Bogotá (Colombia); Caracas (Venezuela); Lima (Perú); Paramaribo (Suriname); Quito (Ecuador); Santa Cruz de La Sierra (Bolivia); Belém and São Paulo (Brasil).

2012

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Urban district on the outskirts of Manaus encroaching on the forest. Manaus, Brasil.

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City of Altamira on the shores of the Xingu where the Belo Monte Hydroelectric Dam (UHE) is being built. Pará, Brasil.

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Amazonas river during one of the worst droughts registered in Amazonia. Barreirinha, Amazonas, Brasil.

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Alunorte, the world's largest aluminum refinery. Barcarena, Pará, Brasil.

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Waste disposal from the Alunorte refinery. Barcarena, Pará, Brasil.

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Tucuruí Hydroelectric Plant, on the Tocantins river. Pará, Brasil.

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Aluminum ingot storage zone owned by Albras. Barcarena, Pará, Brasil.

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Mechanized soya harvesting. Campo Verde, Mato Grosso, Brasil.

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Cattle ranch previously forestland, between Querência and São José do Xingu. Mato Grosso, Brasil.

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Yard of one of the 140 logging companies established in Tailândia, in 2008. Pará, Brasil.

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Mechanical plowing in a soybean plantation in Mato Grosso, Brazil. © Francisco Beccari, 2010

Subsidence along the Amazon riverbed as a result of the mechanical clearing of agriculture. © Benoy Pai Brasil / © Paulo Santos, 2012

Terreno de Curvado and surrounding land being deforested. Rio de Janeiro, Brazil. © Rogério Petito, 2009

Deforestation of a heavy forest zone surrounding an oil seep. Marã basins, Brazil. © Claudio de Sant’Agostino, 2007

Enlargement of the Amazon. © Claudio de Sant’Agostino, 2007

Agricultural link road between Itacoatiara and the border with Brazil. © Rogério Petito, 2009
### Amazonia under Pressure

**RAISG Amazonian Network of Georeferenced Socio-environmental Information**

[Imazon], Maria Oliveira-Miranda (Provita), Melvin Uiterloo (ACT Suriname), Milton Romero-Ruíz (Gaia), Sandra Hernández (text)

**Revision and standardization of abbreviations:**

**Translation**

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Amazonia under Pressure is the result of a joint project involving civil society and research organizations from the Amazonian Network of Georeferenced Socio-Environmental Information (RAISG).

The first attempt to structure this collaborative space was sponsored by ISA in 1996, based on its experience of working in Brazil, accumulated since the 1970s.

From the outset the proposal was to build a fertile environment for developing a long-term accumulative and decentralized process that would enable the compilation, generation and publication of information and analysis of the contemporary dynamics of (Pan)Amazonia.

After a low-profile period, from 2007 onwards, as part of the new ‘Amazonian wave’ linked to the global debate on climate change, we were able to mobilize a group of institutions that together combine the minimal conditions needed to elaborate a joint work plan:

- have a socio-environmental agenda;
- make strategic use of geographic information systems; and
- able to exchange and combine databases at (Pan)Amazonian scale.

Since then considerable effort has been invested in creating and implementing technical and political protocols, as well as investments in equipment, computing tools and staff capacity building, with support from the Rainforest Foundation Norway, the Ford Foundation, Avina and the Skoll Foundation.

The composition of the network has remained basically stable throughout the process with only a few changes. It is currently composed of 11 institutions (see page 4).

The work required a series of face-to-face meetings in São Paulo, Lima, Baidem, Bogotá and Quito in order to adapt methods, define technical criteria, verify information, combine data, prioritize themes, strengthen capacities and exchange experiences and knowledge (the previous page shows a photographic mosaic of RAISG meetings and events held between 2007 and 2012).

Both consultations and virtual meetings with other technical specialists were also held in all of the different countries.

The first output of RAISG’s work was the map AMAZONIA 2009 Protected Areas and Indigenous Territories, printed in Spanish, Portuguese and English. It was made available for downloading in digital format (www.raisg.socioambiental.org).

Following this, each institution set up routines to update regularly the thematic databases on Amazonia in each country, adhering to formats and protocols that ensure that this information can be integrated at various scales.

In mid-2012 an updated version of the 2009 map was published and now this atlas, Amazonia under Pressure, which includes data and analyses on roads, oil and gas, mining, hydroelectric plants, fires and deforestation.

Work on deforestation was assisted by Imazon’s software and experience in interpreting satellite images of the Brazilian Amazon, which helped RAISG to define a methodology suited to the diversity of Andean-Amazonian and Guianese landscapes. The assessment of deforestation carried out using this methodology allowed us to obtain preliminary results for the years 2000, 2005 and 2010, as presented in this atlas and the enclosed map.

The present publication, one of the results of the RAISG initiative, is a contribution from civil society to the democratic debate on pressures in Amazonia and particularly on deforestation, an issue that is presently being assessed by various national governments, as well as at the intergovernmental level of ACTO (Amazon Cooperation Treaty Organization).

RAISG is currently in the process of formulating a 2013-2015 work plan, which will include:

- maintaining basic routines for updating, enhancing, analyzing and disseminating data on the themes of pressures and threats;
- incorporating new work themes;
- establishing cooperation agreements with other networks with the aim of generating joint products; and
- forming regional sub-networks.

RAISG is a collaborative space open to all those interested in promoting a sustainable future and strengthening the socio-environmental diversity of Amazonia. The present Atlas is intended to contribute to consolidating a wide-ranging regional view in which Amazonia is seen to extend beyond Brazil to include the Andean and Guianese countries.

Beto Ricardo
November, 2012
The Amazonia presented in this publication is a territory with a huge socio-environmental diversity now undergoing a process of rapid change. It covers an area of 7.8 million km², including 12 macro-basins and 158 sub-basins, shared by 1,497 municipalities, 68 departments/states/provinces in eight countries: Bolivia (6.2%), Brasil (64.3%), Colombia (6.2%), Ecuador (1.5%), Guyana (2.8%), Perú (10.1%), Suriname (2.1%) and Venezuela (5.8%), as well as Guyane Française (1.1%). Around 33 million people live in Amazonia, including 385 indigenous peoples, as well as some living in ‘isolation.’ There are 610 PNAs and 2,344 ITS that occupy 45% of the Amazonian surface area, without counting the small, medium and large rural landowners, various types of companies, research and support institutions, religious organizations and civil society organizations. This area results from boundaries agreed upon by RAISG members by combining socio-environmental and juridical-administrative criteria, as explained below, in order to define a spatial expression of the information and analyses. The geographical information system developed by RAISG has the flexibility to allow products to be generated using other boundaries, such as those defined by hydrographic or biogeographic criteria, for example. Although countries like Bolivia, Brasil, Colombia, Ecuador and Perú define juridical-administrative boundaries for their portions of Amazonia, public policies do not reflect Amazonian socio-environmental particularities and are far from adopting the necessary (Pan-)Amazonian view and improving cooperation mechanisms. In all cases, there persists a view of Amazonia as a remote frontier providing ‘infinite’ natural resources, with a demographic vacuum open to new forms of farming and extractivist colonization. This view has become more complex over the last 50 years with the new forms in which the region has been integrated into national and international economies. Amazonia is also now considered at national level as a territory capable of ensuring energy sovereignty and as a source of income based on the production and commercialization of raw materials. At the global level, the region is seen as the most important source of fresh water and biodiversity, as a regulator of the planet’s climate and as a carbon sink for large quantities of greenhouse gases. Like the other products generated through the work of RAISG, the main objective of this publication is to overcome our fragmented views of Amazonia and offer an ample panorama of the pressures and threats across the entire region and other sub-units of analysis. The opposite page shows two maps providing a spatial illustration of the combined sum of pressures (map 1) and threats (map 2). Pressures refers to the human actions currently taking place in Amazonia that put at risk the integrity of the ecosystems and the collective and diffuse rights of its inhabitants, whether traditional or otherwise. Threats are the human plans, projects or initiatives marked for the near future, which may turn into pressures once implemented. In all cases RAISG’s members organized information under a set of priority themes mentioned in the preface, compiling and generating high quality information that could be represented cartographically for the entire Amazonian region. The present Atlas contains information on the following six themes, representing the pressures and threats faced by Amazonia over the last decade – roads, oil and gas, hydroelectric plants, mining, fires and deforestation – analyzed in relation to Amazonia as a whole as well as to five different territorial units: Amazonia in each country, Hydrographic Basins, Protected Natural Areas (PNAs), and Indigenous Territories (ITs). These analyses are supported by 55 maps, 61 tables, 23 graphs, 16 boxes and 73 photographs. All this information is organized in thematic chapters running to a total of 68 pages. It should be pointed out that it was not possible to include specific chapters on logging and farming – themes of great importance for a more complete evaluation of the pressures and threats on Amazonia – since no basic information on them exists that covers the region as a whole. These themes will be discussed in two boxes included in the present introduction.

1. The RAISG workgroups decided to maintain the country names as written in their original languages in all publications.
The geographical boundary of Amazonia

The boundaries of Amazonia as a region can be defined using different methodologies as well as a variety of data sources for mapping them. The boundaries most frequently used are the biogeo-graphical boundary, which is defined as a region of the planet where tropical and montane lowland rainforest biomes are predominant, and the biophysical boundary, which is defined by the combination of these two. This latter methodology, which is based on the division of Amazonia into biomes and sub-biomes, is the one that is most widely used in the region.

The biogeo-graphical boundary of Amazonia is defined by the combination of the biomes of the tropical lowlands and montane lowlands. This boundary is delineated using data from various sources, including satellite imagery, ground-based surveys, and historical records. The boundaries of Amazonia are quite complex and vary depending on the methodology used. The biogeo-graphical boundary of Amazonia is defined by the combination of the biomes of the tropical lowlands and montane lowlands.

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Watersheds within the Amazon Basin

The watersheds utilized in the analyses were obtained through data from the Shuttle Radar Topography Mission (SRTM), available with a resolution of 1 arc-seconds (approximately 450 meters) and originally processed by the HydroSHEDS Project.

This data was then used to generate the drainage and accumulate models semi-automatically, along with the 3,362 hierarchical and structured river drainage systems, corresponding to 1,210 basins (more than 1,000,000 km²), 1,680 sub-basins, and 1,420 river sections, influencing the Amazonas and Orinoco rivers, as well as the Guianas, the areas surrounding the Tocantins River and the western part of the Brazilian NE Atlantic.

Using a specially developed algorithm, a unique system was established and applied to certify the elements to be produced in accordance with the six administrative levels, common to the hydrographic network and their respective basins.

Based on the names contained in the digital cartography of rivers, compiled by the institutions belonging to RAISG in the different countries, and the consolidation of different maps, the drainage sections were assigned with the names of the respective river in complete form up to Strahler level 2 and in partial form to levels 3, 4 and 1 (TIN).

The information providing the foundation for this atlas Amazonia Under Pressure was assembled in June 2008 and updated in May 2011. This information was compiled in each country on four different levels of official sources, which show differences in time, scale projection, availability and quality period. The cartographic sources used are cited where appropriate in the thematic chapters.

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After generating the drainage sections as described above, all the respective basins or related areas were generated: structural and isolated level 6 basins; 26 level 5 basins; 60 level 4 basins and 188 level 3 basins. Levels 1 and 2 are still awaiting codification and topography. Level 3 was established as the basis for presenting results on deforestation and other pressures, recognizing that in many cases this level approximates the scale of municipalities and other related administrative units, which may be of interest to local governments.

