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

# Ecuador

UNEP WCMC

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## Introduction

Land-use change, primarily through tropical forest loss and degradation, is estimated to contribute 6–17% of all anthropogenic greenhouse gas (GHG) emissions (van der Werf *et al.* 2009). The maintenance and enhancement of natural carbon stocks are therefore now considered key climate change mitigation measures. An incentive-based mitigation mechanism called 'REDD+', short for '**R**educing **E**missions from **D**eforestation and forest **D**egradation, conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks', is expected to make a large contribution to reducing GHG emissions from land-use change in the future.

Depending on where and how REDD+ is implemented, its actions may generate other benefits in addition to maintaining and enhancing carbon stocks. These co-benefits can include ecosystem and social benefits such as biodiversity conservation, maintenance of ecosystem services and improvement of local people's livelihoods. Planning for co-benefits provides an opportunity for countries to achieve more than GHG savings when implementing REDD+.

Analyses of the spatial relationships between carbon, co-benefits and socio-economic context can support planning and decision-making at national and sub-national scales. When such spatial analyses are based on data developed at an appropriate scale, done in consultation with a wide range of stakeholders, they can help to prioritise among the different benefits and services under consideration and the actions that might best deliver them.

Ecuador is a country with high forest cover and very high biodiversity. However, Ecuadorian forests are under pressure from deforestation and resource exploitation. The government is addressing the issue by planning for a high quality REDD+ mechanism that maximises benefits for the climate, the environment and people. This report presents the result of spatial analyses to support this planning process. More detail on the methods applied, results and data sources are compiled in a separate technical report (UNEP-WCMC and MAE in prep.).

## Forests and REDD+ in Ecuador

The Republic of Ecuador, its name derived from its location astride the equator, is located in the Northwest of South America (Map 1). It is bordered by Colombia to its North, by Peru to its East and South and by the Pacific Ocean to the West. It also includes the Galapagos Islands, ca. 1 000 km from the mainland. In total, Ecuador spans an area of 255 234 $km^2$ (SENPLADES 2009).

There are three mainland geographic regions: the coast, the highlands, and the Amazon rainforest. A number of active volcanoes can be found in the highlands, several of which exceed 5 000 m altitude. Chimborazo, at 6 310 m, is the highest mountain of the country.

The climate across Ecuador is greatly influenced by altitude. In the Andean highlands it is temperate, whereas in the Pacific coastal area and in the Amazon rainforest region the climate is tropical.

As of May 2010, the population of the Republic of Ecuador was estimated to be 14 285 288 (INEC 2010), more than 90% of whom are living in the coastal and Andean regions. Much of the population is poor; in 2009, 46% of the population lived in poverty and 20% in extreme poverty.


**Map 1: Location of the Republic of Ecuador**

Around 50% of the area of the country is covered by forest (Sierra 1999), mostly evergreen forests of the Amazon, the Andean foothills, and the Andes. More than 6.8 million hectares of forest are owned by ancestral peoples, indigenous communities and Afro-Ecuadorian communities. Most of this land is located in the Amazon region of the country and in the province of Esmeraldas.

Ecuador is among the countries with the highest deforestation rates in Latin America. According to FAO (2009), annual deforestation was 1.5% between 1990 and 2000, and increased to 1.7% between 2000 and 2005, totalling 1 980 $km^2$ of forest loss per year. However, there is a strong political will to change this trend. The Ministry of the Environment is developing a New Forestry Governance model, which aims to manage forests in a sustainable manner. One of the specific objectives of the model is to reduce the country's deforestation rate, thereby accomplishing one of the goals of the National Development Plan 2009-2013 (SENPLADES 2009).

The implementation of a REDD+ mechanism will contribute to both the new Forestry Governance Model and the National Climate Change Strategy. Moreover, REDD+ has the potential to contribute to mobilising technical and financial resources for the forestry sector and help accomplish social and environmental goals in addition to reduced deforestation. Consequently, the country is taking firm steps to prepare for the implementation of REDD+.

Ecuador's National REDD+ Strategy, which is currently under development, aims at simultaneously contributing to climate change mitigation and to managing Ecuador's forests in a sustainable manner. This goal will be accomplished through the implementation of policies, measures and activities at national level to reduce deforestation and its associated GHG emissions. The elements of the strategy are in line with the Forestry Governance Model, and include incentive-based policies, forestry control, reforestation and afforestation activities, a forestry information system, sustainable forest management, and land tenure regularization. Further cross-cutting elements pertain to legal, financial and institutional frameworks, financial sustainability, multiple benefits, cross-sectoral planning, management of timber demand, and key stakeholder engagement.

The Government is already implementing a number of activities as part the preparation for REDD+, such as (1) determining the current deforestation rate to establish a Deforestation Baseline; (2) characterizing Ecuador's forests and determining carbon quantities per forest type through a National Forest Inventory, (3) implementing an incentive-based policy for the conservation of native forests called the 'Socio Bosque' Programme, (4) developing the financial structure needed for the uptake and channelling of financial resources coming from the implementation of a REDD+ mechanism, (5) ensuring social and environmental co-benefits, (6) defining a legal and institutional framework for environmental services in Ecuador, (7) designing an Engagement Programme for civil society and indigenous people on REDD+, and (8) designing an incentive-based policy for sustainable forests management complementing the Socio Bosque Programme.

The work presented here supports Ecuador's aim to maximise benefits from REDD+ that are additional to maintaining and enhancing carbon stocks.

## Mapping carbon in Ecuador

In 2008, the country's first forest carbon map was generated for integration into the prioritization system of the Ecuadorian Programa Socio Bosque (MAE 2010b, and see separate section). For this map, the forest cover classes from Sierra (1999) were merged into 4 broad forest cover classes for which average IPCC aboveground biomass carbon estimates are available.

Here, we present an updated national biomass carbon map for the mainland of the country. It is based on an updated vegetation stratification (MAE 2009, updated) and on above-ground biomass estimates compiled from national sources, where possible[1], and includes below-ground as well as above-ground carbon. In the Amazon region, the detail within the forest types was further increased by using spatially explicit biomass estimates from Saatchi *et al.* (2007). Below-ground biomass was calculated by applying IPCC root-to-shoot ratios (IPCC 2006) by ecoregion (FAO 2001; Cárdenas *et al.* 2009; Josse *et al.* 2009). A factor of 0.5 was used to convert from biomass into carbon stocks in tonnes per hectare (Brown 2002). According to the resulting map, a total of 1.63 gigatonnes (Gt) of carbon is stored in biomass in Ecuador. More than 1 Gt of this biomass carbon is stored in areas that were classified as of very high or high carbon density (Figure 1), mainly in the Amazon region or the foothills of the Andes (Map 2).

Results of the updated National Forest Inventory that is planned for late 2010/2011 (MAE 2010b), will be of great importance in further improving knowledge of carbon stocks in Ecuador's different vegetation types.

