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Amazonian Indigenous Peoples Territories and Their Forests Related to Climate Change: Analyses and Policy Options

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Executive Summary

This paper reviews two scientific analyses – different, but associated – that examine the role of Amazonian Indigenous Territories (IT) and Protected Natural Areas (PNA) in the conservation of forests and the carbon stocks found in them. One analysis finds that at the Amazonian Basin level from 2000-2015, while forest in Indigenous Territories and Protected Natural Areas represents 52% of the Amazonian total, **only 17% of deforestation occurred in their boundaries** – a percentage significantly lower than the **83% of deforestation coming from the forests of areas outside of their delimitations**. However, at a country level analysis, the findings were not homogenous. Additionally, an important trend observed at a Basin level was the increase in rates of deforestation loss in Indigenous Territories without legal recognition.

The other analysis examined the above ground biomass – i.e. forest carbon stocks – located in Indigenous Territories and Protected Natural Areas and existing pressures and threats from various extractive activities and infrastructure. The analysis uses new forest carbon stock data from 2014 found in a just published journal article[1].

It finds that 53% of the Basin's forest carbon stocks are found in Indigenous Territories and Protected Natural Areas. Additionally, forest carbon stocks located in Indigenous Territories which endure pressure and threat, correspond to 12% of the Basin's total. This is particularly relevant to

1 A. Baccini1,*, W. Walker1, L. Carvalho2, M. Farina1, D. Sulla-Menashe3, R. A. 'Tropical forests are a net carbon source based on aboveground measurements of gain and loss' Houghton1, Science, 2017. http://science.sciencemag.org/content/358/6360/230

the Amazonian Basin countries due to commitments in their Nationally Determined Contributions (NDCs) to the UNFCCC and Paris Agreement to take action in their forest sectors.

Finally, the paper discusses policy changes that are necessary to ensure continued lower rates of deforestation in Indigenous Territories and the protection of forest carbon stocks found in them. It is important to note that forests are not only valuable to Indigenous Peoples and humanity for their role in climate change mitigation and providing other environmental services, but also because of their cultural and socio-economic roles in the communities who live in them. Recent policy changes and actions in some Amazonian countries (Colombia) are complimentary to conserving forests in Indigenous Territories and Protected Natural Areas, while others (Brazil and Bolivia) are significantly eroding the existing policies used by their inhabitants to protect them.

Policy makers at the global level, donor countries supporting Amazonian forest conservation efforts, and Amazonian basin country domestic policy makers need to heed the science and recommendations in this report to ensure that Indigenous Peoples and the forests in their territories can continue to play the important role they do in mitigating climate change.

About the Authors of this report

This report was produced by an innovative consortium of Indigenous Peoples organizations, scientists, and environmental and human rights advocates. The members of the consortium come from the United States and the Amazon Basin countries. The report is jointly produced with each member contributing their specific expertise and a rigorous consultation and writing process to ensure not only the science is the best, but that the Indigenous Peoples partners are primary actors in the partnership.

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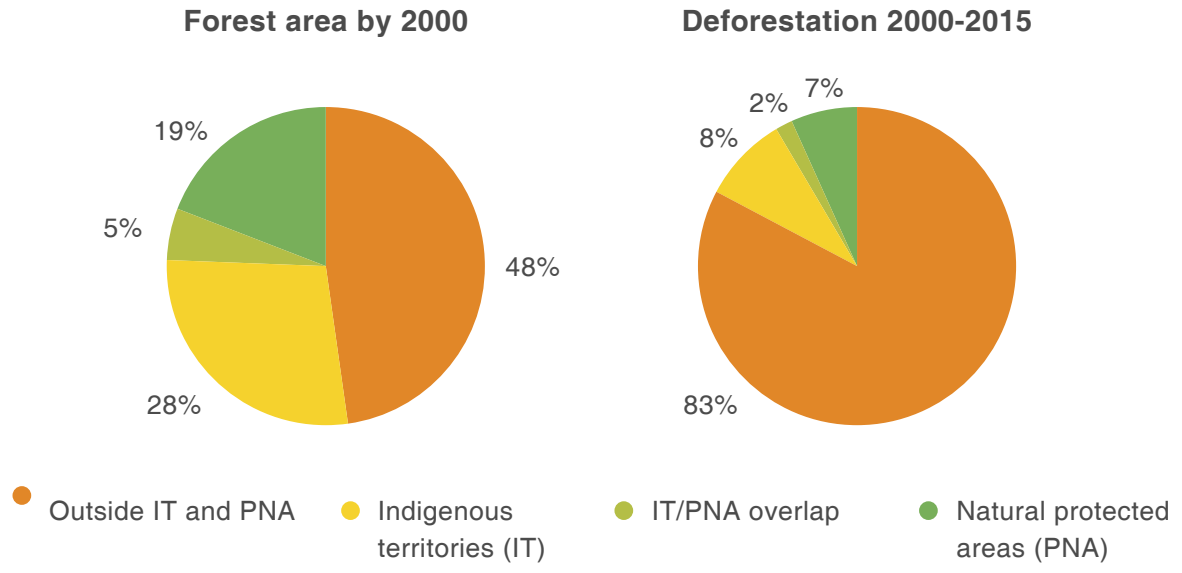
Norad

