Colombia's Natural Capital

GROW Colombia Project Report 1

Socio-Economics of Biodiversity Programme

January 2020

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Colombia's Natural Capital / *Report 1*

The present report provides an extensive review of Colombia's Natural Capital and uses the Driver-Pressure-State-Impact-Response (DPSIR) framework to describe the interactions between society and the environment in Colombia. This review is important to highlight the key environmental, socio-economic and institutional features that can pose challenges to the future sustainable development of Colombia. A subsequent report 2 will concentrate on the policy responses investigated by the GROW Colombia team to promote a switch from current unsustainable agriculture and economic practices toward bio-economy strategies.

The report is organised as follows: the following section describes the problem-structuring DPSIR framework and its utility for understanding the causes of environmental change in Colombia. Prior to the definition of the DPSIR components, this document describes the geographical context of the country in terms of its topography, hydrology and climatic conditions (section 2). This is followed by section 3, which summarises the most important driving forces of environmental change and describes ways in which they apply *pressures* (section 3.4) on the country's natural environment. Afterwards, section 4 assesses the current *state* and trends of biodiversity, natural capital, and ecosystem services in Colombia. The final section (section 5) aims to present examples of relevant institutional, political and academic *responses* to fight back the environmental change and degradation in Colombia. This last section also presents a historical review of the use of payment for ecosystem services in the country as a legal instrument to counter the biodiversity loss and degradation of biodiversity and natural capital (section 5.2). Finally, section 5.3 of the document refers to other initiatives playing a vital role in the promotion of biodiversity conservation in Colombia.

Executive Summary

GROW Colombia is a four year bioscience research and capacity building project to preserve, restore and manage biodiversity through responsible innovation in Colombia. This multidisciplinary initiative is funded by the UK Government's Global Challenge Research Fund and involves a wide, international collaboration of academic and civil society partners united in a shared vision to conserve biodiversity, achieve sustainable prosperity and secure lasting peace in Colombia. The project has a strong socio-economic component involving the Earlham Institute, University of Sydney, Universidad de Los Andes and led by the University of East Anglia.

This report is the first in a series from GROW Colombia's socio-economic team. It contains a scoping exercise to understand the environmental challenges and opportunities that countries like Colombia face in the 21st-century. The future development of Colombia will be dependent on domestic policy decisions and the effects of international trade and global environmental governance.

The second report will look at future policy responses in more detail, for example, switching away from current agricultural regimes to more sustainable production systems for sugar cane and cocoa, and developing more ecotourism. A third report will present case studies of selected green policy switches, through projects seeking to change land use practices and promote new income and employment streams.

Colombia is the second most biodiverse (in terms of plants, animals and habitats) country on Earth. Its natural capital offers great opportunities for wealth creation and accelerated sustainable development, based on rising levels of employment and improved living standards. Colombia's biodiversity is a vast store of wealth, providing humanity with multiple benefits - known as ecosystem services - including food, shelter, livelihoods, cultural and other gains, together with the life support system itself.

In order to bring together the range of issues that surround Colombia's future development and to link together the factors likely to cause environmental changes to nature and human well-being, this report uses the "DPSIWR framework". The analysis is sequential and circular: it starts with the drivers and pressures (DP) causing the state of the environment to change (S), then examines the pressures of these changes on human well-being (IW), and completes the circle by including possible policy responses (R) to mitigate or adapt to the changing environment. Policy changes, when implemented, will have consequent effects on Colombia's environment and socio-economics.

Colombia has particular geographical and climate characteristics, which have also conditioned the prevailing governance processes relevant to environmental policy and management. A key role in these processes is played by SINA, which is a network of institutions that are at the forefront of environmental policy and strategy. To date, policy responses have included payments for ecosystem services schemes in which landowners are paid to conserve elements of biodiversity instead of expending or intensifying of the land uses, as well as other policy measures.

Although we recognise that contemporary environmental challenges faced by all countries demand urgent action, including consideration of social limits to growth, we advocate not a sharp macro policy switch, but an evolutionary transition towards a sustainable, low carbon bioeconomy, facilitated by a national "Green Growth" investment strategy. This approach will promote economic development, maintaining incomes and improving livelihoods, whilst conserving biodiversity resources for future generations.

Decision support systems for natural capital planning and management

1 Decision support systems for natural capital planning and management

Environmental change and consequent impacts on human welfare nationally and regionally, can be scoped and assessed using a natural capital approach encompassed within a so-called DPSIWR (Drivers-Pressures-State-Impact-Welfare-Response) framework. This is an indicator-based framework which brings together information (in a causal chain) covering changes in socio-economic systems (drivers and pressures) with consequential state changes and welfare impacts on humans. As illustrated in Figure 1 the loop is completed by policy responses and systems feedback.

The initial DPSIR framework was adopted by the European Environment Agency in 1995 (later expanded to DPSIWR) to link environmental issues and human actions, and has been modified and enhanced over succeeding years (Elliott et al., 2017). It provides a scoping framework to highlight the indicators needed to enable feedback to policy makers on pressures and drivers of environmental quality changes and resulting socio-economic impact of the choices currently made (policy responses), or to be made in the future.

In the water resource context, the DPSIWR assessment could take the following form: *drivers* such as population growth and food security concerns can stimulate agricultural change activities such as new fertiliser regimes and use rates, expansion of agricultural areas into previously natural / semi-natural areas, which lead to increased release of nutrients (Nitrogen and Phosphorus) into watercourses and loss of biodiverse wetlands and forested lands. The watercourses and their ecosystem services may also be impacted by the release of sewage after accidental leakages and stormwater overflows. The end result is a change in water quality, reducing the potential quality of drinking water, and biodiversity, recreation and amenity benefits with adverse welfare consequences. The water quality impacts and quantity flow problems may be further exacerbated by urban and infrastructure expansion with increased demand for water storage and supplies and accentuated rates of runoff. Policy makers can mitigate these pressures and impacts implementing a set of adequate policy instruments.

This report focuses on the drivers, pressures and impacts on Colombia's environment and economy. A subsequent report concentrates on policy responses within a green growth strategy.