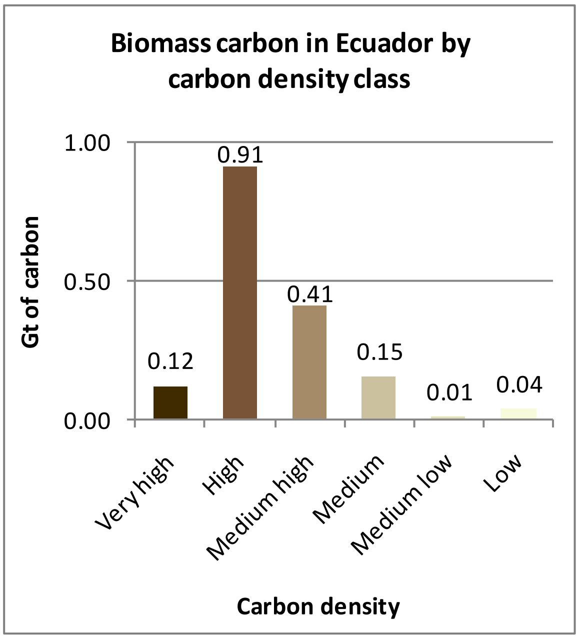
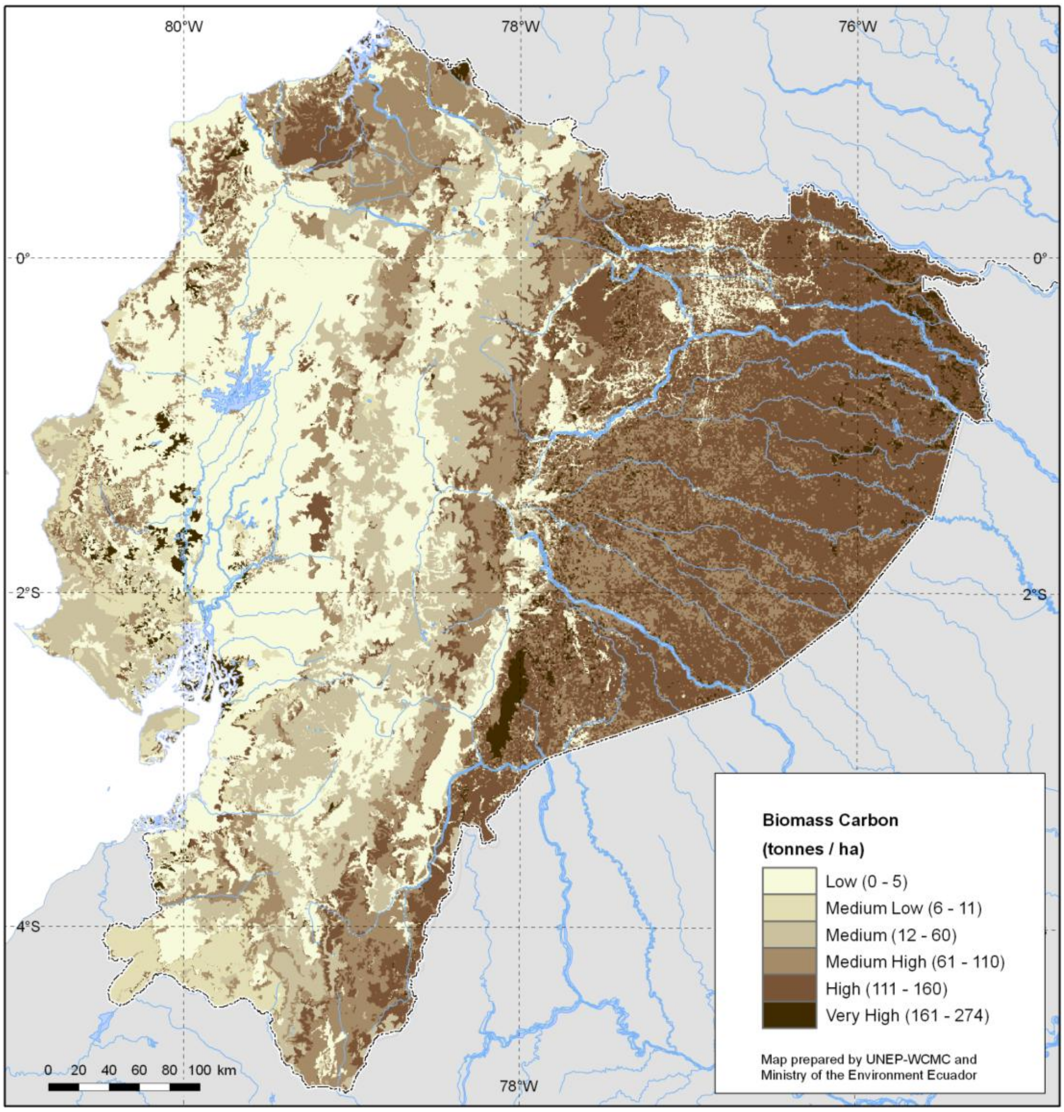



**Figure 1: Distribution of biomass carbon stocks in Ecuador among areas of different biomass carbon density.**

[1] Where no national estimates were available relevant regional or global average estimates were used (for more detail, see UNEP-WCMC and MAE in prep.)




**Map 2: Updated biomass carbon map of the Republic of Ecuador based on vegetation cover data and biomass estimates from national and international sources**

## When soil carbon counts

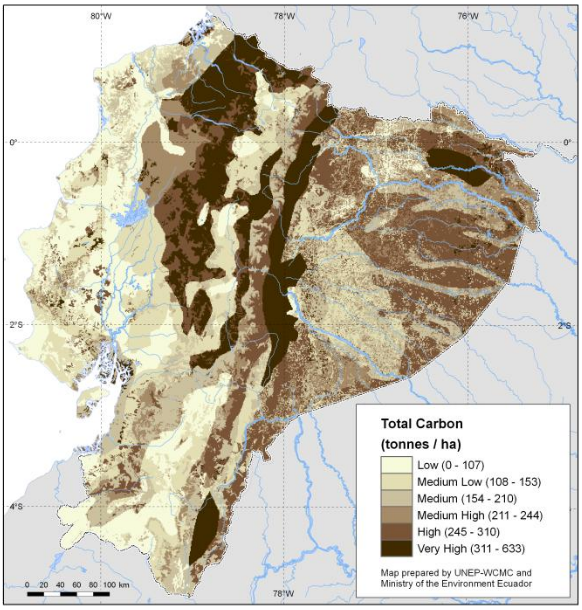
Globally, it is estimated that larger amounts of carbon are stored as soil organic matter than as biomass (IPCC 2000; Feller and Bernoux 2008), and these reserves may be distributed very differently from biomass carbon stocks. However, current knowledge on amounts of carbon stored in different soil types is limited.

It was not possible to obtain a national level dataset on soil characteristics for Ecuador that included sufficient detail to allow for conversion into a national soil carbon map. Consequently, data for Ecuador were clipped from a global map of soil carbon to 1 m depth (Scharlemann *et al.* in prep.), which is based on the Harmonised World Soil Database (FAO *et al.* 2009). According to these data, almost 3.6 Gt of carbon is stored in the soils of Ecuador. Combined with the figures for biomass carbon this gives an estimated total national carbon stock for Ecuador of 5.2 Gt (Map 3).

Overall, the Amazon region of Ecuador, covering about one third of the country's mainland area, stores about 58% of the country's total biomass carbon, whereas the Andean and Coastal regions hold 28 and 13% respectively (Table 1). However, inclusion of soil carbon changes the relative contributions of the regional carbon stocks; the percentage of the total carbon stored in the Amazon region is much lower than that stored in the Andean region.

Including soil carbon also affects the distribution of carbon stocks among land cover types. Almost half of Ecuador's biomass carbon (46%) is stored in the Amazonian lowland evergreen forest, but this vegetation, which occupies 25% of the land area, contains only 27% of the total national carbon storage when soil carbon is taken into account. The evergreen forest of the Andean foothills stores about 11% of the country's biomass carbon and 7% of its total carbon; and the Moretales (palm-rich forests) and evergreen Andean mountain forest store 9 and 8% of the biomass carbon and 10 and 5% of its total carbon stock, respectively (Figure 2). It is notable that cultivated land, which covers about 29% of the mainland, only stores about 2% of its biomass carbon (Figure 2), but houses sufficient soil carbon to account for 20% of the total carbon stock.

These data show the large contribution that soil carbon can make to a country's total carbon stocks and highlight the importance of wise management of soil carbon for climate change mitigation. Options for managing soil carbon stocks include the use of agricultural practices that reduce the release of carbon from soil in cultivated areas.




**Map 3: Total carbon density in Ecuador**

**Table 1: Distribution of Ecuadorean terrestrial carbon stocks among the mainland regions**

| Region | % of total area | % of total biomass carbon | % of total carbon |
|---|---|---|---|
| Amazon | 33 | 58 | 36 |
| Andean | 41 | 28 | 46 |
| Coastal | 26 | 13 | 18 |

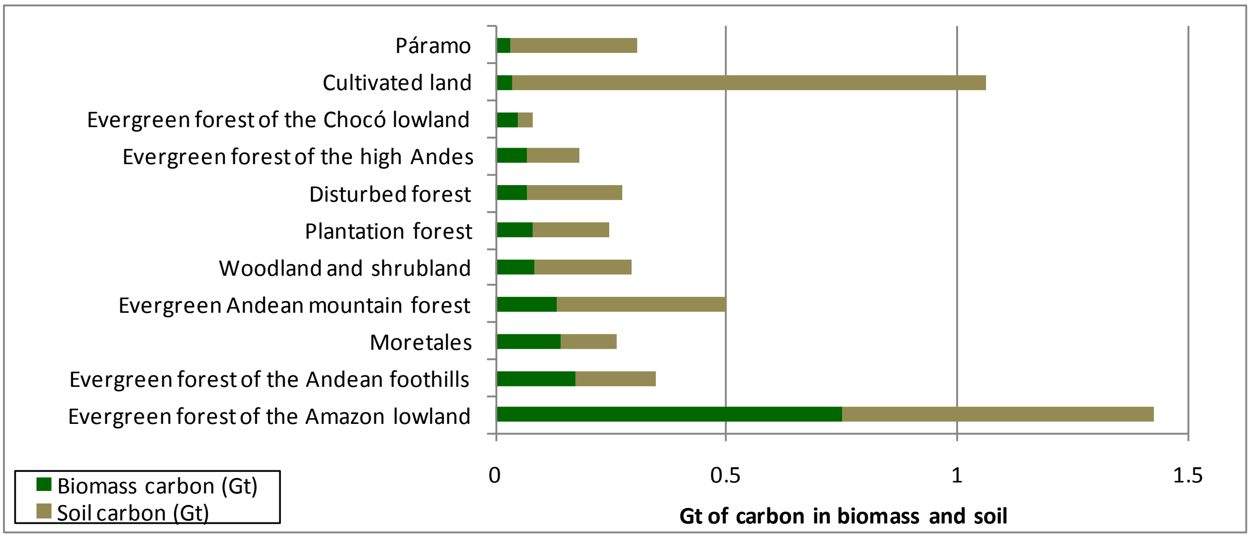



**Figure 2: Biomass and soil carbon in Ecuadorian land cover types** (land cover types with < 0.08 Gt of total carbon not shown)

However, our knowledge of soil carbon stocks is as yet incomplete. Due to the coarseness of the soil data currently available for Ecuador, the maps in this report show only biomass carbon (apart from Map 3). Equally, calculations are based on biomass carbon only. When a more detailed national soil carbon dataset has been generated as the required data become available, maps and calculations can be modified to include the new data.