In this Atlas, macro-basins were those described here as level 5, and sub-basins as those at level 4.
In the course of Brazilian Amazonia the entire area for agriculture represents less than 7%. The total farming area, around 3.0 million hectares has output of 4.1 million. The remaining 65% is covered by forests of different classes with a capacity ranging from 0.6 to 9.2 hectares per ha with an average of 5 hectares. The 3.1 million hectares for agriculture are divided in large-scale commercial crops (sugar, cotton, soybean, rubber) versus small-scale commercial crops (palm heart, bark, palm oil, rubber, cotton, soybean, coffee, rice, sugar cane, manioc, bananas, etc.) (Amazônia Sem Terra and Brazilian Amazonia).

In Amazonian agroecosystems small and large-scale crop production is the primary production activities responsible for deforestation. Two activities result from a variety of reasons: the former for the transformation of forests and the latter for the transformation of pastures and, in both cases, the agricultural development of agriculture. The agricultural development of agriculture is stimulated by small scale commercial crops (sugar, coffee, palm oil, rubber and menioc) and large scale commercial crops (soybean, cotton, rice, sugar cane, etc.) (Roberto Smeraldi/Amigos da Terra-Brazilian Amazonia).

The development of activities that make occupation of the land possible, without any direct connections with production mechanisms, led to the dislocation of the exploitation of forest resources of standing forest, account for just 1.4% of Amazonian producers. (56.5%), cattle ranching (10%) and mixed farming (30%), through systems making intensive use of natural resources management, like cattle, forest and/or fish. These areas are also assigned as forest usage units, each approximately 50 km2 in size, which are handed over to private interests in the form of Forest Concessions (FCs) after a public tender process. These areas remain in State ownership with usufruct given to the concessionaires for up to forty years. The latter are allowed to obtain a maximum area of 500 km2. In August 2011 around 100,000 hectares had either permanent or intermittent coca plots in these four departments. At the start of 2011 around 3.4 million hectares of forest were deforested, representing around 4.5% of Brazilian Amazonia. (Daniel Larrea/FAN).

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In Bolivia the forest legislation is based on Law 1,700, approved in 1992, which in the 1990s stimulated the voluntary conversion of traditional forests into forests. Most of this total (87.8%) was also logged in private unoccupied or disputed areas. This established the concept of Free Production Rights (FPD), individualized forest management for these areas. Most of these FPDs were registered in the form of Forest Concessions (FCs) after a public tender process. These areas remain in State ownership with usufruct given to the concessionaires for up to forty years. The latter are allowed to obtain a maximum area of 500 km2. In August 2011 around 100,000 hectares had either permanent or intermittent coca plots in these four departments. At the start of 2011 around 3.4 million hectares of forest were deforested, representing around 4.5% of Brazilian Amazonia. (Daniel Larrea/FAN).

Logging in Amazonia is a vector of forest degradation and most of it illegal. There are some examples of sustainable forest management carried out by tribes such as the Huaorani (Esmeraldas, Ecuador). The experience of the Gabiawa is extremely interesting, where the income from felled timber plays an important role in capitalizing new agricultural use. In Brasil, the forest legislation is based on Law 6,724, approved in 1979, which in the 1970s stimulated the voluntary conversion of traditional forests into forests. Most of this total (87.8%) was also logged in private unoccupied or disputed areas. This established the concept of Free Production Rights (FPD), individualized forest management for these areas. Most of these FPDs were registered in the form of Forest Concessions (FCs) after a public tender process. These areas remain in State ownership with usufruct given to the concessionaires for up to forty years. The latter are allowed to obtain a maximum area of 500 km2. In August 2011 around 100,000 hectares had either permanent or intermittent coca plots in these four departments. At the start of 2011 around 3.4 million hectares of forest were deforested, representing around 4.5% of Brazilian Amazonia. (Daniel Larrea/FAN).

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ROADS

Over the last 50 years, roads have been recognized as one of the main factors encouraging new forms of using and occupying Amazonia. Their presence supports the advance of Amazonia’s resources and the region’s transformation. They are accountable to expanding human settlements and intensifying farming activities, logging mining and so on.

The correlation between paved roads and deforestation is high. It is estimated that in 80% of cases in Brazilian Amazonia, deforestation is found up to a distance of 30 km from paved roads, although many fire-cleared areas can be found at greater distances (Barreto et al., 2006; CoSiPlan, 2011; RIASG, 2001). The intensity with which areas are affected in each region depends on the socioeconomic context, the development policies in place, and the speed at which changes are occurring in the vegetation cover (Chambers et al., 2008; Barreto et al., 2010; Almeida et al., 2010).

Context

Roads (highways, roads or trails) can accelerate the use of Amazonia’s resources and the region’s transformation. They are accountable to expanding human settlements and intensifying farming activities, logging mining and so on.

The development of the road infrastructure in all the Amazonian countries is justified by governments in various ways: (i) to facilitate transportation of imported goods from sea ports to the different regions of the countries; (ii) to facilitate the transport and exportation of raw materials, minerals, oil and manufactured goods from the different regions to the sea ports; and (iii) to strengthen the regional economy through the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA). Nonetheless, the road system does not necessarily or only meet these objectives.

In the countries of Andean Amazonia, the road system was constructed following a north-south axis in order to generate connections, the main cities. Over the past ten years, though, the road system has been constructed, expanded and improved from east to west in order to connect the populated centers of Brazilian Amazonia with the Andean region and these centers, in turn, with the coast. The roads for which no information exists are located in the most remote areas of the region.

It should be emphasized that across a vast extent of Amazonia, river navigation represents the only form of covering large distances, as well as gain access to communities, cultivated areas and other production zones. Along the Amazon-Axis of the IIRSA, the aim was to connect the Pacific and Atlantic Ocean through a series of land and river routes across or areas covering 113,679 km² (Chambers, 2011).

Methodology

To identify and describe the geographic features of the road distribution, georeferenced information was compiled on the main paved roads, unpaved roads and projected (or planned) roads existing in Amazonia. The roads in the process of being paved and those for which no information exists were classified as “unknown.” Due to the differences in the level of information available in each country, the analyses excluded secondary or tertiary roads (tracks), along with the service roads existing within existing in Amazonia. The roads in the process of being paved and those for which no information exists were classified as “unknown.” Due to the differences in the level of information available in each country, the analyses excluded secondary or tertiary roads (tracks), along with the service roads existing within the Amazonian forest.

The road density per unit of analysis was calculated [(total extent of roads (km)/surface area (km²)] which will be indicated below as km/km². The multiplication of the final value by 1,000 was designed to facilitate one of the following measures distance by the difference in the total length of roads according to the units of analysis used in each country, macro-basin and sub-basin protected areas and indigenous territories.


to connect the Atlantic to the Pacific accelerate the pressures on Amazonian territories

There are 96,500 km of roads throughout Amazonia as a whole. Most of these, 64.5%, are unpaved

Paved and Bolivia are the two countries with highways planned through the heart of Amazonian forest

The peripheral distribution of roads mostly affects the headwaters of the Upper and Middle Amazon basins

PMAs and ITS have a road density 3 to 4 times lower than the regional average

Plans to connect the Atlantic to the Pacific accelerate the pressures on Amazonian territories

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The peripheral distribution of roads mostly affects the headwaters of the Upper and Middle Amazon basins

PMAs and ITS have a road density 3 to 4 times lower than the regional average
The total length of the roads identified in Amazonia was 86,644 km, including paved roads (31,632 km, 36.9% of the total), unpaved roads (33,645 km, 40.2%) and planned roads (21,367 km, 24.9%). The overall density was 57.4 km/km² including paved roads (41.4 km/km²), unpaved roads (67.6 km/km²) and planned roads (22.8 km/km²). The highest density of roads was detected in the basins of Brazil, especially in Guyana, in the southeast and south of Brazilian Amazonia, and in Ecuador.

### Amazônia as a whole

- **Brazilian Amazonia**: The highest concentration of roads is detected in the basins of Brazil, especially in Guyana, in the southeast and south of Brazilian Amazonia.
- **Guyana**: The extent of paved and unpaved roads varies between countries. For example, while in Guyana’s fracture of all the roads are paved, in Colombia, Brazil and Bolivia, more than 70% of the roads are unpaved (see ARISG 18).

### Amazônia in each country

- **Brazil**: The highest road densities are detected in the south of Brazilian Amazonia (density rates between 22.8 and 48.6 km/km²), including a sub-basin shared by Brazil, Bolivia and Peru. The density rates in the rest of the sub-basin shared by Brazil, Bolivia and Peru are lower than 18 km/km².
- **Colombia**: More than 12,000 km of roads are planned in Colombia. The highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved.

### By Basin

- **Western Northeast Atlantic**: The basin of the Western Northeast Atlantic has more than 8,000 km of roads. The highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved. In terms of density, the highest road density is detected in the basins of the Western Northeast Atlantic and Paraná, with more than 8,000 km of roads. These are macro-basins with 4.1% of the roads in Amazonia, most of them unpaved.
### The total length of roads identified in Indigenous Territories (ITs) was 9,530 km, distributed between paved roads (2,111 km, 22.1%) and unpaved roads (7,419 km) and planned roads (239 km). This figure is lower than the national figure (41,779 km in Colombia - 35 km in Ecuador - 27 km in Brazil). This is due to the fact that the identification of unpaved roads is more laborious than the identification of paved roads.

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Length (km)</th>
<th>Density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>9,530</td>
<td>1.00</td>
</tr>
<tr>
<td>Paved</td>
<td>2,111</td>
<td>0.22</td>
</tr>
<tr>
<td>Unpaved</td>
<td>7,419</td>
<td>0.78</td>
</tr>
<tr>
<td>Planned</td>
<td>239</td>
<td>0.03</td>
</tr>
</tbody>
</table>

### The total length of roads identified in Amazonian sub-basins was 7,020 km, distributed between paved roads (23 km, 0.34% of the total), unpaved roads (6,757 km, 97.2%) and planned roads (230 km, 3.4%). The largest lengths were found in indirect use departmental PNAs (1,036 km, 3.3%) and direct use departmental PNAs (6,757 km, 97.2% of the total). The PNAs of other administrative levels and types of use have road lengths ≤ 292 km (TRD6 and MRD6).