Deforestation Analysis Results

Significant differences in the percentage of Amazonian gross deforestation exist between forests located inside Indigenous Territories (IT) and Protected Natural Areas (PNA) compared to forests located outside of them. Many recent reports and journal articles[2] point towards this conclusion, but this is the first report to analyze the phenomenon from a regional or biome level (the Amazon basin countries) and length of time (15 years). Why that this is the case is a question this report does not answer.

Eighty three percent of all the gross deforestation in that period occurred outside of Indigenous Territories and Protected Natural Areas leaving only 17% to have occurred inside them. Interestingly, only 48% of the total area of forests in the Amazon is found outside of the IT and PNA.

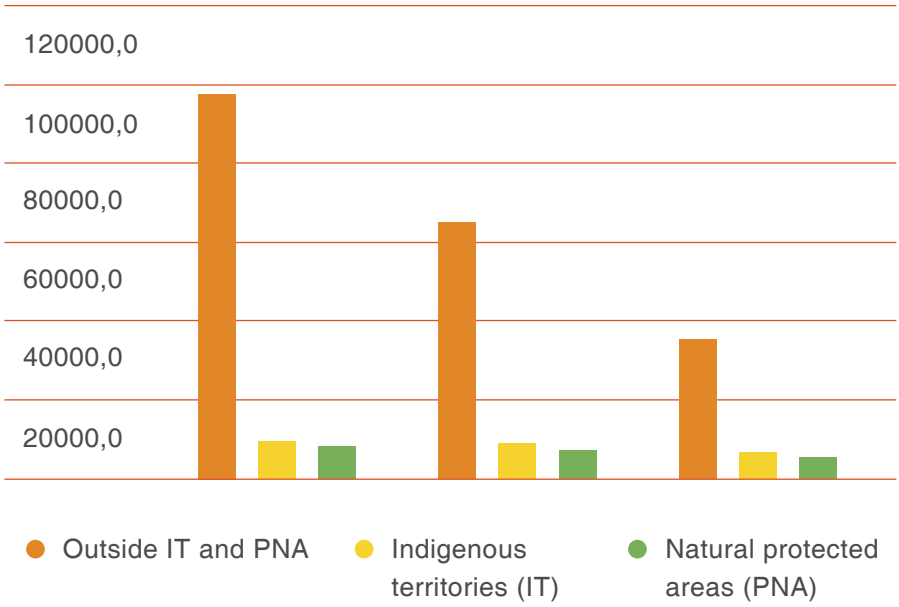
Figure 1. Distribution of forests by category in 2000 for the Amazon (RAISG limit) and deforestation by category in the period 2000-2015.



2 http://www.pnas.org/content/114/16/4123.full

Amazonian deforestation rates external and internal of Indigenous Territories demonstrated a trend downward from 2000-2015. The total amount of deforestation found inside Indigenous Territories fell from 9,195 km2 during the 2000-05 period to 6,586 km2 during the 2010-15 period – a reduction of 28.4%. However the trend was not homogenous for all countries in the region. Brazil, Colombia, and Ecuador all had trends that went downward while French Guyana and Venezuela shared an upward trend.

Figure 2. Deforestation by category in the period 2000-2015 for the Amazon basin (km2). (RAISG limit).



