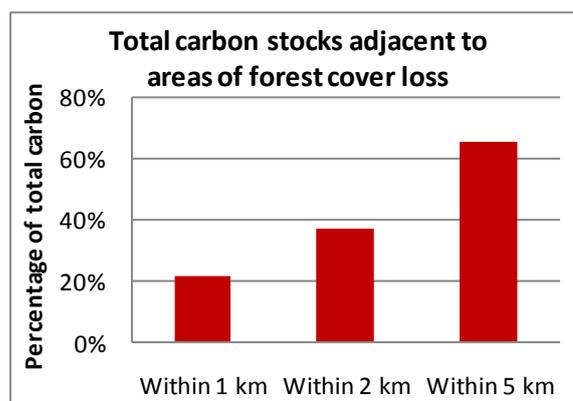
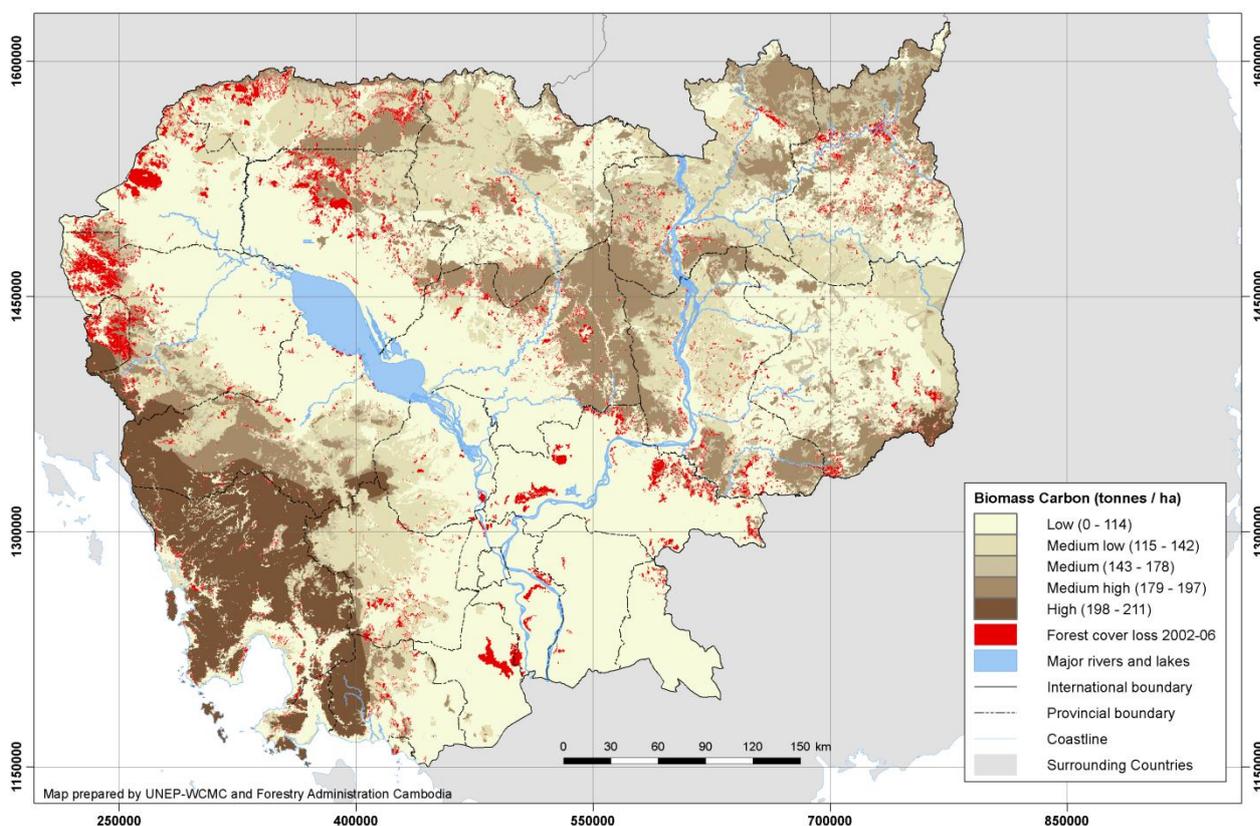