# Exploring co-benefits in Ecuador

There is a huge potential to gain co-benefits from REDD+ in Ecuador. Despite its small size, the country is among the 17 most biodiverse countries in the world (Mittermeier *et al.* 1999); however, many of its species are threatened by different pressures (see Table 2). At the same time, improvements in human well-being are prioritised by national policy. Consequently, the country is seeking to maximise both environmental and social co-benefits from REDD+.

**Table 2: Numbers of known and threatened species in Ecuador (IUCN 2010; MAE 2010a)**

| Taxon | Known species | Threatened species (%) |
|---|---|---|
| Vascular plants | 17 058 | 1 716 (10%) |
| Mammals | 382 | 42 (11%) |
| Birds | 1 655 | 71 (4%) |
| Amphibians | 464 | 171 (37%) |
| Reptiles | 404 | 11 (3%) |
| Fish | 1 539 | 18 (1%) |

## Biodiversity

There are different approaches to identifying areas of importance for biodiversity. Among these approaches is the identification of Key Biodiversity Areas (KBAs) (Eken *et al.* 2004; Langhammer *et al.* 2007), sites of importance for different species according to internationally agreed criteria. Most of the globally identified KBAs are Important Bird Areas (IBAs), key sites for conservation of threatened, restricted range and/or migratory or congregatory bird species.

Ecuador has more than 110 IBAs (BirdLife International 2010). Sixteen of them have also been confirmed as having importance to taxa other than birds (Conservation International 2010). Where boundaries are known, KBAs confirmed as IBAs only are highlighted in green on Map 4, while those KBAs confirmed as important for birds and other taxa are highlighted in pink.

In total, Ecuador's KBAs cover about 36% of the mainland of the country. Biomass carbon within these areas amounts to 0.85 Gt, or 52% of the country's total. KBAs include more than 50% of Ecuador's very high carbon density land and almost 60% of the high carbon density land (Figure 3).

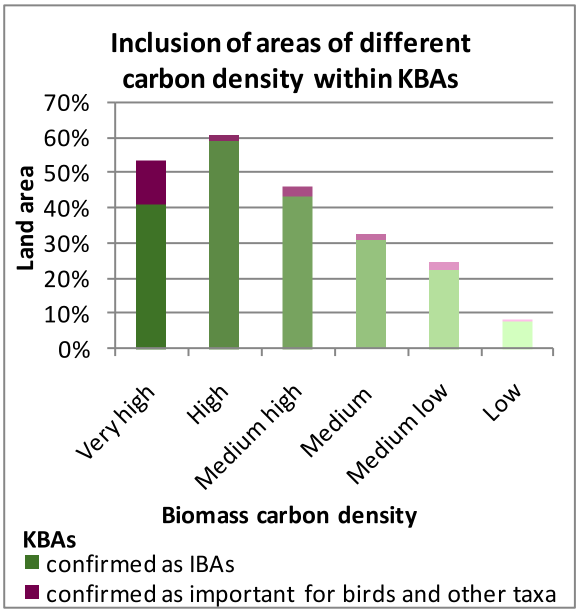
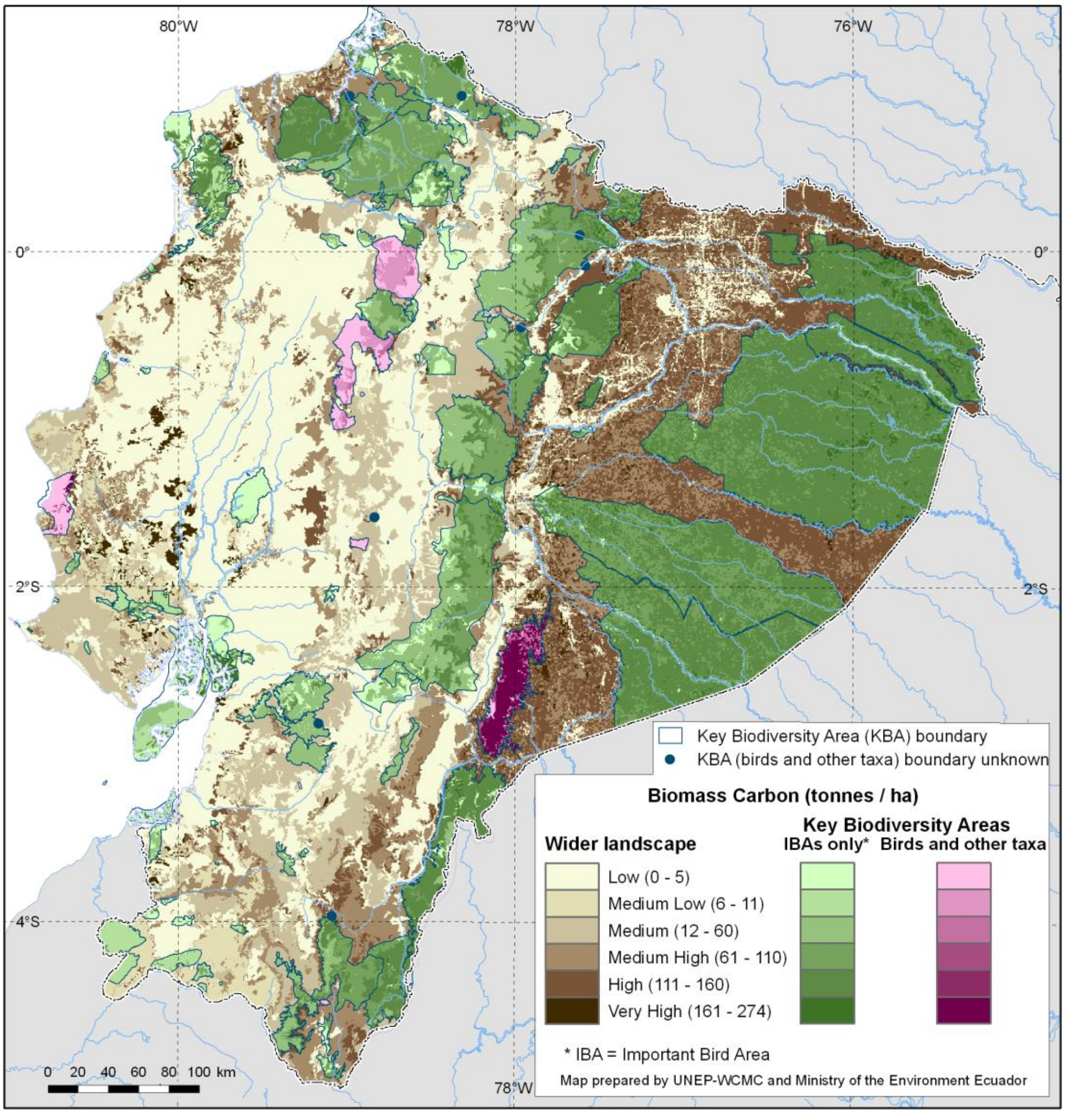



**Figure 3: Percentage of Ecuador's land of different carbon density occurring in KBAs**




**Map 4: Key Biodiversity Areas (KBAs) and biomass carbon in Ecuador.** All areas designated as IBAs also meet the criteria for KBAs, but those areas highlighted in pink have been confirmed as also having significant importance for taxa other than birds.

Ecuador has also identified terrestrial and marine Conservation Priority Areas and 'ecological gaps' in the national protected areas system (Cuesta *et al.* 2006; Terán *et al.* 2006; Campos *et al.* 2007, these areas will jointly be called Conservation Priority Areas). These are areas of importance for conservation of key species and/or ecosystems, and mostly are not yet designated as Protected Areas. The criteria used to identify the sites include occurrence of particular species and habitat types, as well as irreplaceability of sites and their vulnerability to pressures that affect biodiversity (Cuesta *et al.* 2006; Campos *et al.* 2007). Areas were classified into six categories of conservation priority. Here, we focus on the top three categories for terrestrial sites, as explained in Table 3. In Map 5 these Conservation Priority Areas are combined with the new biomass carbon map.

**Table 3: Definitions of three top categories of areas of conservation priority**

| Conservation priority | Definition |
|---|---|
| **Very high** | Sites are highly irreplaceable and very vulnerable |
| **High** | Sites are highly irreplaceable and moderately vulnerable |
| **Medium** | Sites are not highly irreplaceable but very vulnerable |

The three highest priority classes between them hold 0.24 Gt or 15% of Ecuador's biomass carbon (Figure 4).

About 30%, almost 10 200 km$^2$, of the area of very high, high or medium conservation priority falls within KBAs. The relatively small overlap between the two sets of priorities reflects the important role of criteria other than bird species in identifying Conservation Priority Areas.