One concerning trend found was that gross deforestation in Indigenous Territories without legal recognition increased more than 50% from 976 km2 in the 2000-05 period to 1,501 km2 in the 2010-15 period. Lands with title to them are known to reduce the prevalence of deforestation[3]. This is concerning because of the lack of progress titling Indigenous Territories in the region and more recent backsliding in the key country of Brazil.

3 https://www.cgdev.org/publication/ft/stopping-deforestation-what-works-and-what-doesnt

Table 1. Deforestation by category in the period 2000-2015 for the Amazon basin (RAISG limit).

Category	Forest area 2000 (km2)	Deforestation by period (km2)			Total deforestation 2000-2015	Percent (%) deforestation of the 2000 forest
		2000-2005	2005-2010	2010-2015		
Outside IT and PNA	**2,340,206**	**97,519**	**64,965**	**35,250**	**197,734**	**8.45**
Indigenous Territories	**1,934,142**	**9,195**	**9,109**	**6,586**	**24,890**	**1.29**
IT without legal recognition	348,910	976	1,250	1,501	3,727	1.07
Proposed indigenous reserve	40,910	16	32	28	76	0.18
Reserved territory* and Exclusion zone (Zona Intangible)**	30,370	47	35	12	95	0.31
IT legally recognized	1,513,953	8,156	7,792	5,045	20,993	1.39
Protected Natural Areas	**1,445,688**	**7,888**	**7,086**	**5,468**	**20,442**	**1.41**

* In Peru, Territorial Reserves are declared to protect the indigenous peoples in voluntary isolation and in situation of initial contact in the Peruvian Amazon.

***Zonas Intangibles* in the Ecuadorian Amazon are protected areas of exceptional cultural and biological importance in which no extractive activity can be carried out. One of these areas is inhabited by indigenous peoples in voluntary isolation.

Brazil

In the specific case of Brazil, the trend was very positive for the amount of deforestation occurring in Indigenous Territories. However, that trend is not probably holding with the recent upturn in overall deforestation in Brazil and policy changes made to reduce protections of Indigenous Territories and facilitate more deforestation by the agriculture sector[4].

4 Articles about the increasing deforestation in the Brazilian Amazon: http://www.greenpeace.org/brasil/pt/Blog/colocando-mais-gasolina-na-motosserra/blog/58707/?gclid=Cj0KEQjw1JbPBRCr05aKy7HnmJsBEiQA4qPY-R0f7j4y6mWU_R2MJ5rfX8ADQaqoukWy0zFETstKgyoaAmuP8P8HAQ; https://www.socioambiental.org/pt-br/noticias-socioambientais/desmatamento-na-amazonia-explode-entre-2015-e-2016

During the time period from 2000-2015, only 11,313 km2 of gross deforestation occurred in Indigenous Territories, which equaled a loss of 1.2% of their forest cover over the time period. For PNA and the same time period, there was slightly more at 13,757 km2, which means a loss of 1.7%. The rate for land outside of Indigenous Territories and Protected Natural Areas equaled 159,031 km2 and a loss of 11.5% of the forest cover over the time period. Interestingly in the case of Brazil and similar to what is found in the region, while 55% of forest cover in 2000 was found in Indigenous Territories and PNA, only 14% of total deforestation came from those forests. Thus, 86% - the vast majority – occurred in forests outside of Indigenous Territories and PNA even though it contains only 45% of the forest cover.

Table 2. Deforestation by category in the period 2000-2015 for the Brazilian Amazon (RAISG limit).

Category	Forest area 2000 (km2)	Deforestation by period (km2)			Total deforestation 2000-2015	Percent (%) deforestation of the 2000 forest
		2000-2005	2005-2010	2010-2015		
Brazilian Amazon total	3,088,505	94,989	58,767	29,627	183,383	5.94
Outside IT and PNA	**1,380,355**	**84,827**	**50,523**	**23,681**	**159,031**	**11.52**
Indigenous Territories legally recognized*	**952,984**	**4,642**	**4,036**	**2,635**	**11,313**	**1.19**
Protected Natural Areas	**802,256**	**5,908**	**4,420**	**3,429**	**13,757**	**1.71**

*Although there are unfinished IT legalization processes, due to the fact that the Federal Constitution recognizes them independent of the completion of the administrative process, our analysis considers all Brazilian IT as legally recognized. In addition, RAISG estimates that there are another 200 IT requests that have not started the legalization process in Brazil. (Source RAISG, 201: https://www.amazoniasocioambiental.org/wp-content/uploads/2017/04/cartografia_historica_ANP_TI_06abril.pdf)