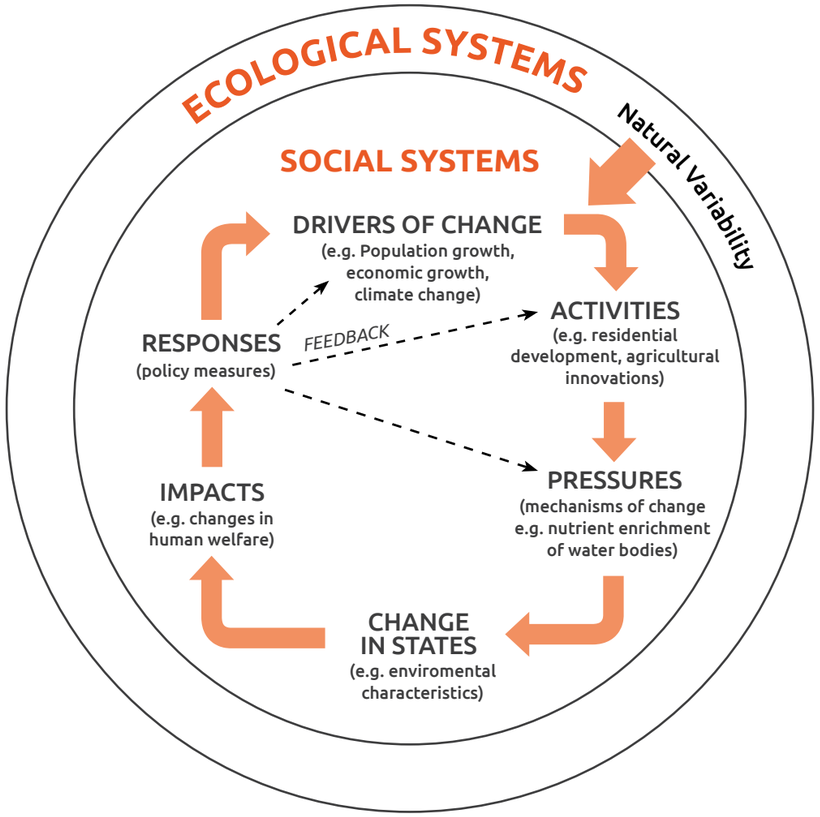


Figure 1. *Natural and ecological boundaries and the extended DPSRI framework*

Geographic context and climate

2 Geographic context and climate

Colombia is a Latin American country with an extensive coastline bordering both the Pacific Ocean and the Caribbean Sea. Colombia's landscape is very complex and diverse and has played an essential role in driving human settlements and economic activities.

Three mountains (the Cordillera Occidental, Oriental and Central) occupy the central south part of the country (see Figure 2). The northern part of the country (St. Marta) has the highest peak of the country, named Pico Cristobal Colon (5775 m). In the western part of the country, there are mountains (the Cordillera Occidental – top 4,670 m) which separate the ocean lowland region from the Cauca valley area. In this region, the Cauca River represents an important natural feature which sustains riparian agricultural areas. The central mountain range is the highest of the three branches of the Colombian Andes. The eastern mountain range is moderately high, and different from the other two, in that it contains several large basins. The Magdalena River is the main river in the country. It stretches from the Andean Cordilleras Central and Oriental in the south to the Caribbean Sea in the north.

In eastern Colombia, the land is flat (or gently rolling) and mostly covered by forests. Colombian lowlands represent almost 60 per cent of the country's total land area. The lowlands in the western part of the country are mostly swampy with the reed-filled marshes. In the east the Guajira Peninsula is semi-arid. To the north of Bogotá, there are two densely populated basins named Chiquinquirá and Boyacá which contain fertile fields, productive mines, and large industrial establishments that produce much of the country's national wealth. Northeast of the Magdalena river, there is the Santander Department, which is a spacious open valley, used for intensive agriculture. The southern side of the country