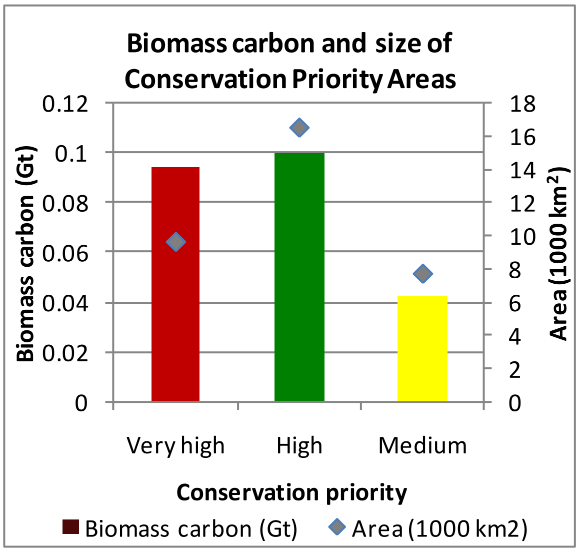
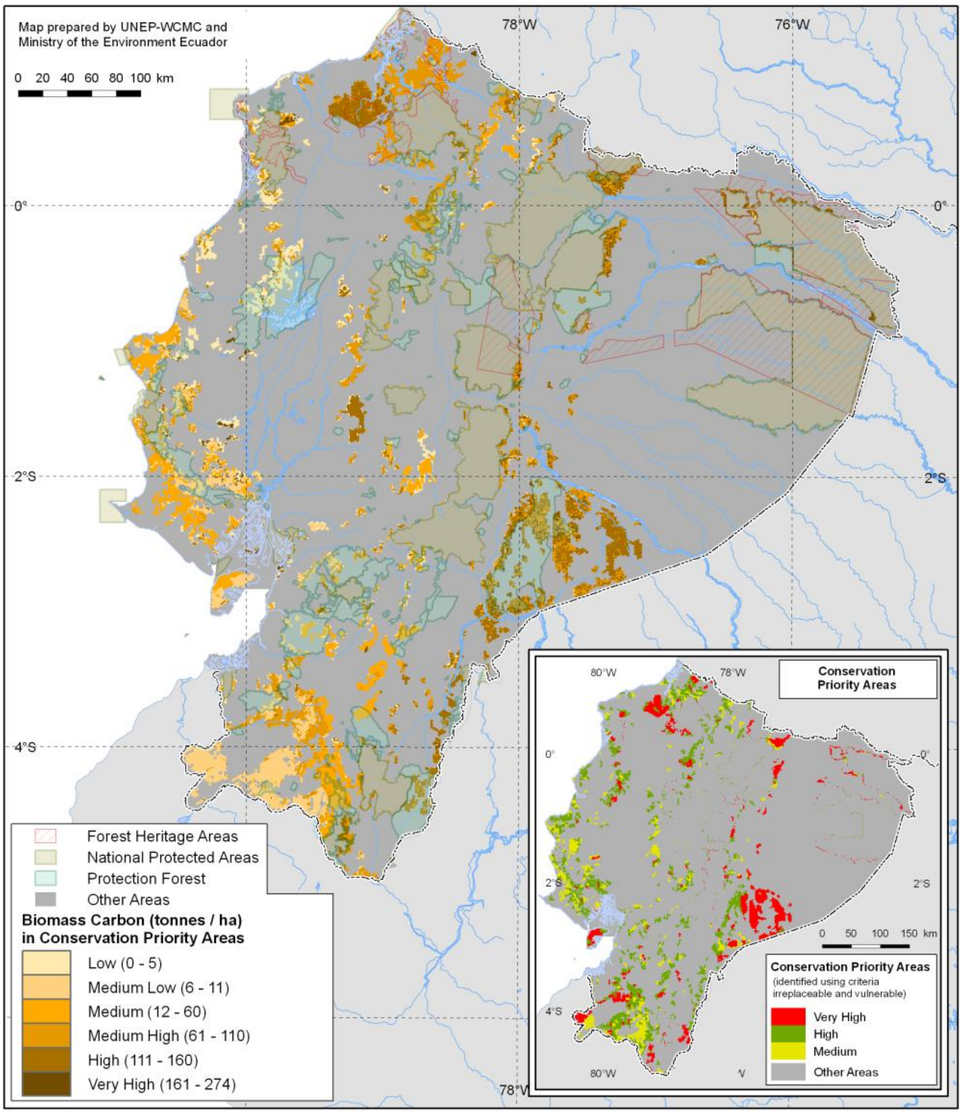



**Figure 4: Biomass carbon in areas of very high, high and medium conservation priority**




**Map 5: Biomass carbon density in relation to Conservation Priority Areas**

## Protected Areas, Protection Forests and National Forest Heritage Areas

Ecuador's National Protected Area System represents a major tool in the country's biodiversity conservation strategy. The system includes National Parks, Biological Reserves, and Wildlife Refuges, which differ in their objectives. All the areas designated as part of the National Protected Area System are administered by the National Biodiversity Directorate. Apart from Protected Areas, there are other management units for forest areas, i.e Protection Forests and National Forest Heritage Areas (Box 1; Map 6, data from MAE 2007; Subsecretaria de Patrimonio Nacional MAE 2010).

While Protected Areas and Protection Forests do not overlap, both of them can fall within National Forest Heritage Areas (Map 6). Almost 24% of Ecuador's mainland biomass carbon is stored in Protected Areas and 8.5% in Protection Forests. The part of National Forest Heritage Areas that is neither a Protected Area nor a Protection Forest contains another 7%. The largest part of the biomass carbon in all three management units is from areas of either very high or high carbon density. Almost 50% of the area classified as of very high carbon density is either within a Protected Area (26%), within a Protection Forest (18%), or within a National Forest Heritage Area (5%). Of the areas of high carbon density, about 44% fall within one of the management units (Figure 5).

The management units considered here follow different objectives. While Protected Areas are established with the main aim to maintain biodiversity and ecosystems, use of natural resources within the other management units, especially the National Forest Heritage Areas is less restricted. Here, careful design of carbon management measures for high biomass carbon density areas could help maintain these important biomass carbon stocks.

**Box 1: Definitions of 'Protected Areas', 'Protection Forests', and 'National Forest Heritage Areas' in Ecuador (MAE 2007 and pers. comm.)**

**Protected Areas:** Areas of public or private property that are of ecological, social, historical, cultural and scenic relevance, established in accordance with the law of the country, with the aim to avoid their destruction and secure research and conservation of their plants or animals, natural landscapes and ecosystems.

**Protection Forests:** Areas of varying size that include formations of natural or cultivated trees, woodland and shrubland. These areas are important for the support of people's wellbeing, protective services and functions mainly related to the provision and regulation of water, and the continuity of ecological processes. They are also important for the development of local communities through multiple and sustainable use of natural resources.

**National Forest Heritage Areas:** Forest land that is owned by the government in accordance with the law of the country, i.e. natural forest, cultivated forest and the forest flora and fauna within those areas. This includes forest areas owned by the government that are unsuitable for agriculture and cattle farming, in a natural state that should be maintained due to the areas' scientific value, importance for the environment, for conservation of ecosystems, flora and fauna, and mangrove forests along the coast.