Colombia

Deforestation in the Colombian Amazon during the 2000-15 period continued its dynamics in the Andean foothills of the Amazon, due to the expansion of the agricultural frontier and, in some areas, illicit coca cultivation. The increase in population due to mining activities in the north and east of the Amazon, also contributed to the increase in deforestation due to the demand for wood and agricultural products. In general, deforestation declined in the forests located in the Indigenous Territories during the period, while external deforestation doubled in the middle period of 2005-10, but returned to the original levels in the last period.

In the period 2000-2015, the Indigenous Territories and Protected Natural Areas of Colombia experienced a percentage loss of their forest cover of 1.37% (0.83% in IT) compared to 7.38% outside their territories and of the ANP. That means in Colombia that percentage of forest loss was an astonishing 537% greater outside of Indigenous Territories. Fortunately for Colombia, almost 75% of Amazonian forests are found in IT and PNA and

only 34% of Amazonian deforestation occurred in them. That means that the other 66% of deforestation occurred in forests outside of IT and ANP.

Within the framework of the first peace agreement with a guerrilla group in Colombia, there is a greater need for land for the demobilized and easier access to areas previously restricted by the armed conflict, which can translate into greater pressure to convert the Amazonian forests. With most of them in IT and PNA, additional monitoring is necessary to ensure that any early signs of increased deforestation can be addressed promptly.

Table 3. Deforestation by category in the period 2000-2015 for the Colombian Amazon (RAISG limit).

Category	Forest area 2000 (km2)	Deforestation by period (km2)			Total deforestation 2000-2015	Percent (%) deforestation of the 2000 forest
		2000-2005	2005-2010	2010-2015		
Colombian Amazon total	423,994	3,445	6,092	3,360	12,896	3.04
Outside IT and PNA	**111,698**	**1,935**	**4,281**	**2,025**	**8,242**	**7.38**
Indigenous Territories legally recognized	**246,735**	**779**	**770**	**491**	**2,040**	**0.83**
Protected Natural Areas	**97,145**	**802**	**1,114**	**765**	**2,681**	**2.76**

Ecuador

The trend in deforestation in Indigenous Territories in Ecuador is downward over the 2000-2015 period. Total area of deforestation between the 2000-2005 period and 2010-2015 period decreased by 26%. The trend overall in Amazonian deforestation in Ecuador was basically static with a bump in the middle period that was not replicated in Indigenous Territories' forests.

Compared to the amount of area deforested in the Ecuadorian Amazon over the examined period (3.56%), the rate in Indigenous Territories and PNA (2.18%) was 39% lower. Even more significant was the difference with area deforested outside of Indigenous Territories and PNA (9.84%), which was a rate of forest loss 451% greater than what was lost in Indigenous Territories and PNA.

Table 4. Deforestation by category in the period 2000-2015 for the Ecuadorian Amazon (RAISG limit).

Category	Forest area 2000 (km2)	Deforestation by period (km2)			Total deforestation 2000-2015	Percent (%) deforestation of the 2000 forest
		2000-2005	2005-2010	2010-2015		
Ecuadorian Amazon total	87,053	1,054	1,090	957	3,101	3.56
Outside IT and PNA	**14,968**	**476**	**540**	**457**	**1,473**	**9.84**
Indigenous Territories	**58,394**	**482**	**427**	**356**	**1,266**	**2.17**
IT without legal recognition	1,153	5	15	16	37	3.18
IT legally recognized	55,978	457	410	339	1,206	2.15
Exclusion zone (Zona Intangible)	1,262	20	2	1	23	1.85
Protected Natural Areas	**29,286**	**240**	**206**	**199**	**645**	**2.20**

Peru

In the case of Peru, the amount of deforestation in Indigenous Territories trended downward as there was less forest loss in the 2010-2015 period than the starting period of 2000-2005. During the middle period of 2005-2010, deforestation rose in the Peruvian Amazon overall and in Indigenous Territories at the same rate. In the case of IT, the increase occurred in two categories: Riparian Peasant Communities, which are accounted for between recognized IT and Proposed Indigenous Reserve (comparable to unrecognized IT), with an increase of 61% and 100% respectively. Similar to a trend at the regional level, an increasing rate of deforestation in Indigenous Territories without recognition is observed.