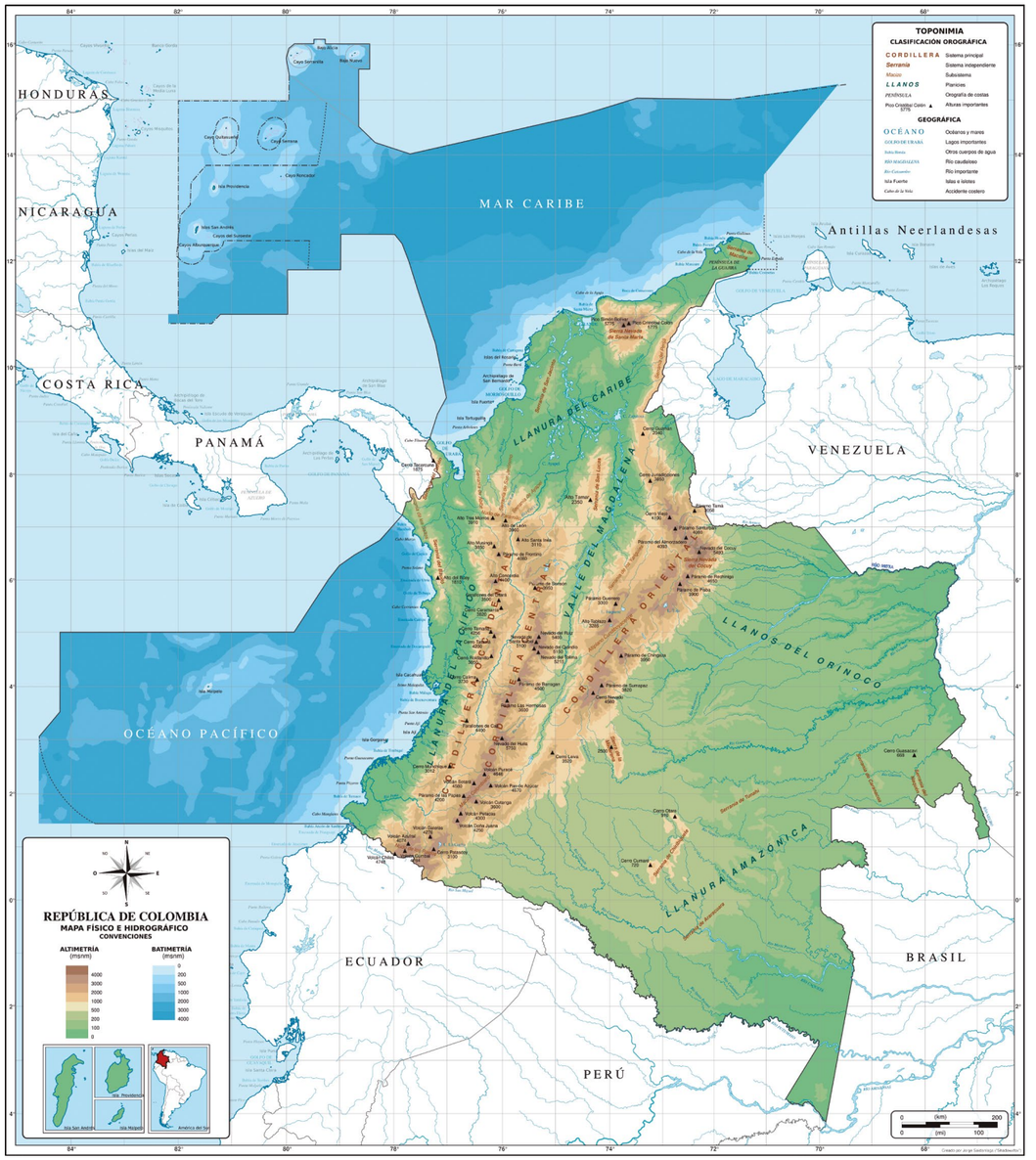


Figure 2. *Geographical map of Colombia* Source: Wikipedia. Available at https://commons.wikimedia.org/wiki/File:Mapa_de_Colombia_(relieve).svg

contains the Orinoco region, which mainly comprises flooding savannas which share the same ecological and environmental function as wetlands. This area has been extensively used for cattle ranching with severe impacts on their provision of Ecosystem Services (ES). Currently, market forces are trying to shift this land use towards palm oil plantation or rice production (Vargas et al. 2015).

The Caribbean lowlands region has the longest coastline in the country. The north of Colombia (region sharing a border with Panama) is covered by the Northern Paramo forest, whereas the southern part of the country contains the Amazonian forest that leads to other Latin American countries. The northeast region (around Cucuta) has well-established communication and transport routes with Venezuela. In the Caribbean Sea, the country has the peninsular archipelago of San Andres Island and the Insular Territories of Colombia. These areas are crucial for experimentation and research in different fields (e.g. genetics, medical treatments), as well as representing a strategic piece of land for military purposes.

Colombia is one of the wettest countries in the world, particularly in the Pacific region. Nonetheless, other regions can suffer from drought or extreme events. For example, Food and Agriculture Organization of the United Nations (FAO) reports that between the years 2015 and 2016 more than 87.000 hectares of land were affected by El Niño, which impacted the country's coffee, cotton and potato production (FAO, 2017). In the central and oriental zones average temperature is warmer (Figure 3), and at the higher elevations of this zone, the agriculture production systems benefit from two wet and two dry seasons each year.

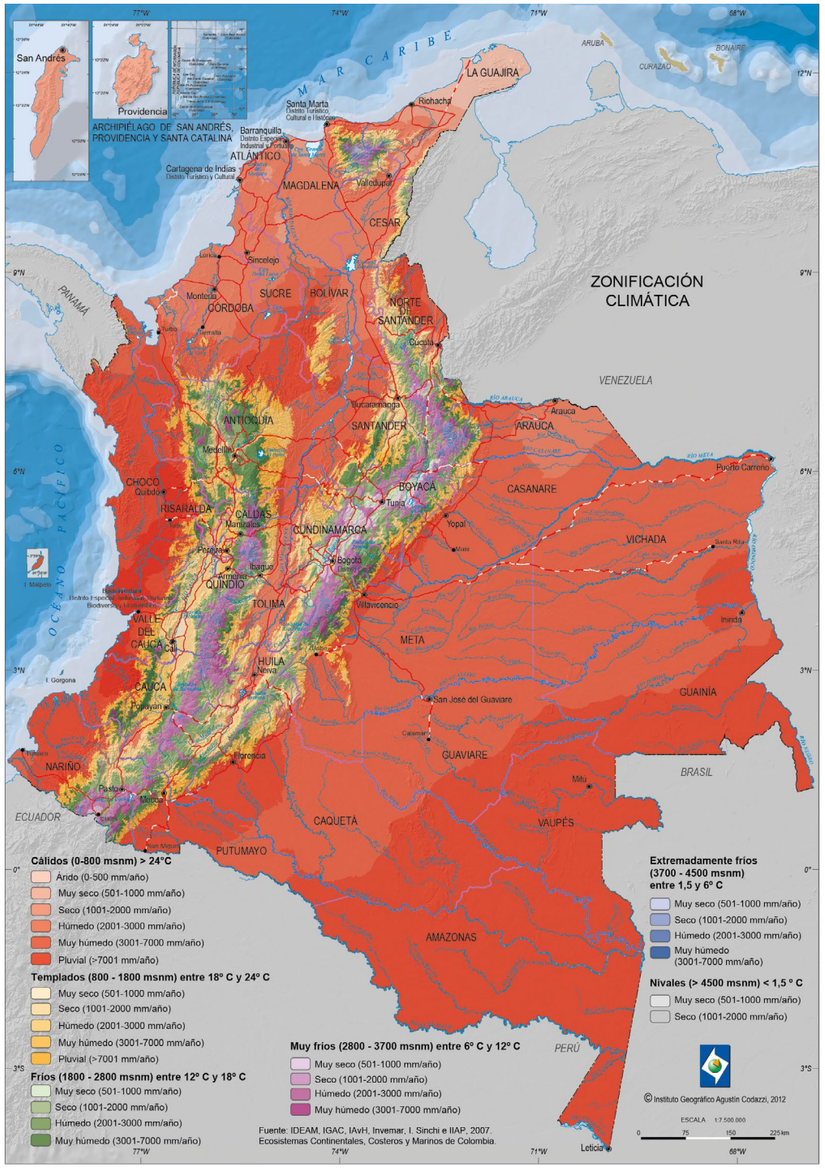


Figure 3.
Climatic zones
Source:
IDEAM,
IGAC, IAvH,
INVEMAR,
SINCHI (2008)

The sunset at Tarapoto lake. (Photo taken Jaime Erazo during the Amazon Expedition in August 2018)

Drivers and Pressures of environmental change

3 Drivers and Pressures of environmental change

The *drivers* of change in the D-P-S-I(W)-R framework, refer to individuals 'basic human needs' for shelter, food and water; as well as the need for mobility, entertainment and culture. *Drivers* of change can be immediate or longer term, and they usually lead to human activities (e.g. transportation, food production) which are developed to meet society's needs. As a result of the production or consumption processes, these economic activities exert *pressures* on the environment, such as the exploitation of environmental resources, accelerated changes in land use, and the rise in emissions of greenhouse gases, chemicals, waste, radiation, noise, to the air, water and soil. In other words, a *pressure* is a means by which at least one driver causes or contributes to the environmental state change.