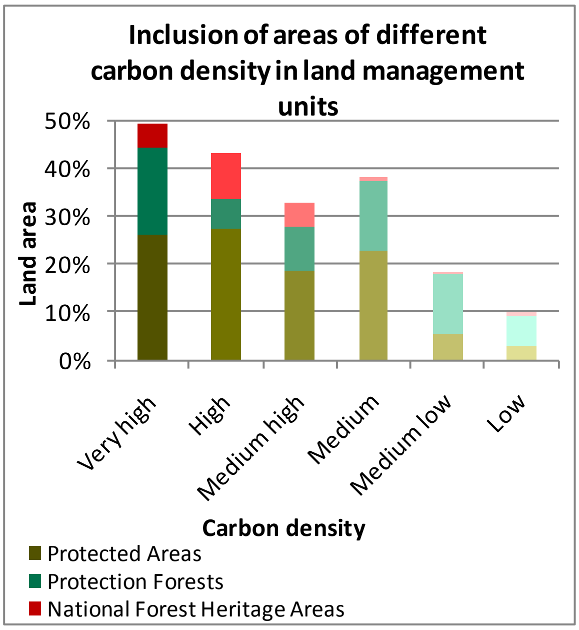
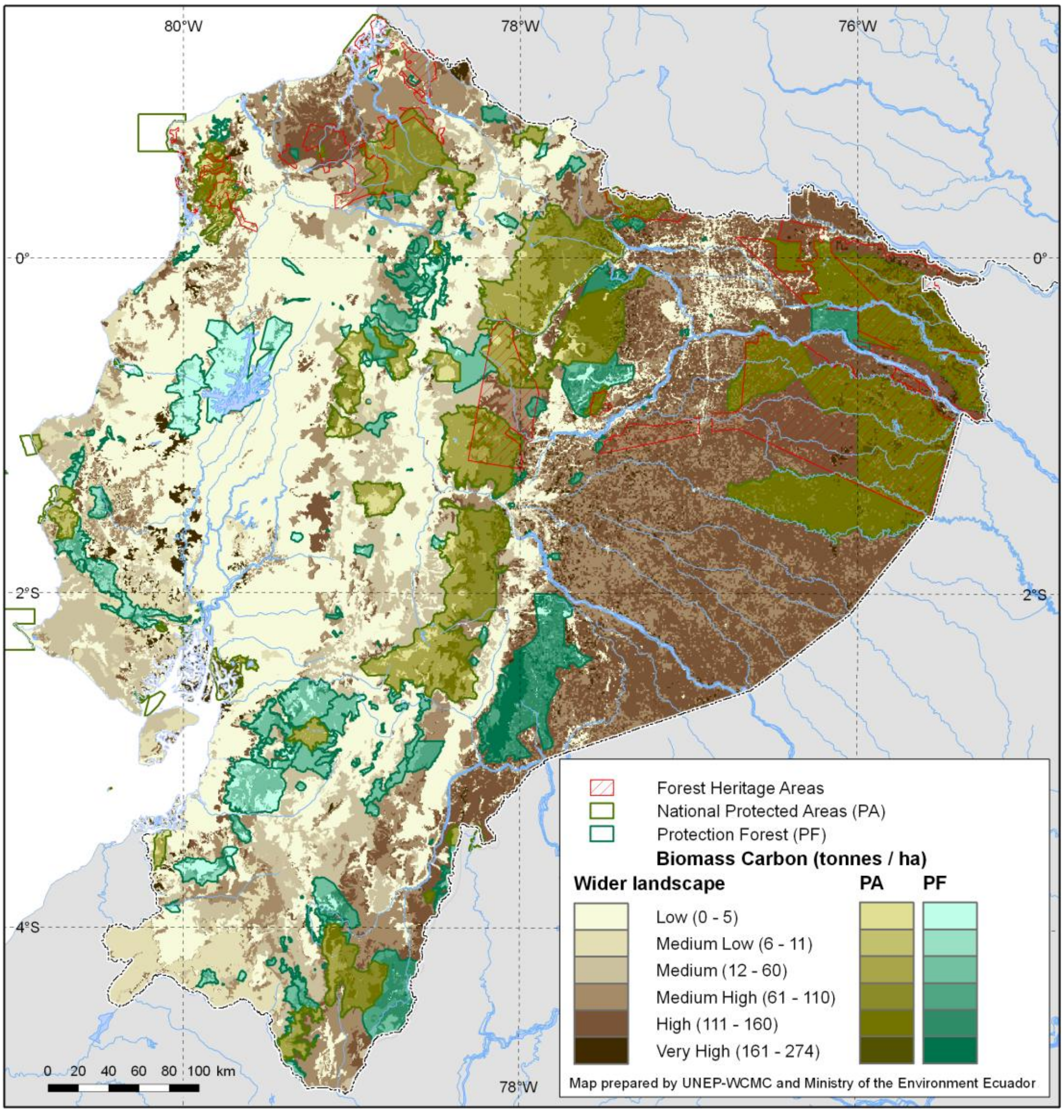



Figure 5: Management designation of areas of different carbon density




**Map 6: Protected Areas, Protection Forests and National Forest Heritage Areas in relation to biomass carbon in Ecuador**

For national policy-making, it may be of interest to know how much of the area that is high in both carbon and biodiversity is within Protected Areas (PAs), Protection Forests (PFs) and National Forest Heritage Areas (NFHAs). To analyse this, high carbon and high biodiversity areas are defined as areas of very high or high carbon density that fall within KBAs or within Conservation Priority Areas (Figure 6). Of the more than 48 800 $km^2$ of high carbon – high biodiversity area, about 43% is located outside of the management units that were considered here. The large overlap between KBAs and Protected Areas leads to 40% of the high carbon – high biodiversity area inside Protected Areas.

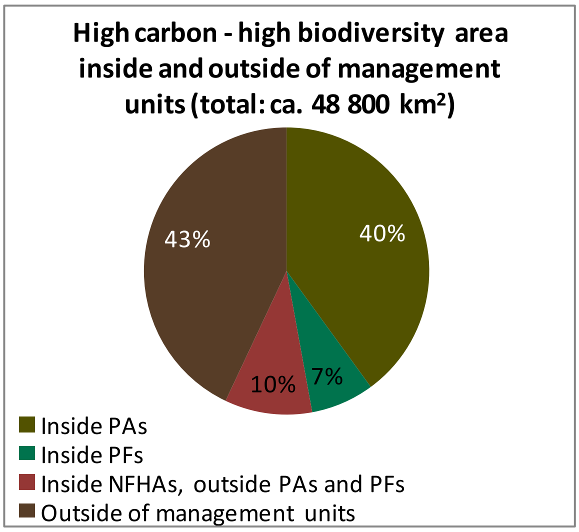



**Figure 6: Distribution of high carbon - high biodiversity area among different land management types**

## Poverty and population density

The socio-economic context is an important factor in planning for co-benefits from REDD+. Where areas of high poverty are targeted for REDD+ activities, their careful design can help improve local livelihoods. Identifying areas with high population density can indicate where REDD+ activities could have an impact on large numbers of people. At the same time, management choices may also depend on future increases in population density coupled with changing demands for the use of the surrounding land and natural resources. Map 7 shows areas of high poverty and high population density (data from SIISE 4.5, 2006) in relation to biomass carbon in Ecuador.

For poverty, the Unsatisfied Basic Needs –index was used. This index is applied on the household level; a household is considered poor when access to education, health, nutrition, housing, urban services and job opportunities is considered unsatisfactory. The dataset used provided the percentage of people with unsatisfactory access to basic needs by province. Provinces with high poverty were defined as those where at least 50% of the population is suffering from unsatisfied basic needs. Population density data was available on parish level and referred to the number of inhabitants per area unit. After grouping the parishes into 5 density classes of approximately equal size, all parishes in the top class were declared as of high population density.

In Map 7, the darkest blue indicates where areas of high carbon density coincide with both areas of high poverty and areas of high population density. Dark grey indicates coincidence of high carbon density and high population density (but not high poverty) and the darkest shade of red indicates coincidence of high carbon density and high poverty (but not high population density).

Of Ecuador's very high carbon density areas, about 17% are at the same time of high poverty and high population density (see dark blue bar in Figure 7). This corresponds to about 1 160 $km^2$, which are mainly in the northern part of the Amazon region (see Map 7). Most of the areas where high poverty and high population density coincide, however, are of medium to low biomass carbon density (lighter blue in Map 7).