The rate of forest loss in Indigenous Territories (1.96%) was only 29% less than the overall rate for the entire Peruvian Amazon (2.76%). It should be taken into account that in Peru IT represent almost 1,400 communities, many

of them with small territories, so the percentage of deforestation relative to its own area yields higher levels compared to regional data. Still, the difference in rates between Indigenous Territories and PNA (1.32%) and outside of Indigenous Territories and PNA (4.41%) was 335% - more than triple.

Table 5. Deforestation by category in the period 2000-2015 for the Peruvian Amazon (RAISG limit).

Category	Forest area 2000 (km2)	Deforestation by period (km2)			Total deforestation 2000-2015	Percent (%) deforestation of the 2000 forest
		2000-2005	2005-2010	2010-2015		
Peruvian Amazon total	705,882	6,919	7,371	5,167	19,458	2.76
Outside IT and PNA	**341,665**	**5,203**	**5,255**	**4,595**	**15,053**	**4.41**
Indigenous Territories	**211,127**	**1,439**	**1,538**	**1,153**	**4,130**	**1.96**
IT without legal recognition	10,917	44	41	62	147	1.35
Proposed indigenous reserve	40,910	16	32	28	76	0.18
Reserved territory	29,108	27	34	11	71	0.25
IT legally recognized	130,192	1,353	1,432	1,051	3,835	2.95
Protected Natural Areas	**184,886**	**264**	**618**	**205**	**1,087**	**0.59**

Biomass and Indigenous Territories Analysis

While it is important that Indigenous Territories were barriers to deforestation, it is concerning that a significant amount of the forest inside them are under significant pressures and threats. It is considered that there are pressures if there is already intervention in the territory and threats if there are projects that will be implemented in the future. Our analysis examined the above ground biomass – i.e. forest carbon stocks – located in Indigenous Territories (IT) and Protected Natural Areas (PNA) and existing pressures and threats from various activities, an analysis similar to that published in 2014 by the same consortium (Walker et al. 2014)[5]. In this case, the analysis uses new forest carbon stock data from 2014 provided by Baccini et al. (2017)[6] to quantify carbon storage within Indigenous Territories and Protected Natural Areas (RAISG 2016)[7]. The results reveal that 53% of the Basin's forest carbon is stored within Indigenous Territories and Protected Natural Areas and that 12% of the total Amazon carbon stocks, which are also inside IT and PNA, are under significant pressure and threat.

5 W. Walker, A. Baccini, S. Schwartzman, S. Ríos, M. Oliveira-Miranda, C. Augusto, M. Romero Ruiz, C. Soria Arrasco, B. Ricardo, R. Smith, C. Meyer C., J. Jintiach, E. Vasquez Campos 'Forest carbon in Amazonia: the unrecognized contribution of indigenous territories and protected natural areas'. Journal Carbon Management Volume 5, 2014 - Issue 5-6. http://www.tandfonline.com/doi/full/10.1080/17583004.2014.990680

6 A. Baccini1,*, W. Walker1, L. Carvalho2, M. Farina1, D. Sulla-Menashe3, R. A. 'Tropical forests are a net carbon source based on aboveground measurements of gain and loss' Houghton1, Science, 2017. http://science.sciencemag.org/content/358/6360/230

7 Data published by RAISG: https://www.amazoniasocioambiental.org/wp-content/uploads/2017/04/AMAZONIA2016_english_18maio.pdfA

The pressures and threats to these areas consist of mining and fossil fuel concessions, roads which drive agriculture expansion, and fires recorded during the period, also, announced large infrastructure projects such as new roads. While these pressures and threats are not necessarily new, they are always there and represent significant higher probability of further deforestation and degradation to be realized.

If that 12% biomass stored in IT and PNA was to be lost, it would equate to nearly 80 Gigatons of CO2 emissions – more than twice the global emissions in 2015.

Trying to calculate the risk against the Amazon Basin countries' Nationally Determined Contributions is difficult because of the use of different methodologies to create them. However, one could do a simple comparison

to Brazil's NDC goal of reducing emissions by 1.3 Gigatons CO2 in 2025 and note the real threat to it meeting its goal if the amount of forest carbon stocks in Indigenous Territories face those levels of pressures and threats.