In Colombia, for example, population change, economic growth, urban development, agricultural change, and climate change are all relevant drivers of environmental change that have caused significant environmental changes (pressures). These include biodiversity loss, deforestation, the overexploitation of fishery and mineral resources. Increasing the understanding of the most important drivers of ecosystems changes in Colombia, as well as the pressures and impacts they cause leading to natural capital and ecosystem services degradation, is vital to understand their effect on human wellbeing (Millennium Ecosystem Assessment, 2005). Similarly, it is relevant to develop policies that aim to safeguard the natural capital and to maintain the provision of ES in Colombia. Therefore, the following section presents some of the most important drivers of environmental change in the Colombian context:

3.1. Population growth and demography

The preliminary results of the National Census (DANE, 2018)[1] released in November 2018 indicate that Colombia has a population of 42.8 million, of whom 48.6% are male, and 51.4% are female. In terms of education, DANE (2018) reported that La Guajira, Sucre, Córdoba, Vichada and Chocó are the departments with the lowest literacy rates in the country (between 83% and 90%).

Colombia's demography is changing. The country is currently going through the final phase of a demographic transition in which the number of young people is reducing, and that of the elderly is increasing. From 1985 to 1990, the birth rate (number of births per 100,000 inhabitants of childbearing age) was 28.8 births. However, the national birth rate projected for the years 2015 to 2020 was only 18 (Vargas, 2017). The life expectancy in Colombia has changed significantly. It has increased from 62.3 years in 1974 to 76.1 years at present (Vargas, 2017). The place of residence of the population in Colombia has also changed drastically in the last century. In 1938, 70% of the inhabitants were located in rural areas, while 30% lived in the cities. However, by the 2005 census, 74% were located in urban areas, in contrast to 26% of people living in rural areas (Vargas, 2017). The most recent statistics developed by DANE (2018) indicate that from the total number of

[1] The preliminary results include a geographical coverage of 99.8% of the territory.

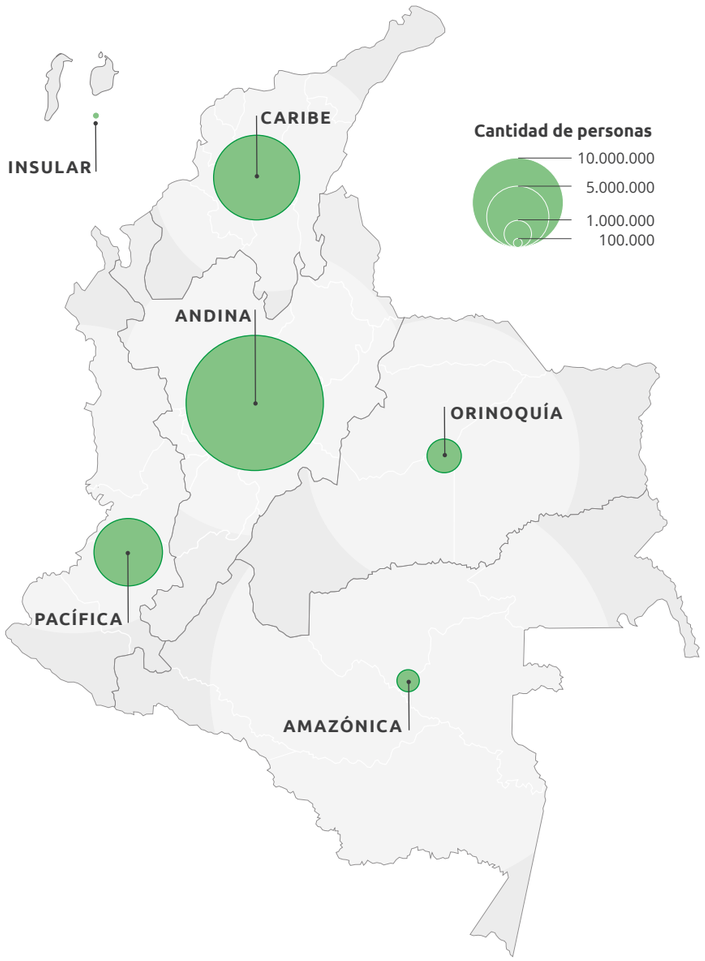
Canoes and port facilities in front of the main Cathedral in Quibdó (Photo taken by Jaime Erazo during the Cocoa Chocó Expedition in March 2019)

censed households, 78.4% reside in the municipal capitals, 15.0% were found in dispersed rural areas and 6.6% in populated centres.

Despite the dynamic of rapid modern urbanisation, regionalism and local identification continue to be an important reference point for classifying cultural differences among Colombians. In the countryside, the urbanisation phenomenon has led to a drastic fall in the size of the population which means that several agricultural activities (e.g. coffee growing) are left short of workers during the harvest season. It has been estimated that in the period 2005 and 2014, the number of inhabitants in the dispersed rural communities (areas dedicated to agriculture and livestock) fell from 7 million inhabitants to 5.1 million (Vargas, 2017).

Currently, Colombia has five cities with more than one million inhabitants: Bogotá (7,150,000 inhabitants), Medellin (2.4 million),

Figure 4.
Population by geographic region
Source:
DANE (2018)



"Chiva" (Photo taken by Jaime Erazo during the ex-combatants workshop in July 2019)

Cali (1.9 million), Barranquilla and Cartagena (Vargas, 2017). The Andean region of Colombia has the largest concentration of the population (Figure 4) (DANE, 2018). The majority of Colombians live in or around Bogota, or in the mountainous western portion of the country, as well as in the northern coastline. The southern and eastern regions of the country contain sparsely inhabited tropical rainforest and inland tropical plains containing large livestock farms, oil and gas production land, small farming communities and indigenous tribes.

The highest proportions of people under 15 years old are concentrated in Vichada, La Guajira, Vaupés, Guainía, Amazonas and Chocó. The highest concentration of population in the productive age range (15 to 64) is located in the centre and southwest of the country. Finally, part of the Andean region, Valle and Nariño have the highest population proportions of people aged 65 and above (DANE, 2018). Regarding the household size, the north and east of the country have larger households (more than three people), whereas in the centre and south-west households have predominantly less than three people (DANE, 2018).