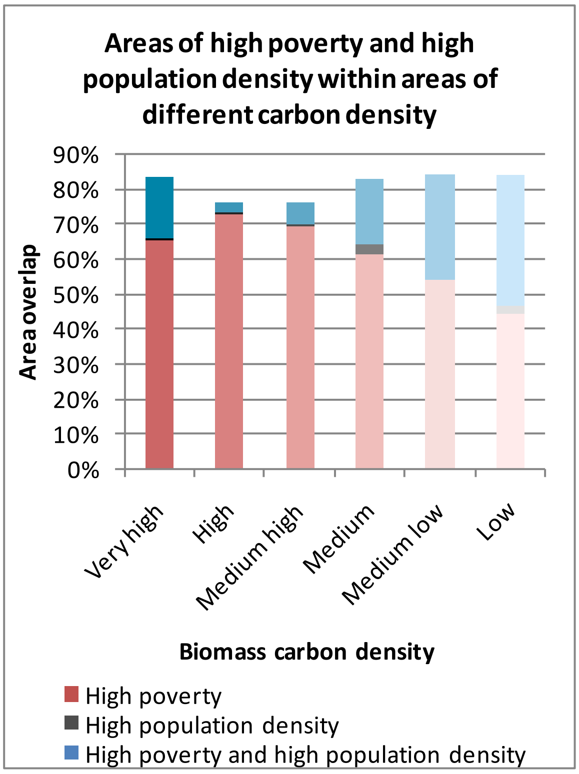
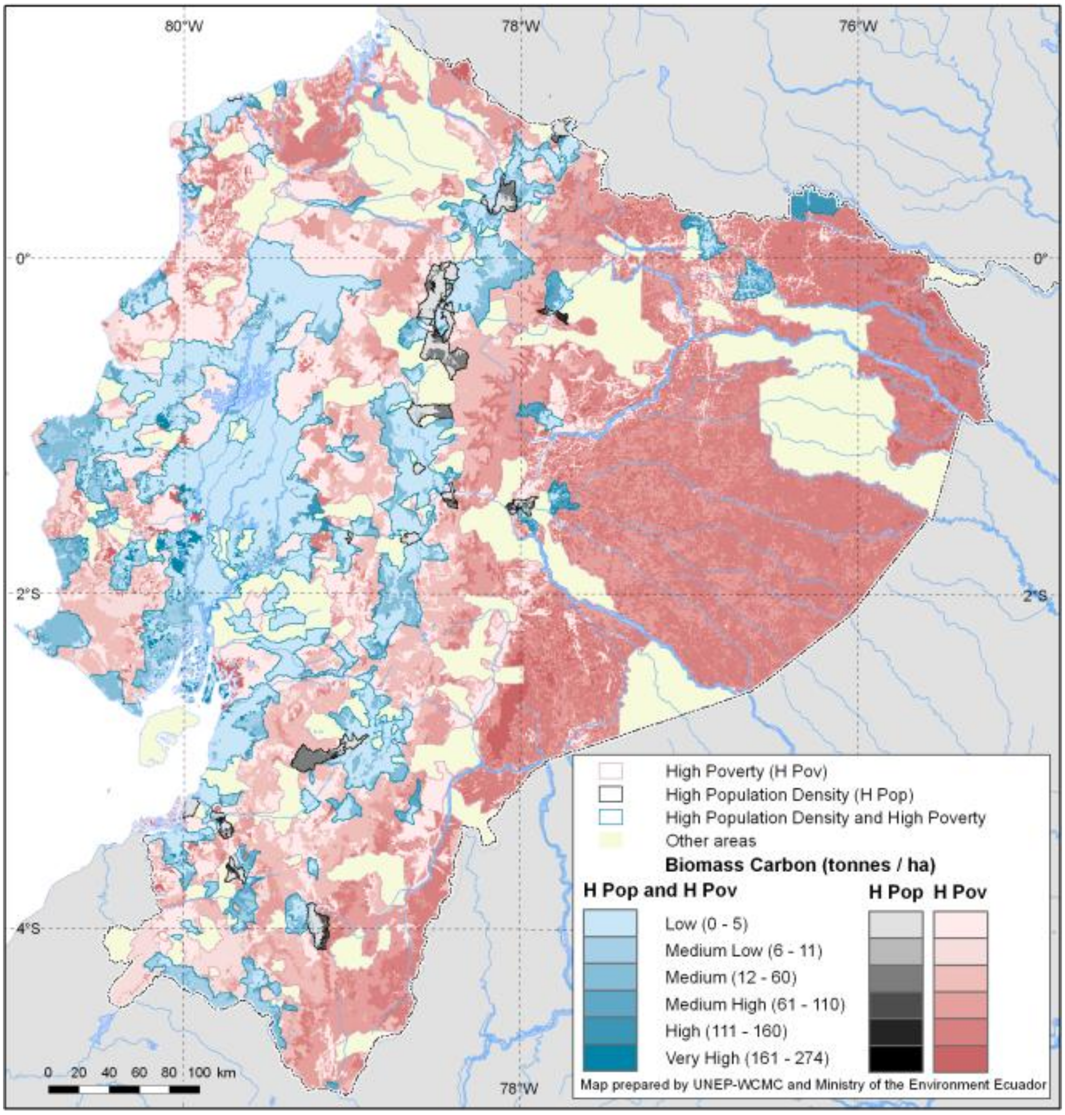



**Figure 7: Overlap of areas of high poverty and high population density with areas of different biomass carbon density**

When only looking at the overlap of high poverty and high or very high biomass carbon density (but not high population density, red areas in Map 7), the situation is very different: More than 65% of the area of very high carbon density and more than 70% of the area of high carbon density are at the same time of high poverty (see dark red and next red bar in Figure 7). Apart from smaller areas in the northwestern part of Ecuador, these areas are mainly in the Amazon region. One reason for these large overlaps is that high poverty areas cover almost 79% of the total area of the country. Most high population density areas are also high in poverty. The small area where population is dense but poverty is not high (black areas in Map 7) is concentrated in the Andean region of Ecuador.

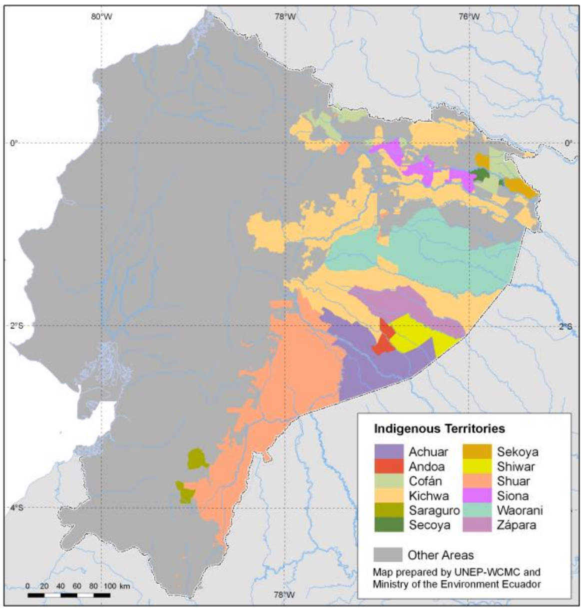


Map 7: Poverty and population density in relation to biomass carbon in Ecuador

## Indigenous people

Ecuador is home to 14 different groups of indigenous peoples. A spatial dataset on the location and size of the territories of the Anchuar, Andoa, Cofan, Kichwa, Saraguro, Secoya, Sekoya, Shiwiar, Shuar, Siona, Waorani, and Zápara (Map 8, data provided by the Ministry of the Environment of Ecuador), was used to estimate biomass carbon stocks within indigenous territories.

The territories of these 12 indigenous people's groups cover about 31% of the country's mainland area, 26% of which are located in the Amazon region and the remainder in the Andean region. These areas store more than half of the country's biomass carbon, and almost 80% of the biomass carbon in the Amazon region.




**Map 8: Location of 12 indigenous people's territories in Ecuador**

There is a significant overlap of indigenous people's territories and other land designations, such as Protected Areas and Protection Forests. Additionally, over 25% of the Conservation Priority Areas are in indigenous people's territories, and the same is true of almost 48% of the KBAs.

These figures suggest that a significant share of areas, where carbon and biodiversity benefits could be secured at the same time, is within indigenous territories. Considering the rights and needs of the indigenous peoples of Ecuador will therefore play a crucial role in the development of a future REDD+ strategy.

**Photo: Landscape in the Amazon region of Ecuador (© Marco Chíu)**

## Ecuador's Socio Bosque Programme

The Ecuadorian Socio Bosque Programme aims to conserve more than 3 million hectares of native forest, 'páramo' (high altitude grassland) and other native vegetation types of Ecuador within seven years with the participation of 500 000 to 1.5 million beneficiaries (MAE 2008), thereby conserving carbon stocks and securing co-benefits.

For the prioritisation of sites for inclusion in the Programme, three different criteria were taken into account: the level of risk of deforestation of the site (defined by accessibility and history of deforestation), ecosystem services provided by the site (i.e. biodiversity, water regulation and biomass carbon storage), and level of poverty at the site. The combination of available information on these criteria at the time of the establishment of the Programme led to the identification of areas of high, medium and low priority (see small inset in Map 9, note that white areas in this map represent areas in the National Protected Area System, which were excluded from the prioritisation). Highest priority was given to areas with native vegetation that are severely exposed to risk of deforestation, are located in proximity of a watershed with natural vegetation, and where the carbon stocks and the basic needs of local people are both high.

The biomass carbon data that have been used to prioritise areas for Socio Bosque were derived from IPCC average estimates of biomass carbon in different vegetation types (MAE 2010b). Here, we compare the Socio Bosque Priorities with the newly developed biomass carbon map for Ecuador. In Map 9, purple areas represent those where Socio Bosque Programme activities are already in place. The yellow areas in the map represent areas of highest Socio Bosque priority where the Programme is not yet active.

Areas where the Socio Bosque Programme is already active cover almost 8 000 km$^2$ of Ecuador's mainland and store just over 5% of the total biomass carbon of the country (Figure 8). Almost 30% of the area where activities are already implemented is of highest priority, almost 50% of second, and 15% of third priority.