Table 6. Total carbon, total carbon under pressure, total carbon under threat, and the sum of carbon under pressure and threat (i.e. total carbon at risk) (millions of metric tons) by category for the Amazon (RAISG limit). Percentage values reflect the percentage of carbon in each category relative to the total carbon in the Amazon basin.

Category	Total Carbon in 2014 (millions of metric tons)	Carbon Under Pressure	Carbon Under Threat	Total Carbon at Risk
PNA	13,571	3,215	506	**3,721**
%	20.03	4.75	0.75	**5.49**
IT	18,195	5,778	1,282	**7,061**
%	26.86	8.53	1.89	**10.42**
PNA/IT Overlap	3,968	828	88	**916**
%	5.86	1.22	0.13	**1.35**
Outside PNA/IT	32,007	18,219	4,241	**22,460**
%	47.25	26.89	6.26	**33.16**
Amazon Total	67,741	28,040	6,118	**34,158**
%	100	41.39	9.03	**50.42**

Political Concerns and Relevance

It is readily apparent from the scientific analysis presented that the forests located in Indigenous Peoples territories are not only important mitigating climate change by storing significant amounts of carbon, but also demonstrate significant lower rates of deforestation. At the same time, one must also recognize the value of the forests located in Indigenous Territories for the multiple other environmental services they provide, such as the regulation of the hydrological cycle and the climate. Their cultural and livelihood values are even of more importance to Indigenous Peoples. All of those benefits are lost when deforestation occurs – not only affecting the Indigenous Peoples, but humanity in general – and existing policy at multiple levels is not facilitating their conservation and rather, facilitating their destruction in many places.

One example of a recent positive policy action taken by a country is in Colombia where it recently approved the formal recognition of indigenous territories with significant forest assets in the Amazon[8]. Additionally, the Peruvian government set an example of including Indigenous Peoples in forest conservation policy making by including components of their Indigenous Amazonian REDD+ proposal into its National REDD+ Strategy document that is to be submitted to the UNFCCC[9].

8 Article on the recent expansion of indigenous reserves in Colombia: https://news.mongabay.com/2017/07/colombia-expands-indigenous-reserves-near-key-deforestation-hotspot/

9 The National REDD Strategy of Peru: http://www.gruporeddperu.com/estrategia-nacional/

Unfortunately, not all countries are moving in the right direction. In Bolivia, the government is once again moving to building a road through the Tipnis reservation without securing the consent of the Indigenous Peoples living there[10]. Additionally, the government of Brazil recently made it harder for Indigenous Peoples with existing claims for their traditional lands to receive formal recognition to them[11].

The Coordinating Body of the Indigenous Organizations of the Amazon Basin (COICA) and its base organizations that represent the Amazonian regions in the 9 Amazon basin countries advocate the following policy changes to ensure their ability to continue conserving the forests in their territories:

1. Titling of unsecured lands:

Recognition of the rights of indigenous peoples and forest communities to land tenure has widely been proved to be a viable strategy for mitigating climate change. Nevertheless, progress on the recognition of these rights worldwide has slowed recently, and in some cases such as Brazil, being walked back. A renewed focus on these efforts and resources to implement the titling are necessary.

10 Article on Tipnis: https://www.theguardian.com/environment/2017/aug/15/bolivia-approves-highway-in-amazon-biodiversity-hotspot-as-big-as-jamaica

11 Article on negative policy changes on indigenous and environmental issues in Brazil: http://blogs.edf.org/climatetalks/2017/08/21/temers-rollback-of-brazils-environmental-and-indigenous-protections-threatens-livelihoods-and-worlds-climate-goals/

2. Inclusion of Indigenous Peoples in the elaboration and implementation of Nationally Determined Contributions (NDCs):

At COP23, additional guidance to countries on what needs to be included in their NDCs will be approved. This guidance should not only include a requirement to discuss how Indigenous Peoples are being included in plans for implementing NDCs, but also require their active participation in the elaboration and development of the NDC of each of their countries. Such guidance for Indigenous Peoples “full and effective participation” would be consistent with existing UNFCCC guidance in the Cancun Safeguards for REDD+.