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Length (km)</th>
<th>Density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>7,020</td>
<td>1.00</td>
</tr>
<tr>
<td>Paved</td>
<td>23</td>
<td>0.00</td>
</tr>
<tr>
<td>Unpaved</td>
<td>6,757</td>
<td>0.96</td>
</tr>
<tr>
<td>Planned</td>
<td>230</td>
<td>0.33</td>
</tr>
</tbody>
</table>

### By Indigenous Areas

#### TRD7. The ten PNAs (with areas over 100 km²) with the highest road density in Amazonia

<table>
<thead>
<tr>
<th>PNA</th>
<th>Road Length (km)</th>
<th>Road Density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon (Brazil)</td>
<td>1,280</td>
<td>3.0</td>
</tr>
<tr>
<td>Middle Juruena (Brasil)</td>
<td>5,314</td>
<td>0.0</td>
</tr>
<tr>
<td>Araguaia (Brasil)</td>
<td>23,587</td>
<td>0.1</td>
</tr>
<tr>
<td>Sierra del Divisor (Brasil)</td>
<td>75,564</td>
<td>0.1</td>
</tr>
<tr>
<td>Mesopotamia (Brasil)</td>
<td>129,730</td>
<td>0.4</td>
</tr>
<tr>
<td>Middle-Lower Tocantins (Brasil)</td>
<td>171,294</td>
<td>0.5</td>
</tr>
<tr>
<td>Upper Tocantins (Brasil)</td>
<td>211,143</td>
<td>1.1</td>
</tr>
<tr>
<td>Lower Tocantins (Brasil)</td>
<td>279,545</td>
<td>3.3</td>
</tr>
<tr>
<td>Upper Amazonas (Brasil)</td>
<td>359,174</td>
<td>7.2</td>
</tr>
<tr>
<td>Lower Amazonas (Brasil)</td>
<td>676,563</td>
<td>11.7</td>
</tr>
</tbody>
</table>

#### TRD8. Length and density of road types in Amazonian ITs, by territory type

<table>
<thead>
<tr>
<th>Territory Type</th>
<th>Total Length (km)</th>
<th>Paved (km)</th>
<th>Unpaved (km)</th>
<th>Planned (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>2,124.661</td>
<td>715</td>
<td>6,424</td>
<td>2,391</td>
</tr>
<tr>
<td>State Park</td>
<td>3,583</td>
<td>45</td>
<td>1,910</td>
<td>1,228</td>
</tr>
<tr>
<td>Indigenous Protected Area</td>
<td>1,910</td>
<td>45</td>
<td>1,330</td>
<td>521</td>
</tr>
<tr>
<td>State Park</td>
<td>3,583</td>
<td>45</td>
<td>1,360</td>
<td>2,228</td>
</tr>
<tr>
<td>Natural Monument</td>
<td>1,910</td>
<td>45</td>
<td>1,159</td>
<td>223</td>
</tr>
<tr>
<td>Territorial Reservation</td>
<td>1,910</td>
<td>45</td>
<td>1,190</td>
<td>223</td>
</tr>
<tr>
<td>Intangible</td>
<td>1,910</td>
<td>45</td>
<td>1,190</td>
<td>223</td>
</tr>
</tbody>
</table>

### By Protected Areas

The total length of roads identified in Protected Natural Areas (PNAs) was 3,200 km, distributed between paved roads (21 km, 0.66% of the total), unpaved roads (3,032 km, 95.1%) and planned roads (65 km, 2.1%). The largest lengths were found in direct use departmental PNAs (1,050 km, 32.8%) and direct use national PNAs (1,040 km, 32.5%) followed by indirect use national PNAs (1,040 km, 32.5%) and by direct use national PNAs (1,040 km, 32.5%). The PNAs of other administrative levels and types of use have road lengths ≤ 211 km (TRD6 and MRD6).

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Length (km)</th>
<th>Density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3,200</td>
<td>1.00</td>
</tr>
<tr>
<td>Paved</td>
<td>21</td>
<td>0.00</td>
</tr>
<tr>
<td>Unpaved</td>
<td>3,032</td>
<td>0.95</td>
</tr>
<tr>
<td>Planned</td>
<td>65</td>
<td>0.02</td>
</tr>
</tbody>
</table>

### MRD5. Road density by Amazonian sub-basin

<table>
<thead>
<tr>
<th>Sub-Basin</th>
<th>Road Density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon (Brazil)</td>
<td>2.1</td>
</tr>
<tr>
<td>Middle Juruena (Brasil)</td>
<td>0.2</td>
</tr>
<tr>
<td>Araguaia (Brasil)</td>
<td>0.1</td>
</tr>
<tr>
<td>Sierra del Divisor (Brasil)</td>
<td>0.0</td>
</tr>
<tr>
<td>Mesopotamia (Brasil)</td>
<td>0.4</td>
</tr>
<tr>
<td>Middle-Lower Tocantins (Brasil)</td>
<td>0.5</td>
</tr>
<tr>
<td>Upper Tocantins (Brasil)</td>
<td>1.1</td>
</tr>
<tr>
<td>Lower Tocantins (Brasil)</td>
<td>3.3</td>
</tr>
<tr>
<td>Upper Amazonas (Brasil)</td>
<td>7.2</td>
</tr>
<tr>
<td>Lower Amazonas (Brasil)</td>
<td>11.7</td>
</tr>
</tbody>
</table>

### MRD6. Road density by PNA in Amazonia

<table>
<thead>
<tr>
<th>PNA</th>
<th>Road Density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon (Brazil)</td>
<td>3.0</td>
</tr>
<tr>
<td>Middle Juruena (Brasil)</td>
<td>0.0</td>
</tr>
<tr>
<td>Araguaia (Brasil)</td>
<td>0.1</td>
</tr>
<tr>
<td>Sierra del Divisor (Brasil)</td>
<td>0.0</td>
</tr>
<tr>
<td>Mesopotamia (Brasil)</td>
<td>0.4</td>
</tr>
<tr>
<td>Middle-Lower Tocantins (Brasil)</td>
<td>0.5</td>
</tr>
<tr>
<td>Upper Tocantins (Brasil)</td>
<td>1.1</td>
</tr>
<tr>
<td>Lower Tocantins (Brasil)</td>
<td>3.3</td>
</tr>
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<td>7.2</td>
</tr>
<tr>
<td>Lower Amazonas (Brasil)</td>
<td>11.7</td>
</tr>
</tbody>
</table>

### Notes

1. The highest densities are found in direct/indirect use national PNAs (1.6 km/km²), followed by direct use departmental PNAs (0.7 km/km²) and the direct use national PNAs (0.5 km/km²). The PNAs of other administrative levels and types of use densities ≤ 0.2 km/km² (TRD6 and MRD6).

2. The PNAs with the highest road densities are organized in a density figure between 11.4 km/km² and 11.7 km/km², located in them in direct or indirect departmental PNAs and those in direct use national PNAs (7.2 km/km²).
The density of roads identified inside ITs was 4.2 km/km², including paved roads (1.1 km²), unpaved roads (2.2 km²), and planned roads (0.9 km²). The highest densities were found in areas of traditional occupation without official recognition (8.1 km²/km²), followed by officially recognized ITs (1.9 km²/km²) and territorial reserves or unallocated zones (2.2 km²/km²). At national level, in the two countries with the highest road density in ITs (Guyana and Ecuador) (32.0 and 26.9 km²/km², respectively), followed by Bolivia (12.8 km²/km² with an official recognition of infrastructure and 4.2 km²/km² in officially recognized ITs). The remaining countries show figures lower than 10 km²/km² (Perú and Colombia). With the exception of the density road in officially recognized ITs in Bolivia, the figures exceeded the regional density (10 km²/km²).

The density of paved roads within ITs is high in Ecuador (14.4 km²/km²), while the density of unpaved roads is significantly high in officially recognized ITs in Guyana (32.0 km²/km²). The density of planned roads is high in Peru, affecting especially officially recognized ITs (2.9 km²/km²) and territorial reserves in areas of traditional occupation without official recognition (8.1 km²/km²), followed by officially recognized ITs with a density of 116.8 km²/km²) and Bolivia (Yaminahua Machineri IT, with a density of 114.6 km²/km²)

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OIL and GAS

The growing demand for oil and gas at the global level and the high price of oil have stimulated prospecting and drilling activities in Amazonia at unprecedented levels (Finn et al., 2006). The Amazonian countries view oil and gas as strategic resources and claim ownership at the constitutional level. Governments allocate these resources via policies that typically fail to include preventive and mitigative socio-environmental impacts generated by the exploitation of these resources. Similarly, the judicial entities at the national and international levels are showing an inclination to recognize the collective rights of indigenous peoples and the protection of nature. The opposition of indigenous and environmental movements to hydrocarbon activities is increasingly more common. At the same time, judicial entities at the national and international levels are showing a tendency to recognize the collective rights of indigenous peoples and the protection of nature. The opposition of indigenous and environmental movements to hydrocarbon activities is increasingly more common.

Context

The environmental policies and regulations regarding the exploration and extraction of hydrocarbons, as well as those for other extractive industries, vary in the process of being consolidated in the different countries of the region. Generally speaking there is a lack of planning instruments that can guide and include the conservation and sustainable use of natural resources in the plans, programs and policies of this sector. This situation fails to meet the obligations established in Convention 169 of the ILO (1991) – ratified by all the Amazonian countries except Guyana, Guyane Française and Suriname – and the Convention on Biological Diversity (CBD), ratified by all the countries. The protection of the socio-environmental heritage of Amazonia is an urgent issue for the region’s governments. The opposition of indigenous and environmental movements to hydrocarbon activities is increasingly more common.

As part of the socio-environmental dynamics of Amazonia, the ecosystemic services and the traditional and scientific bodies of knowledge are also considered strategic resources, especially within the framework of climate change. The global economic context poses a serious threat to the developing and emerging countries: on one hand, the need to eradicate poverty and hunger; and on the other the need to maintain socio-environmental diversity, as a vital part of the development of oil and gas resources, as well as a search for alternative energy sources compatible with the region’s unique features.

Neither the industrialized countries nor the developing countries have managed to reach a consensus on progressively and decisively reducing their high dependence on fossil fuels. Countries like Perú, Colombia and Ecuador have sizeable oil reserves in Amazonia from which they expect to obtain the financing for the path traveled to satisfy their national needs and development projects. As a result, oil exploration and production in Amazonia has multiplied over the last decade and will continue to grow over the foreseeable future.

Problem

The construction of roads, oil/gas pipelines and other associated infrastructure exacerbates infrastructural development and infrastructure, causing negative impacts and pressures that are exacerbated in particular, fragile ecosystems such as those of Amazonia (term PNGs). The main companies with interests in Amazonia are overlapped by oil/gas blocks. The construction of roads, oil/gas pipelines and other associated infrastructure exacerbates infrastructural development and infrastructure, causing negative impacts and pressures that are exacerbated in particular, fragile ecosystems such as those of Amazonia (term PNGs). The main companies with interests in Amazonia are overlapped by oil/gas blocks.

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Amazônia under Pressure

The geophysical information on the concessionary blocks awarded for hydrocarbon activities was compiled from several secondary sources located in the different Amazonian countries. These blocks were classified into four types according to their current phase. Open for Bidding (concessionary blocks directed to the government), Under Tender (process to transfer concessions to the government), Under Exploration (concessionary blocks with a company actively prospecting) and Under Production (concessionary blocks producing oil or gas). Table 1 shows which of the six countries that issue concessionary hydrocarbon blocks recognize each of these phases.

In order to classify the results, blocks eligible for national authorities using the area of analysis was less than 10 km².

Amazônia in each country

The Amazonian countries with the largest surface area dedicated to hydrocarbon activities in all phases are Peru (46%), Colombia (30%) and Ecuador (21%). Ecuador is the country with the largest area of hydrocarbon blocks under production in Amazonia. Although only 2% of Brazilian Amazonia has blocks, these occupy 172,682 km², which represents the third largest surface area after Peru and Colombia (30% and 24% respectively). Conversely, the area occupied by concessionary blocks in Brazil is under production; these occupy 57,177 km², which represents the largest area in Amazonia. The companies exploring the largest areas are: Petrobras with 61,487 km²; Talisman Energy of Canada with 30,491 km²; OGX Petróleo e Gás Ltda of Brazil with 28,744 km² in the

There are currently 207 hydrocarbon blocks in Amazonia. They cover a total area of 1,069,704 km² (24% of the Amazonian surface). These include 90 Open for Bidding, 72 Under Tender, 30 Under Exploration and 15 Under Production. The 80 blocks where exploration is taking place occupy a total area of 618,846 km² (60%).