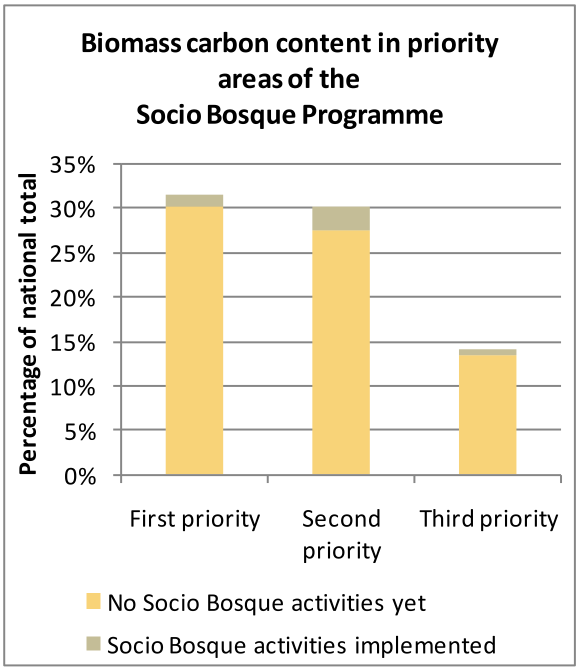
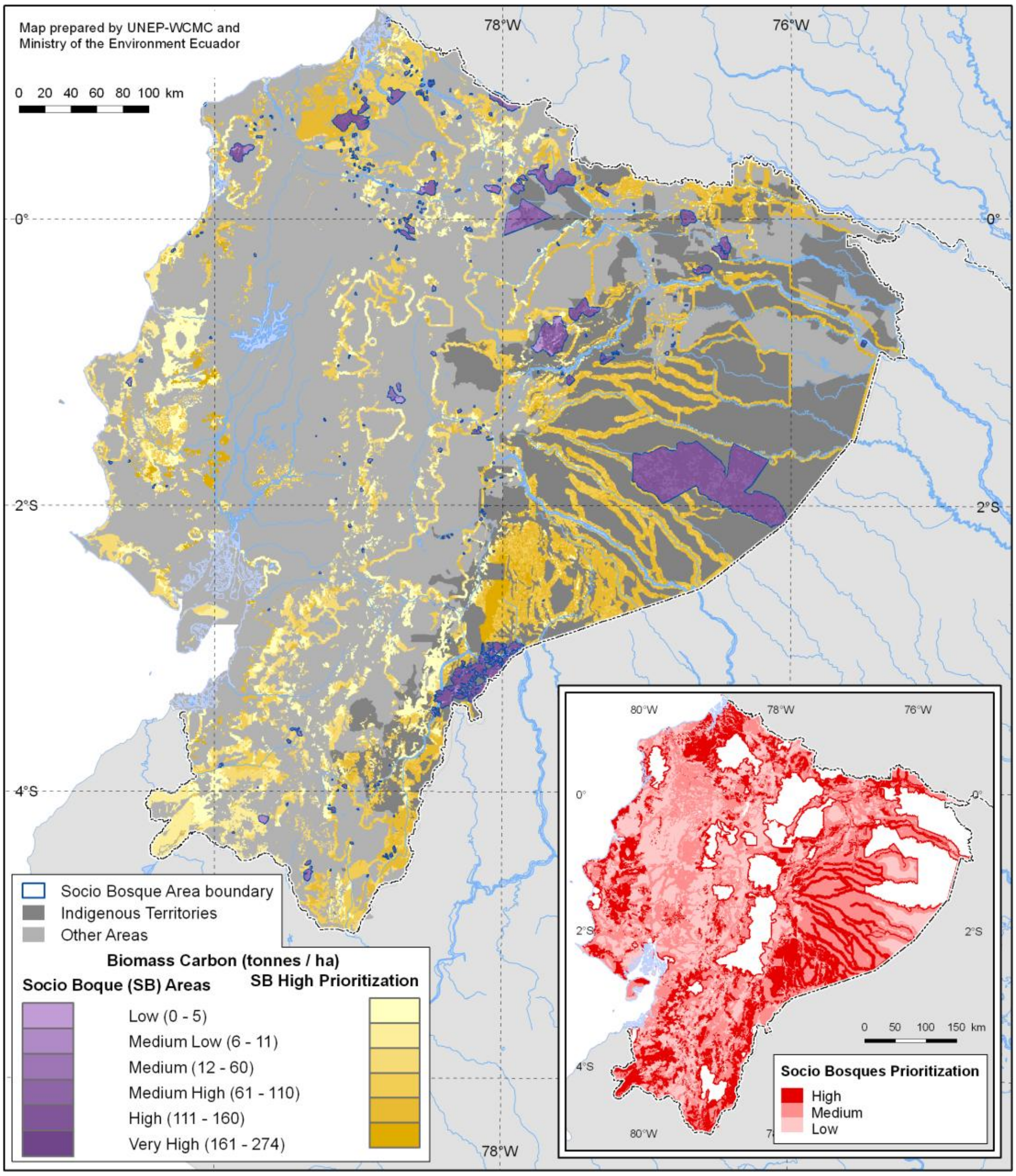



**Figure 8: Biomass carbon content in areas of different priority for the Socio Bosque Programme**

Figure 8 also shows that the first and second priority areas jointly store about 62% of the national biomass carbon. Third priority areas contain about 14% and the remaining 24% of the national biomass carbon are within Protected Areas which are excluded from the Socio Bosque prioritization.

More than one third of the first priority areas (yellow in Map 9) is of either very high or high biomass carbon density. However, another 20% are of low biomass carbon density, which may reflect the differences between the biomass carbon data that was used for the prioritisation and the new map used here.




**Map 9: Established Socio Bosque areas, areas of highest priority for the Socio Bosque Programme, indigenous territories and biomass carbon (data provided by the Ministry of the Environment of Ecuador).** The inset shows all three priority classes of the Socio Bosque Programme, white areas represent protected areas which are excluded from the prioritization scheme.

## Pressures on carbon and co-benefits

### Forest cover loss

Areas currently identified as having high potential for securing carbon and co-benefits may lose this potential as a result of different pressures exerted on them, including deforestation. While the government is currently analysing remote sensing data to update existing figures on forest cover loss in Ecuador, we used a spatial dataset on deforestation between 1990 and 2000 generated by Conservation International (Harper *et al.* 2006, Map 10) to assess potential pressure on carbon stocks in surrounding areas.

Buffers of 2 km, 5 km and 10 km were drawn around the areas of forest cover loss as per this dataset and biomass carbon stocks within these buffers were calculated. Figure 9 shows the percentage of total biomass carbon of Ecuador that is included in these buffer areas separately for the Amazon, Andean and Coastal region.

Overall, 20% of the country's total biomass carbon is within 2 km of recent deforestation. This figure increases to 41% within 5 km and to over 60% within the 10 km buffer areas.

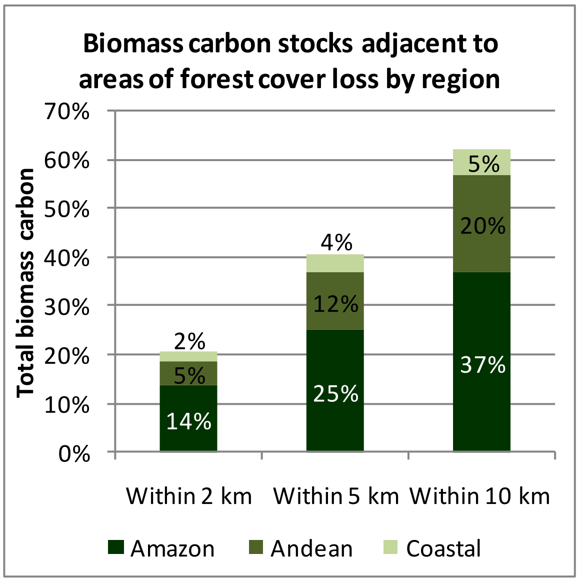
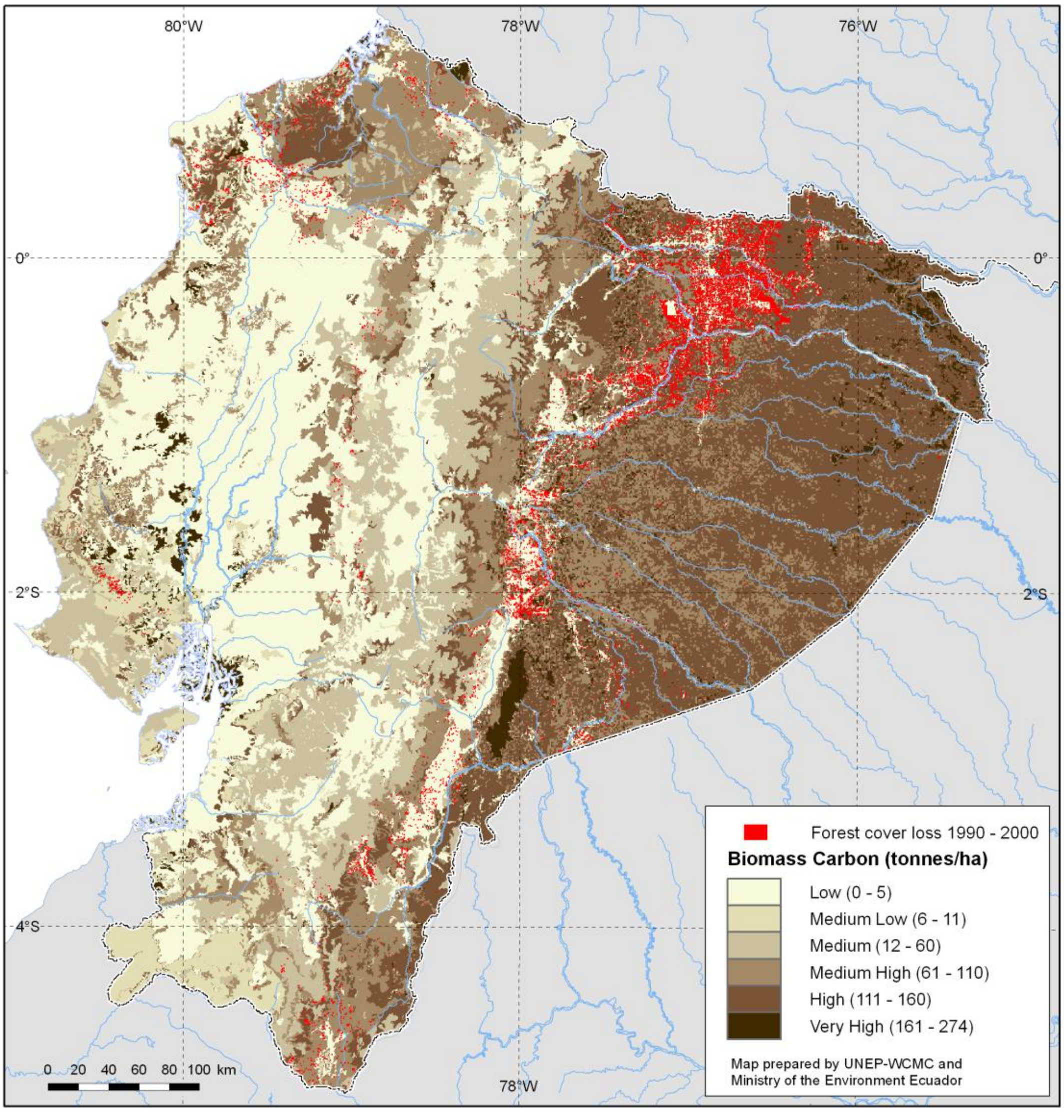