Figure 8: Carbon stocks within 1, 2 and 5 km of areas of forest cover loss



Map 7: Pressures on biomass carbon: forest cover loss 2002-2006 (data on forest cover loss from Kingdom of Cambodia 2007)

## Conclusions

### Carbon and co-benefits

Much of Cambodia's terrestrial carbon stock occurs in areas that are also important for biodiversity conservation. Many of these areas (and significant amounts of carbon) have some form of protection status. Actions to secure more of these areas and their carbon and to improve their management are likely to achieve substantial biodiversity-related co-benefits. However, some areas of importance for biodiversity have lower carbon density, and are less likely to be the focus of forest carbon management initiatives such as REDD+; other resources and action will be needed to help ensure their persistence.

Planning for forest carbon management, including under REDD+ will also need to take account of existing plans and designations for land management. The carbon stocks of different land management units, the many uses and values of these areas, and the different jurisdictions and stakeholders they involve are also likely to be key components of decisions regarding terrestrial carbon management in Cambodia. Ideally such decisions would aim to minimize existing pressures, and to secure as many co-benefits as possible.

### Outlook

These results represent a first step in exploring the potential for co-benefits of carbon management for climate mitigation under REDD+ in Cambodia. There is great potential for improving the analysis through collaboration with a wider range of government institutions and stakeholders. Future enhancements of the analysis are likely to include: improvement of the national carbon map by incorporating nationally sourced data on soil carbon;

development and integration of datasets on ecosystem services, such as hydrological regulation, soil stabilisation and provision of non-timber forest products; and incorporation of additional datasets relating to pressures on carbon (e.g. infrastructure, mining) and to people and the way they may be influenced by management decisions (e.g. population density, poverty).

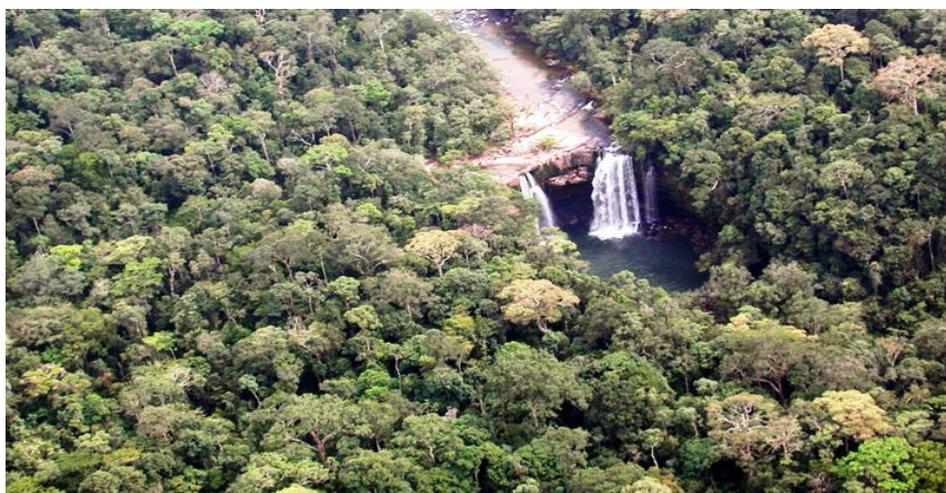


Photo: Forest in Cambodia (© Forestry Administration of Cambodia)