Amazonia in each region

The region with the highest number of blocks is Andean Amazonia (33%), followed by Perú (20%), Brazil (12%) and Colombia (11%).

There are 24 companies involved in oil exploration regionally. Nine of them operate in 78% (31,835 km²) of the surface area of blocks where research is taking place. The companies exploring the largest areas are: Petrobras with 61,487 km²; Talisman Energy of Canada with 30,491 km²; OGX Petróleo e Gás Ltda of Brazil with 28,744 km² in the

The Amazonian macro-basin containing the largest surface area of hydrocarbon blocks (in all phases) is the upper Amazonas (668,125 km²), equivalent to 40% of the basin’s total surface area. Below this, with a respective area of 32% and 16% respectively, are the Orinoco and Madeira basins, respectively.

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Hydrocarbon blocks in Amazonia overlap with 9% (11,764,704 km²) of the total surface area of the Brazilian Federal Reserve of the Amazon (PFRA) (FIFA). The blocks open for bidding superimposed with PFRA make up 50% of the total (6,231,604 km²), those under exploitation make up 2% (193,260 km²), those under exploration make up 10% (3,373,604 km²) and those under production make up 7% (766,604 km²). The most critical situations appear in Peru where 6% of the PFAs are covered with hydrocarbon blocks, Bolivia (22%) and Ecuador (17%), irrespective of the phase in which they are found (MPOCA).

90% of the total surface area of hydrocarbon blocks in PFAs, corresponds to those up for bidding, under exploitation and under production. Most of these are located in Peru and Bolivia. Ecuador systematizes the largest number of blocks under production inside PFAs (562,805). The area of PFAs under production is considered the “new frontier,” now an integral part of the 2018 Terceira Plan and the 2017 Multi-year Plan (2017-2021) with a planned investment of US$ 3.5 billion in five phases.

Since 2007 various research phases have been carried out in Rio State and the southwestern portion of Amazonas and included aerial optical in-situ monitoring and geophysical and environmental and aeromagnetic data along 100,000 km in three protected areas of the forest reserve of the Act 2nd from Colombia. The Forest Reserve of the Act 2nd of Colombia.

In 2010 terrestrial seismic data, collected by INTESSA (2010), was reprocessed along the basin of the lower Juruá. The results showed indications of thermogenic hydrocarbon gases. The survey results across a 31,000 km² area on the Upper Juruá (Acre and Amazonas states) showed indications of thermogenic hydrocarbon gases.

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Since the beginning of European conquest in Amazonia there has been a continuous search for ‘El Dorado,’ promoted by the stories of the enormous mineral wealth contained in the region. For centuries prospecting and mining was concentrated in the eastern rich gold and iron mines of the Andean region. It was only in the 20th century, with the discovery of large mineral deposits, like the Serra do Carajás block in Brazilian Amazonia, that mining activity began to spread into the Amazonian region, whether in the form of industrial production plants or concessionary blocks, as well as illegal mining.

During this period the increase in the prices of precious minerals, the growing demand for other strategic minerals (aluminum, iron, titanium, vanadium and so on), and the need in the region’s countries to generate income through the use of Amazonia’s natural resources, has made mining a key economic sector. To ensure they would receive maximum economic benefits, national development policies have included mining in their 

...
The mining industry in Colombia is one of the most critical causes of contamination of water, sediments and soil by mercury and other heavy metals, affecting both indigenous and non-indigenous communities. Mining activities have been growing since the 1970s with a greater emphasis over the last 20 years (Dusanssou, 2009). A similar scenario is the degeneration mining in the Madre de Dios basin in Brazil. Here more than 100,000 km² of aboriginal lands, well suited to agriculture, have been completely degraded (Dusanssou, 2009).

In addition to the damage caused to entire ecosystems, illegal mining also generates other serious collateral effects in areas of indigenous peoples who are uncontacted or only recently contacted, such as the Yanomami in the border region between Venezuela and Brazil (Pereira, 1998; TMN1). The new gold rush in Amazonia.

Methodology
The analysis of the information regarding the concessionary blocks for mining established by the government and the mining activities in Amazonia is based on official data compiled in each country. It has been systemized and classified into five categories according to the procedural phase that both concessionary blocks are currently in. These are: (i) Open for Bidding (concessionary blocks offered by the government), (ii) Under Tender (concessionary blocks with a pending offer awaiting official approval), (iii) Under Exploration (concessionary blocks with a company actively prospecting), (iv) Under Production (concessionary blocks currently in production), and (v) Under T ender (concessionary blocks with a pending offer awaiting official approval). Under Exploration (concessionary blocks with a company actively prospecting), Under Production (concessionary blocks currently in production), and Under T ender (concessionary blocks with a pending offer awaiting official approval) categories do not have current information. In Peru some of Ecuador's mining blocks it was impossible to differentiate between blocks under exploration and those under production. In these cases the blocks were analyzed as both. As information on illegal mining was not obtainable for all the countries, this data was not included in the analyses.

Due to differences in the information sources, geographic (topological) corrections had to be made in order for the data to be analyzed and compared. Consequently differences may exist between the results published here and the figures obtained in analyses conducted in the countries. To avoid double counting areas and over-estimation of surface areas, the analysis excluded overlapping areas between mining blocks that were on the same phase. After excluding these overlaps, only areas over five hectares were included in the analyses. The classification of concessionary blocks by phase is different in each country (shown in Table 1).

An analysis of the data on illegal mining was not possible for all countries, this data was not included in the analyses. According to the analysis of mining blocks by country, most of the uranium areas under mining blocks in Guyana and Bolivia is under exploration. In Ecuador and Peru the largest proportion corresponds to blocks under tender (Pereira, 1998).

Amazonia as a whole
For 2010 there are a total of 52,974 blocks in Amazonia with mining interests covering a total area of 1,628.850 km², which corresponds to 27% of the entire region (Table 1). The majority of mining blocks are under tender (50.8%), followed by those under exploration (30.8%). Here more than 150,000 ha of alluvial soils, well suited to agriculture, have been completely degraded (Dusanssou, 2009).

Therika, the main mining companies and the largest mining projects
Among the main mining ventures in Amazonia we can identify the Minas de Dios mining region, in Peru on the border with Colombia, the southern border of the province of Mora in Suriname and at Zonas Compacte with the Minas de Bornos and Mazaruni projects in Ecuador. The largest mining region operated by Guaynabo in Guyana, the Paget project being explored, the Canareo mine in the Orinoco river, where the Talcica mining company will mine graphite, and the Vaca project, a concession in the Amazon river for mining bauxite. These last two ventures are located in Brazil.

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The majority of mining activities in Amazonia are concentrated in the Madre de Dios basin in Brazil. More than 100,000 km² of aboriginal lands, well suited to agriculture, have been completely degraded (Dusanssou, 2009).

According to the analysis of mining blocks by country, most of the uranium areas under mining blocks in Guyana and Bolivia is under exploration. In Ecuador and Peru the largest proportion corresponds to blocks under tender (Pereira, 1998).

By basin
The macro-basin within Amazonia with the largest area covered by mining blocks is the Albertine Rift (MNN3), followed by the Middle-Lower Amazonas (BMN2), Tocantins (BMN2), and Negro (BMN2). In terms of individual phases of concessionary blocks, the largest surface areas covered by blocks in the Queré for Bidding and Under Exploration phases are in the Amazonas (Middle-Lower; Tocantins; and Guaporé and Guaporé/Negro regions). The largest area covered by blocks in the Under Production phase is in the Madeira Basin (Guaporé and Guaporé/Negro regions).

Table 1 shows the sub-basins with the largest surface areas covered by illegal mining blocks. In the different phases, the sub-basins with the largest areas covered by blocks in all phases are the Amazonas (Middle-Lower; Tocantins; and Guaporé and Guaporé/Negro regions). The largest area covered by blocks in the Under Production phase is in the Madeira Basin (Guaporé and Guaporé/Negro regions). Illegally mining blocks can be observed in map (TMN4).

In relation to mining blocks in the Under Production phase, the Cuyp sub-basin, covering an area of Guyana and Venezuela, presented the largest area with 20.836 km² (12.011 km² and 8.825 km²). According to the analysis of mining blocks by country, most of the uranium areas under mining blocks in Guyana and Bolivia is under exploration. In Ecuador and Peru the largest proportion corresponds to blocks under tender (Pereira, 1998)

The total surface area covered by mining blocks under tender represents 15.7% of Amazonas (537.143 km²), while the areas under exploration occupy 36.5% (620.580 km²).

Amazonia in each country
Guyana is the country with the highest percentage of its Amazonia region covered by mining blocks in categories of exploration (827,142 km²), followed by Brazil with 620,580 km² and Suriname with 116,689 km². The country with the lowest proportion of its Amazonia region covered by mining blocks is Bolivia at 0.6% (in terms of the number of mining blocks). 65.3% of the mining blocks are located in Brasil and 11% in Peru. The surface covered by the different categories of mining blocks in each country is shown in the map (TMN5) for large mining projects and mining blocks in Guyana, in the medium term this will be the main threat following hydrocarbon activities.
The area covered by mining blocks and their distribution are displayed in table 1.1 and on figure 4. The total combined surface area of mining blocks, in all phases, overlapping Permanent Natural Areas (PNAs) is 265,586 km², which corresponds to 15% of the total surface area of PNAs in Amazonia. In terms of categories of PNAs, the largest areas of mining blocks, in all phases, is located in direct use departmental (PNAs 265,586 km²), followed by direct use national (PNAs 132,500 km²), indirect use departmental (PNAs 63,380 km²), and indirect use national (PNAs 56,551 km²). The PNAs with the largest number of mining blocks in the combined exploration/production phase are: APA T apajós, FN Amazonas, PN Montanhas do T umucumaque and EE Jari, all in Brasil, and the PN Yacuri, both in Ecuador. The PNAs with the largest number of mining blocks in the transitory phase are: REc Cofán Bermejo, RfVS El Zarza, RBi El Quimi and PN Yacuri, all in Ecuador. The area covered by mining blocks and their distribution are displayed in table 1.1 and on figure 4. The total combined surface area of mining blocks, in all phases, overlapping Permanent Natural Areas (PNAs) is 265,586 km², which corresponds to 15% of the total surface area of PNAs in Amazonia. The PNAs with the largest number of mining blocks in the combined exploration/production phase are: APA T apajós, FN Amazonas, PN Montanhas do T umucumaque and EE Jari, all in Brasil, and the PN Yacuri, both in Ecuador. The PNAs with the largest number of mining blocks in the transitory phase are: REc Cofán Bermejo, RfVS El Zarza, RBi El Quimi and PN Yacuri, all in Ecuador.

Over the last 20 years various AMAs and AMAs has been under pressure from the increase in small-scale illegal semi- mechanized alluvial gold mining. This gold rush was stimulated by the exponential increase in the price of the metal, which has risen more than 500% over the last ten years. The pressure is now more intense as the area is sustained by a network of intermediates traders (Figure 1.1). The semi-mechanized prospecting model causes river silting, the loss of biodiversity in the aquatic ecosystems, including due to the tailings, and soil erosion and deforestation. It causes a loss of the total forest carbon potential and causes substantial health and environmental impacts. More than an estimated 100 tons of mercury are used each year in illegal gold mining in Amazonia.