Colombia, together with Brazil, Peru and Mexico, is a country that possesses an important cultural heritage related to the indigenous population (Arango and Sánchez, 2004). By 2005, the national census estimated the indigenous population at 1,378,884 people, which represents 3.3% of the total national population (MADS and PNUD, 2014). Indigenous people reside in the tropical forest and the natural savannas of the Amazon and the Orinoquia, the mountain ranges of the Baudo (Pacific); the peninsula of La Guajira; the northwest of the department of Cauca and the Sierra Nevada de Santa Marta. In the other regions of the country, the indigenous people live in small

Colombia poses a rich and diverse cultural asset including indigenous communities who still occupy natural areas

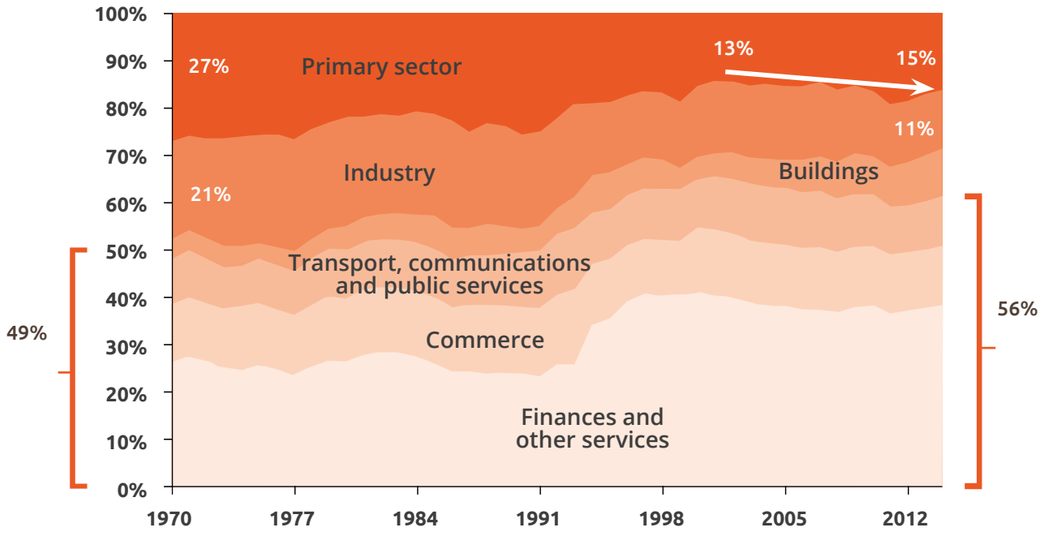


Figure 5.
Colombia's PIB evolution
Source: Pérez-Rincón (2016)

There are more than 83 indigenous tribes who speak approximately 68 languages and 292 dialects in Colombia (MADS and PNUD, 2014).

3.2. Economic growth

Colombia's primary industries are textiles, chemical products, metallurgy, cement, cardboard containers, plastic resins and beverages. The services sector in the country has become increasingly important (Figure 5), currently representing 60.3% of the GDP and employing 69.9% of the workforce (Nordea Trade Portal, 2018). The trade routes in the country go through Cartagena, Barranquilla, Santa Marta, and the other ports located along the Carribean communities or in areas where the *mestizo*[2] population predominates.

The Airport in Bogota city has the largest cargo volume in Latin America and registers the highest number of tourists (per year) in the country. A project to build a second airport in Bogota city is also being discussed. Bogota is the principal economic, trade and industrial centre of Colombia. In 2016, Bogota attracted the attention of the World Cities Study Group and Network (GaWC) who defined it as an important world city that links major economic regions into the world economy (called Alpha-cities). Bogota is a modern city with an extensive and comprehensive network of bike paths. Colombia has other "green projects". For instance, it has increased its biofuel blend mandate to 10 per cent for most of the country (Conlon and Gomez, 2018). This policy has coast. Inland from these cities, there are swamps, small streams, and shallow lakes that support banana and cotton plantations.

[2] Mixed race individuals, having Spanish and indigenous descent.

increased the demand for palm oil plantations in different areas of the country (Colombia is already a leading producer). Thus the association of palm oil producers has suggested raising its production to a level which will require 743,000 ha of land by the year 2020[3].

The city of Cartagena is the main seaport in the country with important petrochemical and tourism activities. Santa Marta is a smaller seaport and tourist city in the country. Barranquilla city (located 25 miles from the Caribbean coastline) is a more developed city with a greater number of industries and commercial places (e.g. metalwork and construction). Barranquilla's inhabitants have the highest education level in the region, and the city is well-known as the starting point of the country's development (phones, public lighting, air mail, planes and industrial works).

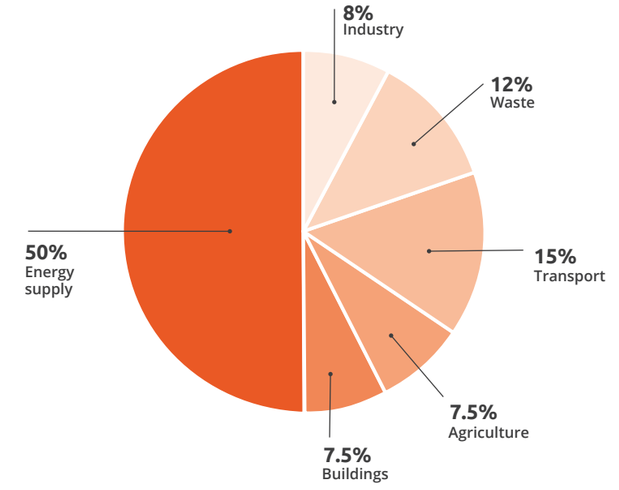
3.3. Climate change

Climate change is one of the most significant challenges humanity is currently facing. During the last two decades, Colombia has experienced a rise in greenhouse gas (GHG) emissions. The highest contributors to GHG emissions in the country are the agriculture, silviculture and other related land uses. The energy sector (i.e. transportation sector and energy generation) also has a significant contribution to the national GHG emissions (Pardo Martínez and Alfonso Pina, 2018).

[3] The area of land used for palm oil in 2011 was 427,000 ha.