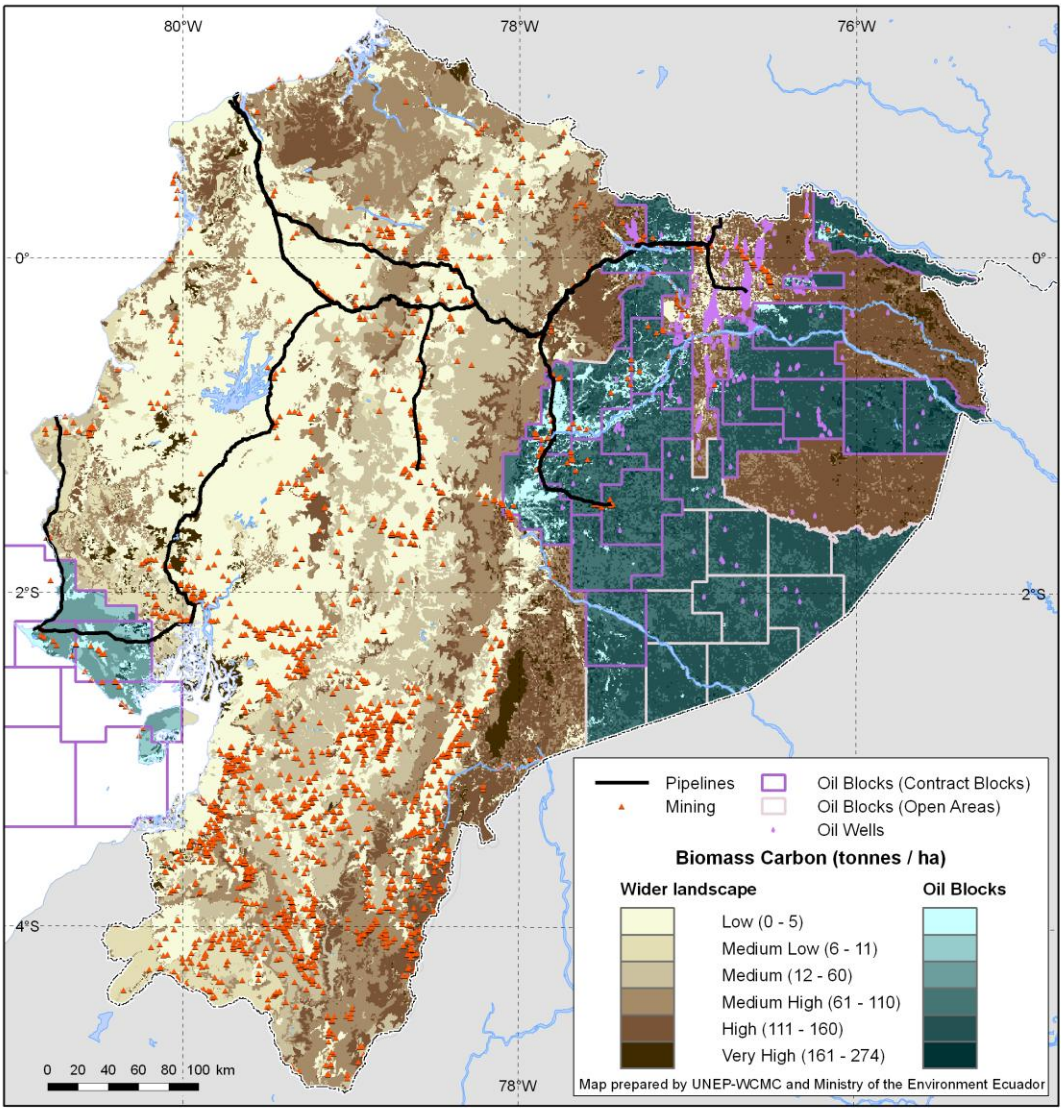

**Figure 9: Biomass carbon stocks around areas of forest cover loss by region**




**Map 10: Forest cover loss between 1990 and 2000 in relation to biomass carbon**

## Oil, gas and mining

Activities related to the exploitation of oil, gas, and minerals are another source of pressure on carbon and biodiversity. Ecuador is rich in mineral resources, and the potential for oil exploitation is especially high in the Amazon region of the country. Map 11 shows biomass carbon in relation to mining activities, oil wells and pipelines (data provided by the Ministry of the Environment of Ecuador). It also shows areas where oil exploitation is currently happening or planned (contract blocks), and areas where oil exploitation may happen in the future (open areas, i.e. oil blocks that are not currently leased to third parties). The map shows that large areas of Ecuador are potentially subject to some form of mineral exploitation and helps to visualise the potential effect on carbon stocks. However, no distinction is made between contract blocks for exploration and contract blocks for exploitation. In any case, it will be important to consider future plans for further exploitation of these resources when identifying sites for the establishment of REDD+ activities. In order to avoid establishing potentially contradictory policies in these areas the Ministry of the Environment of Ecuador is promoting cross-sectoral planning.




**Map 11: Oil, gas and mining activities in relation to biomass carbon**

## Conclusions and next steps

Understanding the spatial relationship between areas that may be targeted for carbon management and areas that have the potential to deliver co-benefits can help inform REDD+ planning. The inclusion of existing management units, indigenous territories, socio-economic conditions and potential pressures on carbon stocks is important to help ensure that REDD+ actions are effective and take account of the needs and priorities of local people.

The results of the analyses presented here, which are based on an updated biomass carbon map, provide a first step towards better informed REDD+ planning and enhance the likelihood of achieving co-benefits from REDD+ in Ecuador. These analyses show that the factors under consideration all have different relationships with the distribution of biomass carbon stocks, and that some areas, which are especially important for carbon and biodiversity, provide opportunities for gaining additional benefits from carbon management decisions.

They also show that several different authorities have responsibility for land that is high in carbon and that several pressures act on these areas. This emphasises the importance of enhanced cross-sectoral collaboration in planning for REDD+ and for other land uses, e.g. in the context of activities related to oil, gas and mining. Accordingly, the Ministry of the Environment in Ecuador is actively promoting such cross-sectoral cooperation.

The government's current activities, including the new National Forest Inventory and more detailed analyses of forest cover loss and deforestation rates, will allow for further refinement of the biomass carbon map and better analyses of potential impacts of deforestation and/or REDD+ actions on biomass carbon stocks.

A second phase of collaboration between UNEP-WCMC and the Ministry of the Environment of Ecuador is planned to develop this work further by incorporating national soil carbon data and information on other ecosystem services, discussing the Socio Bosque Prioritisation in more detail, and exploring options for monitoring of co-benefits as part of Measuring, Reporting and Verification (MRV) for REDD+.

**Photo: Toucan in Ecuador (© Ministry of the Environment of Ecuador)**

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**Photo: Forest landscape in the Ecuadorian Amazon region (© Daniela Carrión)**

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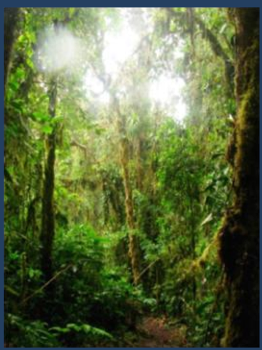
The benefits of actions to maintain and enhance carbon stocks for climate change mitigation can be increased by taking into account the relationship between the distributions of carbon, biodiversity, and other factors of relevance to REDD+ planning. Here, we present an updated map of biomass carbon stocks in Ecuador and analyses of the relationships between carbon and biodiversity, Protected Areas, indigenous people's territories, poverty, human population density, and other factors, including potential pressures on carbon and biodiversity.



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