By unprotected area

Over the last 20 years various AMAs and AMAs has been under pressure from the increase in small-scale illegal semi-mechanized alluvial gold mining. This gold rush was stimulated by the exponential increase in the price of the metal, which has risen more than 500% over the last ten years. The pressure is now more intense as the area is sustained by a network of intermediates traders (Figure 1.1). The semi-mechanized prospecting model causes river silting, the loss of biodiversity in the aquatic ecosystems, including due to the tailings, and soil erosion and deforestation. It causes a loss of the total forest carbon potential and causes substantial health and environmental impacts. More than an estimated 100 tons of mercury are used each year in illegal gold mining in Amazonia.

By unprotected area

In the Under Exploration phase, Brasil contains the largest areas in all categories of PNAs: 20,060 km² overlapping direct use national PNAs, followed by direct use departmental (PNAs 31,036 km²), indirect use departmental (PNAs 3,921 km²) and indirect use national (PNAs 921 km²). The PNAs with the largest number of mining blocks in the combined exploration/production phase are: APA T apajós, FN Amazonas, PN Montanhas do T umucumaque and EE Jari, all in Brasil, and the PN Yacuri, both in Ecuador. The PNAs with the largest number of mining blocks in the transitory phase are: REc Cofán Bermejo, RfVS El Zarza, RBi El Quimi and PN Yacuri, all in Ecuador. The PNAs with the largest number of mining blocks in the combined exploration/production phase are: APA T apajós, FN Amazonas, PN Montanhas do T umucumaque and EE Jari, all in Brasil, and the PN Yacuri, both in Ecuador. The PNAs with the largest number of mining blocks in the transitory phase are: REc Cofán Bermejo, RfVS El Zarza, RBi El Quimi and PN Yacuri, all in Ecuador.

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The largest areas of blocks in the Under Production phase is found in national PNAs intended for direct use (31,036 km²) and indirect use (5,636 km²). The PNAs with the highest pressure are those mining production are: Tn Guayana Taya (1,396 km²), FN Coaípe (1,107 km²) and FN Susan (1,068 km²) in Brasil, the Yanomami National parks in Colombia (756 km²), the PN Caucais in Venezuela (300 km²), the AP Aripuanã (532 km²) and the RM Maturita (117 km²) in Brasil. The PNAs with the largest number of mining blocks in the combined exploration/production phase are: RNC Colón/Bermejas, RNV Zs Zariba, RBQ DOS Quinsin and PN Wezal, all in Guyana.

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The large number of blocks under tender overlapping ITs in Brasil is due to a failure to introduce specific laws to regulate mining on Indigenous Territories, as required by the Federal Constitution. Eighty-eight per cent (88%) of the mining blocks under tender within ITs are located in Brasil (307,245 km²) and the remaining 12% in Colombia (46,779 km²). Around 65% of these are located inside recognized ITs, the most threatened being Yanomami, Meté, Guajajara, Awa, Rio Hondo, Bau and Uru-Eu-Wau-Wau.

Due to the increase in the price of gold and other selected minerals on the international market, mining has increased substantially over the last 20 years. The governments in all the Amazonian countries have identified specific blocks for mining concessions which are now in one of the different phases mentioned above (Open for Bidding, Under Tender, Under Exploration and Under Production). Guyana and Brasil are the countries with the largest areas covered by them. Mining interests, reflected in the existing concessionary blocks, are concentrated on the periphery of Amazonia, negatively affecting cultural and biological diversity in the region. The impacts of this activity at local level on water quality, soil nutrients and air quality are potentially very serious. An important next step will be to analyze the existing concessionary blocks, are concentrated on the periphery of Amazonia, negatively affecting cultural and biological diversity. The impacts of this activity at local level on water quality, soil nutrients and air quality are potentially very serious. An important next step will be to analyze the existing concessionary blocks, are concentrated on the periphery of Amazonia, negatively affecting cultural and biological diversity. The impacts of this activity at local level on water quality, soil nutrients and air quality are potentially very serious. An important next step will be to analyze the existing concessionary blocks, are concentrated on the periphery of Amazonia, negatively affecting cultural and biological diversity.
HYDROELECTRIC PLANTS

The Amazon basin is seen by governments, companies, investors and consumers as a virtually inexhaustible source of water resources for energy production. This view is based on two facts: 1. the current supply of electrical energy from Amazonia to the region’s countries is sufficient up to 75% of the national energy supply in Peru, Bolivia and Ecuador, and 2. a potential contribution of Amazonia to those countries’ electrical energy need is very high. The latter fact is based on the potential for high-capacity installations in the Andean-Amazonian transfrontier region along with the capacity of the giant Amazon itself where the Brazilian hydroelectric potential is estimated at 300,000 MW, accounting for more than 50% of the exploitable capacity of the entire Amazon region (Gouveia & Cueto, 2012). Hence the major challenge posed by Amazonian countries is the need to reconcile the exploitation of Amazonia’s hydroelectric potential with the integrated management of basins, including the recuperation and conservation of the ecological, social, economic and cultural cycles of a region that values and essentially depends on its rivers.

Context

The great hydroelectric potential of the Amazonian rivers provides the possibility of obtaining low-cost electricity without resorting to fossil fuels or nuclear reactors, and at the same time, at opportunity to attain high levels of sustainability in electrical energy supplies. In Ecuador the government presented the implementation of the Coca Codo Sinclair hydroelectric project as a possibility to make the country energy independent, while renewing the current purchase of electricity from Colombia and Peru (up to 10% of the supply) in the dry season and perhaps even selling electricity to those same countries. Despite the considerable technical problems (the lack of studies for upgrading to 500 kV transmission lines) and financial issues (lack of funds), identified by critics in relation to this project, the government plans for the hydroelectric plant to enter into operation from 2014 (Cueto, 2011). Likewise the energy agreement between Peru and Brazil for the production and exportation of electricity in Peru’s border areas (the Tambopata megaplan and others) is justified by the annual increase in electricity demand. Based on the expected level of growth over the next decade, under a permanent planning scheme, Brazil will require national and foreign hydroelectric energy sources. Consequently, and very recently, with the construction in Amazonia of Brasil’s largest hydroelectric plant, theＧuaiba plant (4,220 MW), called Hydroelectric Units (UHEs), and Small Hydroelectric Plants (PCHs), with the capacity to generate more than 30 MW. In addition, some information was compiled for 17 projected hydroelectric plants with capacities of more than 300 MW in Ecuador and Peru these were not included in the cartographic sources for the theme Amazonia, a region where various Amazonian rivers rise and that is an extremely important transition zone in the region’s hydrography.

Methodology

An operational database with the location of current hydroelectric plants and analysis for building future plants was compiled and systemized, based on both official and non-official sources. Despite the considerable technical problems (the lack of studies for upgrading to 500 kV transmission lines) and financial issues (lack of funds), identified by critics in relation to this project, the government plans for the hydroelectric plant to enter into operation from 2014 (Cueto, 2011). Likewise the energy agreement between Peru and Brazil for the production and exportation of electricity in Peru’s border areas (the Tambopata megaplan and others) is justified by the annual increase in electricity demand. Based on the expected level of growth over the next decade, under a permanent planning scheme, Brazil will require national and foreign hydroelectric energy sources. Consequently, and very recently, with the construction in Amazonia of Brasil’s largest hydroelectric plant, the Guaiba plant (4,220 MW), called Hydroelectric Units (UHEs), and Small Hydroelectric Plants (PCHs), with the capacity to generate more than 30 MW. In addition, some information was compiled for 17 projected hydroelectric plants with capacities of more than 300 MW in Ecuador and Peru these were not included in the carteographic sources for the theme Amazonia, a region where various Amazonian rivers rise and that is an extremely important transition zone in the region’s hydrography.

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Aerial view of the workers’ shelters for the Belo Monte Hydroelectric Plant (UHE). Altamira, Pará, Brasil.

In 2009 the Brazilian government authorized Belo Monte (UHE), built and operated by large hydroelectric plants in the northern covered western side of the Brazilian Amazon, with the broad objective of developing energy needs, related to Brazil at the cost of approximately US$ 15 billion, ten times more expensive than originally budgeted. Brasil. The 11,233 MW generation capacity of the Belo Monte plant, second largest in the world, is divided on the Xingu river, an important tributary of the Amazonas river. This project is one of the clearest of large, medium and small hydroelectric plants planned for the next ten years. The socio-environmental impacts of the construction and operation of the hydroelectric dams and reservoirs – such as alterations in the water regime, reduction of hydrobiological diversity, water contamination and accelerated deforestation – are underlined or simply ignored. Measurement units of green House gases (GHG) in the Vaupés reservoir in Guiana and the Pastel Reservoir in Guiana France have shown that the hydroelectric plants may also be significant sources of GHG (Romero & Ponce, 2010).

There are 171 hydroelectric plants in operation or under construction in Amazonia as a whole, and 248 planned or under study.

With the completion of the Belo Monte Dam, Brasil will have the largest hydroelectric plant in Amazonia, with a capacity of 11,233 MW.

The Upper Amazon macro-basin has the highest number of hydroelectric plants in operation or under construction.

The PCHs are primarily affected by small hydroelectric plants.

The transfrontier issues relating to hydroelectric plants are not being debated publicly.

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Spillway of the Tucuruí Hydroelectric Plant (UHE), work begun in 1975 on the Tocantins river and completed 30 years later at the cost of approximately US$ 15 billion, ten times more expensive than originally budgeted. Brasil.

Closing 180,000 km² and containing 11 hydrometric terrains, the basin of the Amazon river has a slope of 17% planted, as well as one gigantic plant.

Thus to analyze lake drainages, the Santo Antônio and Area hydroelectric plants on the Amazon river have the subject of a transfrontier socio-environmental assessment.

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The Santo Antônio Project is one of the dozens of projects being analyzed by the Peruvian Congress’s Foreign Affairs Commission. Meanwhile Brasil is building future plants with the clear objective of solving future energy demand. “Based on the expected level of growth over the next decade, under a permanent planning scheme, Brasil will require national and foreign hydroelectric energy sources. Consequently and very recently, with the construction in Amazonia of Brasil’s largest hydroelectric plant, the Guaiba plant (4,220 MW), called Hydroelectric Units (UHE), and Small Hydroelectric Plants (PCHs), with the capacity to generate more than 30 MW.” In addition, some information was compiled for 17 projected hydroelectric plants with capacities of more than 300 MW in Ecuador and Peru these were not included in the cartographic sources for the theme Amazonia, a region where various Amazonian rivers rise and that is an extremely important transition zone in the region’s hydrography.
The hydroelectric plant under construction has the highest projected capacity (11,233 MW). The increase in the number of PCHs (63) and the number of UHEs (51) indicates that much of the future use of the water resources of Amazonia may be structured around this kind of production. If all the planned hydroelectric units were constructed, there would be an increase in the number of units currently in operation and under construction. The increase in the number of PCHs would be 149% and the number of UHEs 131%. This data suggests that the Amazonas (Middle-Lower) macro-basin has the highest number of hydroelectric plants in operation and under construction. The most important hydroelectric plant in operation is the Guri Hydroelectric complex located in Venezuela (Falkner, 1999). Ten hydroelectric plants have been included in the administrative region, of which 17 are hydroelectric plants with a capacity of more than 30 MW. The majority of hydroelectric plants were situated in the southern part of Amazonas, followed by the western and eastern regions. Eleven hydroelectric plants were recorded in the central and northern regions. If all the planned hydroelectric units were constructed, these would be a 144% increase in the number of units currently in operation or under construction. The increase in the number of PCHs would be 149% and the number of UHEs 131%. This suggests that much of the future use of the water resources of Amazonas may be structured around this kind of production.