The population of Colombia is at high risk from climate change impacts since the main settlements have been established in coastal zones which are prone to flooding, as well as in unstable lands in the elevated Andes where there is a propensity to water shortages (PNUD Colombia, 2010). Moreover, Colombia has a high incidence of extreme natural disasters that might become more recurrent with changing climatic conditions (Pardo Martínez and Alfonso Pina, 2018). Nonetheless, the government has developed a Low Carbon Development Strategy, which aims to i) identify and assess low-carbon alternatives and opportunities; ii) design of low-carbon plans, policies and measures; as well as design and construction of a measurement, reporting and verification system (UNDP, 2019). To the date, the country has formulated 12 Nationally Appropriate Mitigation Actions (NAMAs) of which 50% are developed in the energy supply sector, 15% in the transport sector and 7.5% in the agriculture industry (see Figure 6).

Figure 6.
Sectoral distribution of Colombia's NAMAS
Source: NAMA Database (2019)

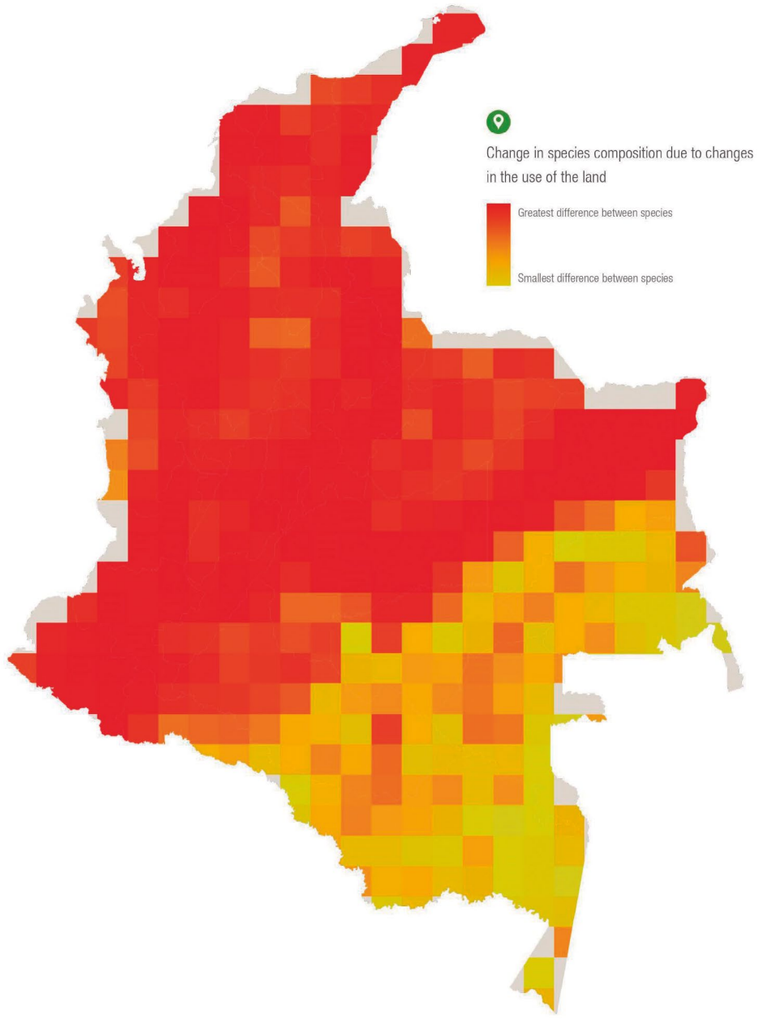


3.4. Biodiversity threats

Areas where primary vegetation has been replaced by homogenous vegetation covers such as crops and grasslands (see the yellow areas in Figure 7 which represent the agricultural land) have experienced significant loss of biodiversity. Red areas suggest a reduction in species composition, due to reductions in the number of species or replacement by invasive species. The environmental transitions shown in this figure caused an 18% change in species composition over the whole country, but mainly, in areas where anthropic presence is more extensive such as the Andean region.

The most critical economic pressures to biodiversity in Colombia relates to the unplanned and uncontrolled development of infrastructure, the mining industry (8.5 million ha in 2010), hydrocarbon extraction (oil production increased by a third and natural gas production by 70%), livestock farming (35% of the Colombian territory), the agricultural industry, and logging (WWF-Colombia, 2017).

Figure 7.
Change in species composition due to changes in the use of land
Source: Moreno et al. (2016)



According to MADS and PNUD (2014) the activities identified as drivers of biodiversity loss are: a) the agroindustry expansion, which generates homogenous landscapes dominated by monocultures; b) the expansion of mining areas which occupied 35% of the Colombian territory (40 million hectares between solicitations, granted and strategic areas) in 2012, and generates land use conflicts as mining areas overlap with agricultural and forest conservation areas; c) hydropower generation, which changes hydrological regimes and affects species migration and influence wetlands and other flooding areas; d) urbanization, that might result in adverse environmental effects on surrounding rural areas; and e) overfishing that generates ecosystems' deterioration and overexploitation and has led to significant reductions on the total catches (e.g. the 2010 catch represented only 25% of the 83,000 tons estimated for the 1972 production).

Other threats affecting biodiversity loss identified by WWF-Colombia (2017) are:

a) Deforestation: responsible for most impacts on socio-ecological systems. The most deforested areas between 2005 and 2010 are the Andes and Amazons regions.
b) Expansion of the agricultural sector: between 2000 and 2011, the total harvest area reached 6.7 million hectares; and between 2005 and 2010 at least 55.7% of the transformation of the land cover area can be attributed to this driver.