3. Direct Access to climate finance:

Despite significant efforts by indigenous peoples to defend and preserve their territories, they have yet to receive adequate recognition from climate financing mechanisms such as the Green Climate Fund. The majority of resources for forest conservation are passed through governments or civil society intermediaries, which result in less resources being available to those actually living in and protecting the forests. Therefore, more balanced and direct funding for indigenous peoples organizations and communities is paramount to provide the resources necessary to continue to conserve these important forests and therefore ensure climate change mitigation.

4. Implementation of free, prior, and informed consent:

This principle is fundamental to reaching working operational frameworks of governance supported by mutual consensus between local and external actors. Moreover, it is key to ensure that the considerable upfront investments in climate change initiatives are not lost due to the denial of consent by indigenous peoples.

5. Recognition of Amazonian Indigenous Peoples' traditional knowledge as a climate solution:

The platform for traditional knowledge from Indigenous Peoples and Local Communities needs to be approved at COP23. This platform will facilitate the collection and use in an appropriate manner the traditional knowledge of Indigenous Peoples that is of utmost importance when considering the challenges the world faces to adapt to and mitigate climate change.

Methodology

Deforestation analysis 2000 - 2015

First, a deforestation analysis for the period 2000-2013 was carried out according to a methodological program developed by the member institutions of RAISG. This protocol is based on the ImgTools software, created by the Institute of People and the Environment of the Amazon (IMAZON) , which allows the processing of Landsat 5, 7 and 8 satellite images. ImgTools is software written in programming language IDL (Interactive Data Language) spectral mixture, NDFI (Normalized Difference Fraction Index) and performs classifications using decision trees. Satellite images, with the lowest percentage possible of cloud coverage, are acquired through USGS (US Geological Survey) servers.

The year 2000 was defined as baseline and the years 2005, 2010 and 2013 as cut-off points for the analysis. Since there are not enough images of the necessary quality for the same year, for 2000, images were taken between June 1998 and July 2002; for 2005, images between June 2003 and July 2007 were considered, and for 2010, images between June 2008 and September 2011 were used. Finally, for 2013 images were considered between August 2012 and March 2014.

For the analysis of the period 2013-2015, the methodological protocol migrated to the Google Earth Engine (GEE) platform, a Google service that offers a large collection of Landsat satellite images at various levels of processing. The new protocol required an interface on the GEE platform for the development of the codes that made it as robust as for the construction of a large library of algorithms for processing satellite images. The updated methodological protocol allows to process all the images in a

cloud computing “Google Cloud Computer”, it also allows the use of several images of a single region to compose a temporal mosaic and reduce areas with the presence of clouds. The protocol included auxiliary layers such as elevation, incorporated to facilitate the differentiation of the deforested areas from the shadows generated by the relief.

For the calculation of deforestation in each period, August 1st was taken as a cut-off point, so that the annual rates consider forest losses that occur from August 1st of a year, i.e. 2000, until 31 July of the following year, in this case would be 2001. Thus, the defined periods go from August 1st 2000 to July 31 2005, from August 1st 2005 to July 31 2010, and August 1st 2010 to July 31 2013.

A 2015 deforestation map was created following the same procedures, and new deforestation occurred between August 1st 2013 and July 31 2015, was added to obtain a deforestation total for 2010 – 2015.

Threatened biomass analysis

The pressures and threats used in the analysis correspond to the collection of information that RAISG makes with the contribution of institutions in each country, obtaining information from the most appropriate sources in each case. The topics considered were roads, fires, mining, gas, and oil concessions, these being considered as pressures if there is already intervention in the territory and as threats if they correspond to projects to be implemented in the future. Given the period of the biomass data used for the analysis (2003-2014), the used pressure layer was defined up to 2014, while the threats were updated to 2016. In the case of roads, an area of influence (buffer) of 10 km was created on each side of the road axis.

The amount of biomass under pressure areas is calculated for all the areas where at least one of the mentioned pressures is present, obtaining a unique mask for all the Amazonian area analyzed. The same process was performed with threat areas, obtaining also a mask and amounts of biomass for the areas where at least one threat exist.

For the methodology used to calculate the above ground biomass, please see the recent Baccini et al.: **http://science.sciencemag.org/content/358/6360/230**.

Images and Pictures: Fundación EcoCiencia, Archivo de la COICA, Nicolás Kingman, Afuera Producciones, Belo Monte by Juliana Spinola, Juliana Splendore.