Twelve hydroelectric plants have a capacity of more than 30 MW were identified (seven in operation and five under construction). The most important hydroelectric plant in operation is the Guri Hydroelectric complex located in Venezuela (Falkner, 1999). Ten hydroelectric plants have been included in the administrative region, of which 17 are hydroelectric plants with a capacity of more than 30 MW. The majority of hydroelectric plants were situated in the southern part of Amazonas, followed by the western and eastern regions. Eleven hydroelectric plants were recorded in the central and northern regions.

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The basin of the Juruena river, which flows into the left side of the Tapajós, is a hot spot of PCHs (Small Hydroelectric Plants) that have operated or are under construction, as identified by the rainforest protection plan. Of those, 22% (27) of the 124 plants have already operated or are currently under construction. With a surface area of 146,000 km², the basin includes 11 indigenous lands and a large mixture of environments.

Currently there exist across Amazonia 120 PCHs already installed or under construction and 188 planned, concentrated precisely in the Central-West region of Brasil and the Peruvian Amazonia. The installation of the PCHs has increased exponentially in Brazilian Amazonia over the last 30 years.

Small Brownian (PCMs) are defined as plants with a capacity to generate between 1 and 3 MW with a minor impact on less than 1 km². These were established by the National Energy Agency (ANEEL) in 1998. The following process is simplified and responsibility assigned to the state governments. Systematic analyses of the socio-environmental impacts are not required and authorization is given case by case, without prior evaluation integrated with the socio-environmental impacts of small Brownian PCHs. The licensing process is simplified and responsibility assigned to the state governments. Systematic analyses of the socio-environmental impacts are not required and authorization is given case by case, without prior evaluation integrated with the socio-environmental impacts of small Brownian PCHs.

In 2008, the Enawenê-nawê re-evaluated this agreement, alarmed by the fact that the start of construction work on a PCH upstream on the Juruena had already altered the flow of fish, compromising the performance of Yakwã, perhaps the longest ritual cycle of any indigenous people in contemporary Amazonia. Juruena had already altered the flow of fish, compromising the performance of Yakwã, perhaps the longest ritual cycle of any indigenous people in contemporary Amazonia.

Erikpatsa (Brasil) 1 1 1
FE Paru (Brasil) 1 1
REx Ituxi (Brasil) 1 1
PE Cristalino II (Brasil) 1 1
RDS Rio Iratapuru (Brasil) 1 1
APA (D) Nascentes do Rio Paraguai (Brasil) 1 1
APA (D) Lago de Santa Isabel (Brasil) 1 1
APA (D) Lago de Peixe Angical (Brasil) 1 1
FN Amapá (Brasil) 1 1
FE do Amapá (Brasil) 9 1 10
PI Aripuanã (Brasil) 1 1 1
PN Cayambe Coca (Ecuador) 3 3
Shuar (Ecuador) 2 2 2
APA (D) Lago de Peixe Itaimbê (Brasil) 1 1
PB Marimbus (Brasil) 1 1
RCSP Nova Veneza (Brasil) 1 1
RCSP Sítio Capitão (Brasil) 1 1
AP São Félix (Brasil) 1 1
AP Itaituba (Brasil) 1 1
AP Utinga (Brasil) 1 1
AP Uiramutã (Brasil) 1 1
AP Uiramutã (Brasil) 1 1
AP Oiapoque (Brasil) 1 1
AP Oiapoque (Brasil) 1 1
AP Nova Alvorada (Brasil) 1 1
RCSP Nova Veneza (Brasil) 1 1
RCSP Nova Veneza (Brasil) 1 1
RCSP Nova Veneza (Brasil) 1 1
Total 20 19 4

Conclusion
The hydroelectric plants are concentrated in the south of Amazonia and in a small area of the Andean-Amazonian region (mainly in Peru). The construction of these plants, their current operation and the building of others in the short and medium term, are linked by national development plans regarding the country: proposed energy matrix. The socio-environmental impacts of these plants must be integrated and addressed with the socio-environmental impacts of small Brownian PCHs. The construction of these plants, their current operation and the building of others in the short and medium term, are linked by national development plans regarding the country: proposed energy matrix. The socio-environmental impacts of these plants must be integrated and addressed with the socio-environmental impacts of small Brownian PCHs.

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Indigenous Territories
7 8 1 5 5 2 12

By Indigenous Territories
In relation to ITs, 17 (3.5%) of the 491 hydroelectric plants in operation in 2012 are partially or fully situated within the five UHEs and five PCHs). While 11 future hydroelectric plants (in the 246 planned as of 2012) will operate inside ITs (three UHEs and seven PCHs). These sites are under customary jurisdictions and are threatened by future constructions of hydroelectric plants. Currently the ITs facing the pressure from actual plants are found in Brasil (2), Peru (2), Ecuador (1) and Colombia (1), while the ITs directly threatened by proposed plants are located in Brasil (2), Peru (2) and Bolivia (1) (map).

By Protected Areas
A total of 171 hydroelectric plants were in operation or under construction within Protected Natural Areas (PNAs) as of 2010. Thirteen (7.6%) of these were wholly or partially located within PNAs (eight Brasil (3), Brasil (8), Perú (1) and Guyane Française (1), while the PNAs under threat from projected plants are found in Brasil (263), Peru (170) and Bolivia (38).
Fires – AmAzoniA under Pressure

Fires, increasingly common and more intense in the region, are not limited just to the infamous "arc of deforestation" of Brazil and Bolivia. New fires have been occurring in more remote areas and within Protected Nature Areas (PNAs). Indigenous and traditional communities, including some who initially resisted fire from the colonisation frontiers, have denounced problems in controlling fires and in raising the need to develop procedures for adapting to the climate changes under way. One example of this is the case of Xingu Indigenous Park (Parque Indígena Xingu, PIX), land of forest surrounded by deforestation produced over the last 20 years by farming activities, where 16 ethnic groups live in more than 50 different communities. In 2009 an experimental process was begun to mobilise twelve communities, belonging to seven ethnic groups, to create new forms of managing and fighting fires: The Xingu Indigenous Fire Path (the fogo do parque indígena Xingu).

Fires, occurring more often in areas which, according to the literature on deforestation, can be considered under pressure from deforestation (Bolivia and Brazil), have new areas which are more remote and within the zone of cerrado and dry transition forests, which are already naturally more prone to fire due to the effects of selective logging, which increases sunlight penetration and wind penetration, lowering the relative humidity of the forest (Laurence et al., 2002; Steinger et al., 2001; Laurance et al., 2001). The main factors described include: 1) the advance of farming in Bolivian and Brazilian Amazonia close to areas of cerrado and dry transition forests, which are already naturally more prone to fire; 2) the degradation of forest areas through selective logging, which increases sunlight and wind penetration, lowering the relative humidity of the forest (VeríSSimo et al., 1992); 3) the severity and duration of the dry season, worsened by the fires themselves, which cause cloud formation and delay the onset of the rainy season (Laurance et al., 2002); and 4) the fact that fires in Amazonia are not adapted to fire, which means that after the first fire has burnt the surface, it is susceptible to re-lighting and easily increases, significantly augmenting the intensity of subsequent fires (VeríSSimo, 2005).

This immediate and most evident consequence of the increase in fires is the loss of diversity, in wildlife and plants alike, pollution with the consequent impact on human health, the increase in greenhouse gas emissions and the reduction in local rainfall due to the smoke.

Recent estimates indicate that the combination of deforestation and climate change may lead to a 50% increase in the occurrence of fires in Amazonia by 2050 (VeríSSimo et al., 2011), intensifying forest degradation and impoverishment.

Methodology

Georeferenced information on "hot spots" in Amazonia for the 2000-2010 period was obtained from Brasil’s National Space Research Institute (Instituto Nacional de Pesquisas Espaciais do Brasil: INPE), taking into account: (i) the recorded date of hotspots, and (ii) the type of sensor used. Only data from the NOAA-12 (from 01/01/2000 to 09/08/2007) and NOAA-15 (from 10/08/2007 to 31/12/2010) satellites were used. For these satellites, a hotspot appears as a 1 km area of high temperature, which may represent the occurrence of a single small fire, several small fires or a larger fire. These satellite cannot detect fires that occur on the ground under the tree cover. To facilitate analysis, the data was filtered to only include those fires in the Xingu Indigenous Park, Amazonas, Brazil. In 2015, the number of fires in the Xingu Indigenous Park reached 884, almost three times as high as in 2002. This level is higher than in a decade.

Fires can no longer be considered just an issue of forest degradation and impoverishment. They are a millennial agricultural practice, fire is no longer restricted to border areas and is advancing deep into Amazonia.

The years 2002, 2004 and 2005 recorded the highest number of fires.

The southeast of Amazonia, in the region of the Arc of Deforestation (Brasil and Bolivia) is the region with the highest number of fires recorded.

All 10 indigenous territories most heavily affected by fire in the period 2000-2010 are located in Bolivia and Brazil.

The traditional forms of managing fire used by indigenous peoples will have to adapt to climate change

A millennial agricultural practice, fire is no longer restricted to border areas and is advancing deep into Amazonia.

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Fires (Hot Spots) in Amazonia

Fires (Hot Spots) in Amazonia
Amazônia as a whole

A total of 1,320,866 fires were recorded for the period 2000-2010. The years with the highest number of fires were 2004, 2005 and 2002, with the lowest in the years 2009 (39,627) and 2000 (66,175). The months with the largest number of fires were August, September and October, with the highest figures recorded for September 2009 (34,688), August 2005 (31,921) and September 2006 (28,926).

These fires were detected in larger proportion in the southwest of Amazonia (MS), a zone called the ‘arc of deforestation’ of Brazilian Amazonia (Schor et al., 2008; Vieira et al., 2008) and Bolivian Amazonia.

Table 1. Fires counted monthly in Amazonia over the period 2000-2010:

<table>
<thead>
<tr>
<th>Month</th>
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<tbody>
<tr>
<td>January</td>
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<tr>
<td>February</td>
<td>12,079</td>
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<tr>
<td>March</td>
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<td>April</td>
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Amazônia in each country

A total of 1,194,060 (90%) fires occurred in Brazilian Amazonia during the 2000-2010 period. The largest numbers occurred in the years 2004 (166,750), 2005 (161,589) and 2002 (157,299), and the lowest in the years 2009 (39,627) and 2000 (66,175). The months with the largest number of fires were August, September and October, with the highest figures recorded for September 2009 (34,688), August 2005 (31,921) and September 2006 (28,926).

The largest proportion of fires in Bolivia, Brasil, Ecuador, Perú and Venezuela were detected in the 2000-2005 period, while in Colombia, Suriname, Guyana Guiana Francais and Suriname the highest numbers were in the 2006-2010 period. The intensity of fire per country in the period 2000-2010 is represented in Fig. 2.

Table 2. Fires counted monthly in Amazonia over the period 2000-2010:

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Fires in Amazonia in the period 2000-2010 (quantity per 10 km2 squares) GFI1. Fires recorded annually in Amazonia over the period 2000-2010

GFI2. Fires recorded monthly in Amazonia over the period 2000-2010, represented in 10 km2 boxes and separated into two periods: 2000-2005 and 2006-2010. The information was analyzed for the following units: Amazonia, Amazonian countries, macro-basins and sub-basins. Protected Natural Areas and Indigenous Territories.