Biodiversity is an important store of wealth and should be protected.

c) Livestock farming: 35% of the Colombian territory is being used for livestock farming, but only 50% of this area is suitable for herding. Extensive livestock farming is a crucial factor leading to deforestation and land degradation outside natural savannahs, where 54% (1.18 million hectares) of plant cover in wetlands is affected by this driver.
d) Mining and energy production: mining titles had increased from 1 million in 2000 to 8.5 million in 2010. Coal production doubled between 2000 and 2011, turning the country into the first most significant producer of Latin America (11th worldwide). Around 90% of mining operations of precious metals in the Pacific Coast are illegal, and this activity

A Green Growth strategy can help to transition to a more sustainable low carbon economy

degrades 79,000 hectares. There are also mining titles that have been requested inside protected areas.

e) Wood and charcoal: illegal extraction is a significant threat to biodiversity since 40% to 50% of lumber is taken this way.

f) Wildlife trafficking: this driver is a cause of the decrease of local wildlife populations in Colombia (i.e. birds, mammals, reptiles, amphibians, fish). Between 1996 and 2010, Colombia was the second largest exporter of live reptiles (2.9 million) and reptile skins (9.6 million) in the world.

g) Introduction of exotic species: accidental or deliberate introduction of these species can generate changes in structure and composition of natural species, ecological imbalances, degradation and loss of ecological integrity and reduction of genetic diversity.

h) Water and soil pollution: in 2012, it is estimated that 205 tons of mercury spilt to soils and waters from 179 municipalities in 15 states. This pollutant is mainly used for gold (72%) and silver mining (27%).

i) Climate change: Colombia emits 0.4% of worlds total greenhouse gas emissions. However, large-scale changes are expected in the country and in particular in the Andes and the Caribbean region. In these regions, the weather is projected to shift from semi-humid to semiarid in the next century. Climate change can increase the number of threatened species in tropical mountains and cause extinctions (Moreno et al., 2016).

j) Armed conflict: Attacks against oil pipeline infrastructure have caused environmental damage. The armed groups have also deforested large areas to cultivate illegal crops and open unauthorised highways in protected areas. The signing of a peace treaty between the Colombian government and FARC presents an opportunity to manage natural resources more sustainably but also could lead to large-scale landscape transformation processes, since the armed conflict served as a barrier to the exploitation of natural resources in several rural and difficult to access areas characterised by high biodiversity (Earth Institute, 2018).

k) Water and soil pollution: Colombia is ranked the third country in the world in terms of pollution due to mercury emissions and the first country in the world in terms of mercury emission per capita.

Some of the drivers that generate changes over coastal and marine ecosystems, and associated ecosystem services are (INVEMAR, 2018):

a) **Inadequate use of fishing** resources: overfishing led to a decline in fishing yield of the Pacific and Caribbean coasts; also, it has caused reductions in fish abundance due to high levels of capture. There is also a decline in the income obtained from using several fishing techniques, and some of them are lower than the minimum salary;

b) Marine contaminants from terrestrial sources: the inadequate treatment of liquid and solid waste from the populations and socio-economic activities that take place both in coastal areas and in the interior of the country. In addition to this, there are environmental emergency events, such as spillage of crude oil intentionally or accidentally, with deficient contingency plans.

c) Low sanitation coverage: a situation affecting most municipalities in the Pacific coast and some of the Caribbean coast, where the is a lack of adequate management, treatment and final disposal of generated waste collected by the service provider. As a result, there is the accumulation of solid residuals on beaches, mangroves and coral reefs.

d) Discharge of pollutants by tributary rivers: tributaries that flow into the Colombian Caribbean and Pacific coasts bring with them pollutants produced by the socio-economic activities that develop along its basin (e.g. agriculture, livestock, mining, industry). The marine ecosystems receive organic matter, suspended solids, hydrocarbons, heavy metals, and other contaminants that deteriorate sea environmental quality.

Low sanitation condition in the river of Quibdó (Photo taken by Jaime Erazo during the CacaoBio Expedition in Chocó in March 2019)

e) An increase in some areas of potentially harmful microalgae: in previous years there have been reports on fish mortality increase from different microorganism like cyanobacteria, potentially toxic dinoflagellates and other potentially toxin producers' microalgae. It occurs in specific areas of bays, marshes and in particular months, but is increasing overall.

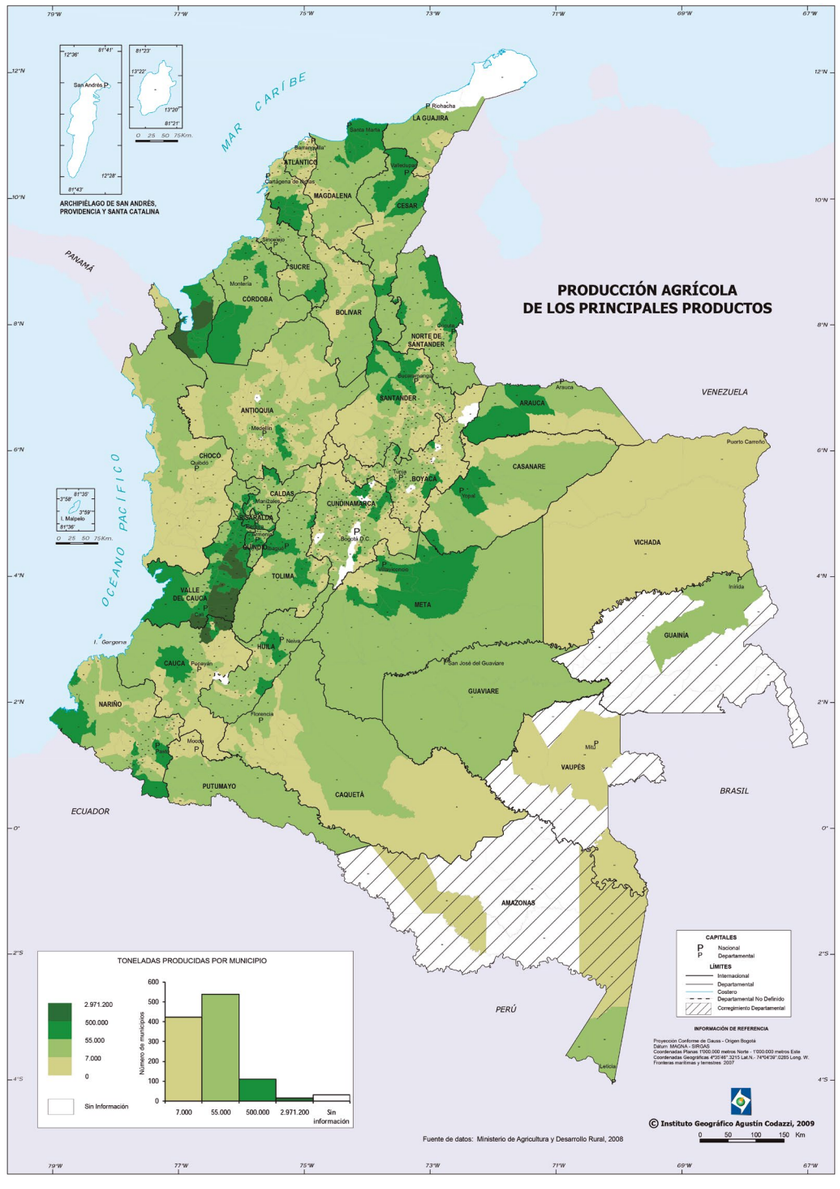


Figure 8. *Agricultural production of the main products* Source: SIG-OT (2008)

3.4.1. Agriculture expansion

Historically, agriculture has been one of the main engines of Colombian economic development. The agricultural economic activity contributes to 6% of the country's GDP and 5% of the value of exports (World Bank, 2015).