## References

- BirdLife International 2010a. Important Bird Areas [<http://www.birdlife.org/action/science/sites/>]. Accessed 29.7.2010a.
- BirdLife International 2010b. Important Bird Areas (GIS data). Birdlife International, Cambridge, UK. 29-7-2010b.
- BirdLife International 2010c. Important Bird Areas are also important for other terrestrial vertebrates in East Africa. Presented as part of the BirdLife State of the world's birds website. [<http://www.biodiversityinfo.org/casestudy.php?r=introduction&id=71>]. Accessed 9.2010c.
- CBD National Focal Point Cambodia 2009. Draft Fourth National Report to the Convention on Biological Diversity [<http://cdn.www.cbd.int/doc/world/kh/kh-nr-04-en.pdf>]. Accessed 25.5.2010.
- Dudley, N. 2008. Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland, and Cambridge, UK.
- FAO 2001. Global Forest Resources Assessment 2000. Food and Agriculture Organization of the United Nations, Rome, Italy. FAO Forestry Paper 140.
- FAO 2007. Brief on National Forest Inventory (NFI): Cambodia. Food and Agriculture Organization of the United Nations, FAO, Rome, Italy.
- IPCC 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. (eds. Eggleston, H.S. *et al.*). Institute for Global Environmental Strategies, IGES, Japan.
- IUCN 2010. IUCN Red List of Threatened Species [<http://www.iucnredlist.org/>]. Accessed 4.8.2010.
- IUCN and UNEP-WCMC 2010. The World Database on Protected Areas (WDPA): Annual Release [On-line]. UNEP-WCMC, Cambridge, UK [[www.wdpa.org](http://www.wdpa.org)]. Accessed 18.5.2010.
- JICA 2002. Land Use Map of Cambodia 2002. Japan International Cooperation Agency, Tokyo, Japan.
- Kingdom of Cambodia 2003. Cambodia Millennium Development Goals Report 2003. Ministry of Planning, Kingdom of Cambodia, Phnom Penh, Cambodia.
- Kingdom of Cambodia 2007. Forest Cover Assessment for Year 2005/2006. Final Report. Kingdom of Cambodia, Forestry Administration, Watershed Management and Forestland Office, Phnom Penh, Cambodia.
- Kingdom of Cambodia 2010. National Strategic Development Plan, Update 2009-2013. Royal Government of Cambodia, Phnom Penh, Cambodia.
- Leng, C., Ravilious, C., Kapos, V., Bertzky, M. in prep. Carbon, biodiversity and ecosystem services: Exploring co-benefits. Cambodia Technical Report. UNEP-WCMC, Cambridge, UK.
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403, 853-858.
- National Institute of Statistics Cambodia 2009. Cambodia General Population Census 2008. CELADE - Population Division, ECLAC [<http://celade.cepal.org/khmnis/census/khm2008/>]. Accessed 7.2010.
- Scharlemann, J.P.W., Hiederer, R., Kapos, V. in prep. Global map of terrestrial soil organic carbon stocks. UNEP-WCMC & EU-JRC, Cambridge, UK.
- Technical Working Group on Forestry & Environment 2007. Forest Cover Assessment for Year 2005/2006. Final Report. Kingdom of Cambodia, Forestry Administration, Watershed Management and Forestland Office, Phnom Penh, Cambodia.
- van der Werf, G.R., Morton, D.C., DeFries, R.S., Olivier, J.G.J., Kasibhatla, P.S., Jackson, R.B., Collatz, G.J., Randerson, J.T. 2009. CO2 emissions from forest loss. *Nature Geoscience* 2, 737-738.
- Wikramanayake, E., Dinerstein, E., Loucke, C.J., Olson, D.M., Morrison, J., Lamoreaux, J., McKnight, M., Hedao, P. 2001. Terrestrial ecoregions of the Indo-Pacific: a conservation assessment. Island Press, Washington D.C., USA.

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The benefits of actions to maintain and enhance carbon stocks for climate change mitigation can be increased by taking into account the distribution not only of carbon, but of other ecosystem services, such as biodiversity. Here, we map the distribution of carbon stocks in relation to that of biodiversity in Cambodia. Other relevant factors, such as protected area distribution and land management units are also related to carbon and biodiversity distributions. A new map of carbon in Cambodia's ecosystems has been produced for this analysis.



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