GFI3. Annual quantity of fires recorded in Brazilian Amazonia over the period 2000-2010

GFI4. Quantity of fires per country in Amazonia (2000-2010)

GFI5. Quantity of fires per macro-basin in Amazonia (2000-2010)

GFI6. Quantity of fires per basin in Amazonia (2000-2010)

GFI7. Quantity of fires per sub-basin in Amazonia (2000-2010)

GFI8. Quantity of fires per river in Amazonia (2000-2010)

By Basin

The Middle-Lower Amazonas macro-basin presented the highest number of fires, followed by Suriname and the Orinoco. This trend was maintained over the eleven year time span, although more intensely during the 2000-2005 period. In the Middle-Lower Amazonas, the intensity of fire per country in the period 2000-2010 is represented in Fig. 3.

Table 3. Fires counted monthly in Amazonia over the period 2000-2010:

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Recent estimates indicate that the combination of deforestation and climate change may increase the occurrence of fires in Amazonia higher than in 2007, which was the year with the most forest fires in a decade. This higher significance already exist in many villages. Forest fires are at the same time cause and effect of the profound changes occurring in the Amazon basin (Davidson et al., 2012). Forest fires are at the same time cause and effect of the profound changes occurring in the Amazon basin (Davidson et al., 2012).

BFI1. Fires counted monthly in Amazonia over the period 2000-2010

TFI1. The ‘arc of deforestation’ of Brazilian Amazonia (Schor et al., 2008; Vieira et al., 2008) and Bolivian Amazonia.

Output area: 12.9 mm, borders: 1.9 mm

Fig. 4. The 16 peoples who live in the Xingu Indigenous Park (PIX) – one of the best known indigenous lands in Brazilian Amazonia. Spotting fires during the dry season (October), the fires use the wind to spread the flames, which may produce smoke, affecting local and regional environmental quality. The transition forests found in the region formed by the Xingu River have a diversity of vegetation with medium density and high height, is a zone of transition of the forest with high flammability that has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, has become an ever bigger threat. As the forest has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, these events tend to be more frequent and intense. Fire, traditionally used by indigenous peoples in their subsistence activities (for example, to clear fields, gather honey and honey bees to make honey), has become an ever bigger threat. As the forest has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, these events tend to be more frequent and intense. Fire, traditionally used by indigenous peoples in their subsistence activities (for example, to clear fields, gather honey and honey bees to make honey), has become an ever bigger threat. As the forest has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, these events tend to be more frequent and intense. Fire, traditionally used by indigenous peoples in their subsistence activities (for example, to clear fields, gather honey and honey bees to make honey), has become an ever bigger threat. As the forest has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, these events tend to be more frequent and intense. Fire, traditionally used by indigenous peoples in their subsistence activities (for example, to clear fields, gather honey and honey bees to make honey), has become an ever bigger threat. As the forest has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, these events tend to be more frequent and intense. Fire, traditionally used by indigenous peoples in their subsistence activities (for example, to clear fields, gather honey and honey bees to make honey), has become an ever bigger threat. As the forest has become more inflammable, traditional management practices already no longer seem sufficient to control forest fires, these events tend to be more frequent...
The total number of fires recorded within PNAs was 101,546 (8% of the total recorded in Amazonia). At national level Brasil recorded the highest number of fires within PNAs (83,399), which represented 82.1% of the total recorded in all PNAs. Fires registered inside PNAs in Brasil represent 7% of the national total and 15% of the Amazonian total. The ten PNAs with the highest number of fires were departmental direct use PNAs (18,894), departmental indirect use PNAs (16,262) and national direct use PNAs (15,242) (15.7% of the national total and 3.3% of the total fires recorded in the country). The highest proportions of fires within PNAs compared to the national level were recorded in Perú (45.6%) (4,364 fires or 4.5% of the total in Amazonia). In Venezuela 7,907 fires were registered in ITs, amounting to 39.7% of fires in the country and 8.8% of the total in Amazonia. In Guyana 2,619 fires were recorded in ITs, representing 27.0% of the fires in the country and 4.6% of the total in Amazonia. In Ecuador 1,619 fires were registered in ITs, amounting to 39.7% of fires in the country and 6.8% of the total recorded in Amazonia. The highest proportion of fires in the administrative level was recorded in Brasil (54.6%) and Suriname (4.5%). The ten ITs with the highest number of fires located in Brasil and Bolivia (15%).

By Indigenous Land

The total number of fires recorded during the years from 2000 to 2010 inside Indigenous Territories (ITs) was 53,822 (7% of the total recorded in Amazonia). The largest proportion of fires was recorded in officially recognized ITs (12,294), followed by areas earmarked for the creation of territorial reserves or intangible zones (18) (8,864) and departmental reservations (4,737).

The national level Brazil registered 4,827 fires within ITs, representing 4% of the total number of fires recorded in ITs within Amazonia. In Bolivia, for its part, the number of fires within ITs was 4,488, representing 23.7% of the fires in the country and 4.6% of the total in Amazonia. In Venezuela 297 fires were registered in ITs, amounting to 39.7% of fires in the country and 3.9% of the total recorded in Amazonia. The highest proportion of fires in the administrative level was recorded in Perú (45.6%) and Suriname (4.5%).

The highest concentration of fires coincides with Amazonia’s arc of deforestation, a zone delimitated by the latitudinal variation of the rainforest. There were proportionately fewer fires within the PNAs and ITs, which emphasizes their role as ‘social and natural barriers’ that limit the expansion of fires. The loss of number of fires inside PNAs and ITs may also be explained in large part by the fact that these are normally located in zones with moderate or low population. In addition the adequate management of fires linked to traditional knowledge and practices still used by indigenous and rural peoples living in these territorial units. On the other hand, the ‘arc of deforestation’ zone coincides with the contact zone between agroindustrial fronts that form part of Brazilian Amazonia and where fire is a historical and natural element of the landscape’s dynamics.
DEFORESTATION

Deforestation in Amazonia results from a complex process of land-use change, which leads to the replacement of forest by roads, farming, mining activities, among others, to the construction of large infrastructural works and urban growth. It negatively affects ecosystem services by changing that land or determining climate, biodiversity and other services. Major drivers of deforestation are changes and growth in human activities, which lead to the exploitation of natural resources, such as timber, agriculture, livestock, and mining, and large-scale infrastructure projects like roads, dams, and power lines.

In the Brazilian case, considered the most critical for Amazonia as a whole, deforestation is more so than others, changed the patterns of territorial occupation of Amazonia. Over the last 30 years more than 70 million hectares of Amazonian tropical forest have been cut down, approximately 1% of Amazonia’s territory (PNUMA and OTCA, 2009), where deforestation was responsible for more than 75% of all greenhouse gas emissions in the country (Menezes, 2010).

The main impacts of deforestation in Amazonia include: loss of biodiversity, reduction of the water cycle and quality, as well as contribution to global warming (Vieira et al., 2005). Additionally, climate studies have confirmed the negative effects on human health, the most documented being the increase in deforestation-related deaths (Fearnside, 2005; Vieira et al., 2005). The main drivers of deforestation in Amazonia are: cattle ranching, fire, and oil and gas mining.

Between 2000 and 2010, the pace of deforestation was reduced, primarily due to a reduction in the amount of farming in Brazil, Colombia, Bolivia and Ecuador.

Deforestation increased in the Andean countries, especially Colombia.

Context

The process of deforestation in the nine Amazonian countries began to accelerate from the 1960s onwards. Contingents of rural populations from other more crowded regions were encouraged to colonize and farm Amazonian forestlands. Government programs in Ecuador, Peru and Brazil encouraged deforestation as a prerequisite for being granted ownership of the new lands. This process, more so than others, changed the patterns of territorial occupation of Amazonia.

Over the last 10 years more than 70 million hectares of Brazilian tropical forest have been cut down, approximately 1% of Amazonia’s territory (PNUMA and OTCA, 2009), where deforestation was responsible for more than 75% of all greenhouse gas emissions in the country (Menezes, 2010).

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Deforestation increased in the Andean countries, especially Colombia.

FAO has published reports on deforestation since 1984. The results of the 2010 assessment indicate the forest area is recovering at a global level, but higher rates of deforestation persist in tropics regions such as Amazonia. Among the main causes of deforestation are the expansion of farming, predatory models of forest law enforcement, intensive oil and gas production and infrastructure development (access roads, reservoirs and dams, power transmission lines, oil and gas pipelines) and so on. Although the results of many studies on deforestation in Amazonia, especially Brazilian Amazonia (Table 1), the broad picture has yet been made as a macro-regional level, incorporating Andean Amazonia and the Guiana region.
Amazônia as a whole

The area of forest present in Amazônia in 2000 was equivalent to 68.8% of the entire region (3,271,671 km²). Up to the 2000 base map, devised by the Instituto Nacional de Pesquisas Espaciais (INPE) for the period January 2000 to December 2000, deforestation was determined from the satellite images of Landsat 7-66 in the period 2000-2005. These images were used to buffer the real extent of deforestation. To assess deforestation in the other countries of Amazônia, the deforestation that occurred between 2000 and 2005 was determined from similar images. The areas of forest for the two periods were differentiated in terms of whether they were originally unforested or forested at the reference year 2000 may have been based on scenes taken within the period between 1998 and 2002, the reference period used for the two periods 2000-2005 and 2005-2010. In response to the availability of high quality images with low amounts of cloud cover, Amazônia was divided into Andean Amazonia (Colombia, Ecuador, Peru and Bolivia) and the Guianas (Venezuela, Brazil and French Guyane). Good quality images were unable to be obtained for three scenes covering the Guianas during these three dates. The area excluded determined the effective area of study, comprising 89% of the area for which images and methodological studies were available.

The effective area analyzed represented 99% of the area of forest present in Amazônia in 2000. The exclusion of 1% was due to the loss of images with low quality in the following periods: during 2000, 2005 and 2010 which were not included in the analysis.

The 2000 base map database was established by identifying for each scene: forested areas, unforested areas covered by water and areas covered by clouds. At this point the referred areas were set on a base map (2000-2005) of the Andean and Guianese Amazonian countries in 2000 for the construction of the ‘baseline,’ where the eventually unforested areas, like savannahs, were classified as ‘non-forest’ along with areas already deforested by this date. This baseline was then used to determine the deforestation in the years 2000-2005 and 2005-2010. The 2005 base map database was established by identifying for each scene: forested areas, unforested areas covered by water and areas covered by clouds. At this point the referred areas were set on a base map (2000-2005) of the Andean and Guianese Amazonian countries in 2005 for the construction of the ‘baseline,’ where the originally unforested areas, like savannahs, were classified as ‘non-forest’ along with areas already deforested by this date. This baseline was then used to determine the deforestation in the years 2005-2010 and 2010-2015. Over the period 2000-2010, this forest lost area was reversed by 4.3% (approximately 141,543 km²), equivalent to almost half the Colatoni Amazon, this deforestation primarily occurred in the southern part of the Brazilian Amazon, where the loss of savannahs increased. The loss of forest for the areas under evaluation was greater during the 2000-2005 period (142,183 km²) than in the period existing in 2005-2010 (142,042 km²) 1%. This data reaches the findings published by the FAO (2010), which reported a reduction in forest loss over the 2005-2010 period compared to 2000-2005. Cloud cover in the satellite images makes it difficult to obtain a more precise panorama of what is happening on the ground. In regional terms cloud cover could cover from 2 to 3.6% of the second, however, the particular situation varies among the countries. Ecuador is the most
With a biodiversity of 384 megadiverse species, all five megadiverse countries are particularly affected by deforestation. Guyana’s forest loss during the period from 2000 to 2010 was the highest (76.0%), followed by Colombia (58.0%), Venezuela (59.2%), and Brazil (45.3%). Ecuador had the lowest deforestation level (2.4%).

The country with the highest deforestation rate in the period 2000-2010 was Brazil, which lost 4.5% of its forest cover. These three countries are located in the lower Amazon basin. In the latter two cases deforestation rose from 0.7% to 0.1%, followed by Brazil (from 4.5% to 1.7%).

The deforestation evaluated in the 2000-2010 period took place mainly in Brazil, which had a deforestation rate of 4.5% and was followed by Colombia, Brazil, and Ecuador with rates of 2.8%, 2.5% and 2.4% respectively. The countries with the lowest deforestation levels were Guyana Francaise and Suriname with less than 1%. The forest loss in Brazil represented 80.4% of the total forest cut down during the period under analysis, followed by Peru with 6% and Colombia with 5%. The analysis by five-year period indicated that forest loss rates for the 2000-2005 period was generally lower with the exception of Peru, Colombia and Guyana Francaise (GDF1 and GDF2). The period between 2000-2005 showed a forest loss of 1.7% in Colombia and 1% in Peru, which decreased to 1.1% during the last five years. For Peru the forest loss was 1.7% during the first five years of the period, followed by the second five years and then in the last five years. The countries with the lowest deforestation levels were Guyana Francaise and Suriname with less than 1%. The same also occurred in Bolivia, on the border with Peru, in the Lower and Middle Madeira sub-basins (MDF4).

The deforestation evaluated from 2000 to 2010 was highly affected by deforestation, which took place mainly in Brazil, with a deforestation rate of 6.2%. These three countries are located in the lower Amazon basin. The deforestation rate in Brazil decreased from 6.2% to 1.5%, followed by Brazil (from 4.5% to 1.7%).

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The trend towards higher levels of deforestation in direct use PNAs was identified in all countries. Brazil maintained high levels of deforestation (1.3%), with the direct use departmental PNAs presenting a deforestation rate of 3.8% (TDF7 and GDF2). This is explained in part by the fact that in Brazil the direct use PNAs include Environmental Protection Areas (Áreas de Proteção Ambiental: APA), which have a higher permission system, including urban and process areas within their borders. The APAs account for 63% of all deforestation among the group of PNAs in Brasil.

The variation in the percentage of loss across the different countries was highly significant; as well as the variations within the same country (see TDF8 and GDF2). Brazil had the PNAs with the highest percentage of deforestation during the decade, reaching as high as 41% in the APA Rio Pará. This recent created APA (310 000 ha) is one of the PNAs in Rondonia state where deforestation of age type was delayed, including the consolidation of the illegal occupation of the National Forest that had already taken place. In the other countries for percentages comparison the PNAs were less than 10% as far as, for example, in the North Caucau/Pará/Amapá Management area in Suriname, or the PA Alto Tocantins in Catarina. Both of the latter were lost.

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deForestAtion – AmAzoniA under Pressure

In this chapter are the first steps in this direction. Dislocations in this region was made worse by internal conflict in the country. At the end of the 1950s Law 20 of 1959 was issued, establishing three colonization fronts stimulated by the national government, encouraging colonization in the zones covered by natural vegetation (Martínez & Sánchez, 2007). Due to their geographic position, these basins are characterized by a rich and unique landscape that allows them to be designated as one of the areas rich in biodiversity and natural resources in Colombia. The river is considered an isolated area, populated solely by small indigenous groups. The first colonial advances from Andean settlers occurred at the start of the 20th century when various settlements were founded in the foothills of the departments of Meta, Caquetá, and Vaupés, attracting by the commercialization of coca and cocaine leaf. Later a second wave of dislocations occurred in the 1950s and 1960s, with the expansion of the coca cultivation. Between 2005 and 2010, although this trend had lowered compared to Colombian Amazonia as a whole, it is still the region with the highest level of forest loss. Nonetheless in the period 2005-2010 the country saw a substantial reduction in deforestation, in contrast to other countries, which showed an accelerating trend, in the case of Colombia.

The results presented reinforce the importance role that RAISG and LGMs have been performing in following down and combatting these issues in each country and in Amazonia as a whole. The differences detected between the lands included in these two types of territorial units and those outside clearly support this view. Nevertheless, these results have been achieved thanks to a rich and unique landscape that allows them to be designated as one of the areas rich in biodiversity and natural resources in Colombia. The river is considered an isolated area, populated solely by small indigenous groups. The first colonial advances from Andean settlers occurred at the start of the 20th century when various settlements were founded in the foothills of the departments of Meta, Caquetá, and Vaupés, attracting by the commercialization of coca and cocaine leaf. Later a second wave of dislocations occurred in the 1950s and 1960s, with the expansion of the coca cultivation. Between 2005 and 2010, although this trend had lowered compared to Colombian Amazonia as a whole, it is still the region with the highest level of forest loss. Nonetheless in the period 2005-2010 the country saw a substantial reduction in deforestation, in contrast to other countries, which showed an accelerating trend, in the case of Colombia.

Conclusion

Deforestation is a process affecting a large portion of Amazonia. Brazil is undoubtedly the country with the highest level of forest loss. Nonetheless in the period 2000-2010 the country saw a substantial reduction in deforestation, in contrast to other countries, which showed an accelerating trend, in the case of Colombia.

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The active pressures and threats currently facing Amazonia, evident in the cartographic language used in this publication, are driving enormous changes there: the forest landscapes, socio-environmental diversity and fresh water sources are being replaced by degraded, savannah zones that are clearer and much less diverse.

The planet’s largest and most complex rainforest – with at least 10,000 years of human activities – is fast becoming a space for the extraction and production of agroindustrial inputs and non-renewable raw materials (commodities with a low value added) for national and international markets. This impacts its potential for sustainable long-term development and destroys its inhabitable spaces.

This Atlas has demonstrated that there already is an arc of deforestation that extends from Brazil to Bolivia; areas with great pressure on their aquatic systems; and a general situation of issues like: forest carbon capture and storage according to land uses (protected areas, Indigenous Territories and so on); new extractive uses (protected areas, Indigenous Territories and so on); new extractive activities related to hydroelectric plants or redirection of rivers to provide irrigation and drinking water; promotion of regional integration and its implications in terms of infrastructure, energy security and mobilizing populations; strategies for adapting to climate change in order to reduce socio-environmental vulnerability in mountain rainforest and in the flood plains of Amazonia.

There is also a clear need to adopt other themes from a positive agenda linked to governance (of the environment, forests, water or energy), effective measures for integrated management of basins as part of the adaptation to extreme variability and climate change, good practices and sustainable production chains, among others.

For this Atlas we were unable to include an analysis of key themes such as oil/gas and mining projects, as much as a half of the current Amazonian forest infrastructure projects for transport (roads or multimodal routes), along with the oil/gas and mining projects, as such a half of the current Amazonian forest could disappear in the near future. It is urgent to further analyze what is happening in the Amazonia, based on the information gathered by RAISG, in order to identify the future situation of issues like: forest carbon capture and storage according to land uses (protected areas, Indigenous Territories and so on); new extractive economic frontiers (related to hydroelectric plants or redirection of rivers to provide irrigation and drinking water); promotion of regional integration and its implications in terms of infrastructure, energy security and mobilizing populations; strategies for adapting to climate change in order to reduce socio-environmental vulnerability in mountain rainforest and in the flood plains of Amazonia.

Reversing the current conditions of all the river basins, PNAs and ITs is not always possible. However any effort in this direction should be initiated with a more fine-tuned analysis that identifies management measures, integrated with the participation of local and institutional actors.

Pressures in PNAs and ITs

• The PNAs and ITs could exert the pressures to some extent, but new mechanisms are needed to stop or mitigate the threats based on them.

• Deforestation in the PNAs is lower than the rest of Amazonia, while in the ITs it is lower than in the PNAs.

• 80% of the PNAs and 95% of the ITs are affected by some of the analyzed themes. The PNAs most affected are direct use national areas.

• 1,834 ITs (88%) and 65 PNAs (11%) are affected by oil drilling.

Pressures in hydrographic basins

• All sub-basins have at least one affectation, 45% of them are affected by five of the analyzed themes, either in the form of pressures or threats.

• The sub-basin of the Upper Amazonas have the highest number of affectations for all themes analyzed.

CONCLUSION

The planet’s largest and most complex rainforest – with at least 10,000 years of human activities – is fast becoming a space for the extraction and production of agroindustrial inputs and non-renewable raw materials (commodities with a low value added) for national and international markets. This impacts its potential for sustainable long-term development and destroys its inhabitable spaces.

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For this Atlas we were unable to include an analysis of key themes such as oil/gas and mining, logging and farming due to the lack of quality information which can be visualized on maps for Amazonia as a whole. When these factors are included, the overall panorama will likely be even more adverse.

The analysis of deforestation shows that between 2000 and 2010 around 240,000 km² of Amazonian forest were cut down. This is equivalent to twice the area of Ecuadorian Amazonia or to the entire surface of the United Kingdom.

It is urgent to further analyze what is happening in the Amazonia, based on the information gathered by RAISG, in order to identify the future situation of issues like: forest carbon capture and storage according to land uses (protected areas, Indigenous Territories and so on); new extractive economic frontiers related to hydroelectric plants or redirection of rivers to provide irrigation and drinking water; promotion of regional integration and its implications in terms of infrastructure, energy security and mobilizing populations; strategies for adapting to climate change in order to reduce socio-environmental vulnerability in mountain rainforest and in the flood plains of Amazonia.

As a half of the current Amazonian forest could disappear in the near future. It is urgent to further analyze what is happening in the Amazonia, based on the information gathered by RAISG, in order to identify the future situation of issues like: forest carbon capture and storage according to land uses (protected areas, Indigenous Territories and so on); new extractive economic frontiers related to hydroelectric plants or redirection of rivers to provide irrigation and drinking water; promotion of regional integration and its implications in terms of infrastructure, energy security and mobilizing populations; strategies for adapting to climate change in order to reduce socio-environmental vulnerability in mountain rainforest and in the flood plains of Amazonia.

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Amazonia Under Pressure provides a map-based account of the panorama of current pressures and potential threats to a region covering 7.8 million km², shared by Bolivia, Brasil, Colombia, Ecuador, Guyana, Perú, Suriname, Venezuela and Guyane Française, home to 33 million inhabitants, including 385 indigenous peoples.

The Atlas is one of the results of a cooperation, begun in 2007, between civil society and research organizations under the aegis of the Amazonian Network of Georeferenced Socio-Environmental Information (RAISG). Up-to-date information on roads, oil and gas drilling, mining, hydroelectric plants, fires and deforestation are shown in maps for the whole of Amazonia, the Amazonian region in each country, Protected Natural Areas, Indigenous Territories and at the level of hydrographic basins.

The publication includes the separate map AMAZONIA 2012, Protected Natural Areas, Indigenous Territories and Deforestation (2000-2010).

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