Due to the government's policy of subsidies and incentives, sugarcane crops for ethanol and African palm trees for biodiesel are increasing rapidly, transforming tropical forests or natural grasslands. During the years 2006 to 2010, the total agricultural production in Colombia increased by more than 2.5 million tons (Figure 8). The recent rate of transformation of tropical savannas into agricultural land in Colombia has been the highest in the history of the country (100,000 ha/year) (MADS and PNUD, 2014). Given this situation an in order to control the agricultural expansion, the government has defined the "agricultural frontier" which identifies the region where agriculture could be developed without compromising the biodiversity of the country (UPRA, 2018).

According to the results of the National Agricultural Census (DANE, 2016), the total harvested area in Colombia is 4,618,644 ha, generating a total agricultural production of 23,363,324 million tons. Agro-industrial crops are using the largest percentage of land (35.9% with 1,658,598 ha producing), followed by cereals (22.0% with 1,014,095 ha) and plantations forestry (17.9% with 827,582 ha). The type of crops using the smallest percentage of land (0.1%) were the aromatic, seasoning and medicinal plants. As for production, the total agricultural production in 2016 was 23,363,324 tons, of which 8,711,327 (37.3%) tons correspond to agro-industrial crops, 4,908,427 tons (21.0%) to tuber and plantain crops and 4,781,128 tons (20.5%) to cereal crops.

Within the agro-industrial crops, the largest area is occupied by coffee (42.9%) with 711,011 ha producing 830,723 tonnes and sugar cane (9.5%) with 156,960 ha producing 861,369 tonnes and cocoa (6.6%) with 110,795 ha producing 71,143 tonnes (DANE, 2016). Colombia has an average cocoa yield 0.5 (ton/ha.) of dry grains (DANE, 2014). The departments with the highest participation in the production of dry cocoa is Santander with 25.1%, followed by Nariño and

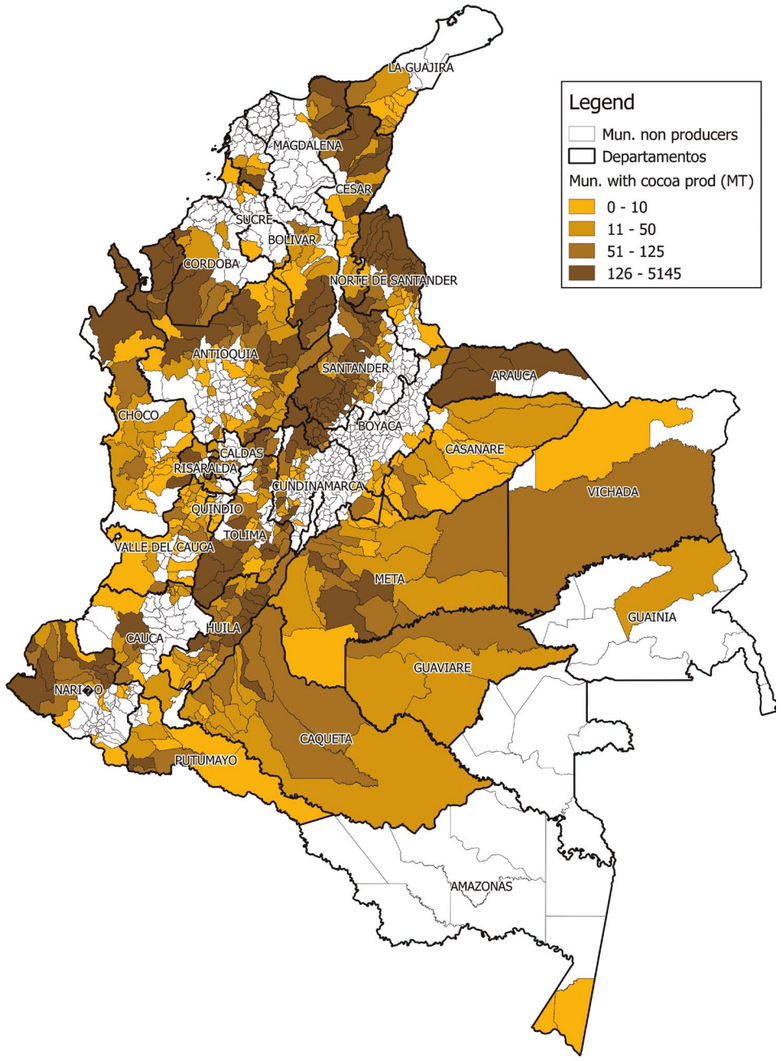


Figure 9. *Cacao production.* Source: UPRA (2016)

Table 1. *Number of APU and area for some agroindustry crops and plantain 2013* Source: Adapted from DANE (2018)

DOMAIN	No. APU - Total agroindustry	Planted area - Total agroindustry	No. APU - coffee	Planted area - coffee	No. APU - cocoa	Planted area - cocoa	No. APU - rubber	Planted area - rubber	No. APU - plantain	Planted area - plantain
Total National	860.147	3.006.466	385.871	902.424	88.567	199.549	8.413	42.108	319.155	915.987
Antioquia	71.622	294.126	44.523	132.448	5.049	15.517	1.049	6.801	33.840	134.022
Atlántico	344	1.000	0	0	0	0	0	0	292	397
Bogotá	0	0	0	0	0	0	0	0	0	0
Bolivar	9.893	51.203	818	1.219	1.959	4.067	42	258	7.249	18.481
Boyacá	28.734	81.527	6.871	9.511	2.014	3.199	15	14	4.298	4.718
Caldas	43.659	148.589	27.268	76.194	2.639	4.905	244	1.642	14.964	42.446
Caquetá	7.620	19.294	636	1.959	1.347	2.088	889	2.544	8.661	20.045
Cauca	133.437	235.888	71.983	98.321	3.946	4.918	66	88	37.754	45.972
Cesar	11.636	95.241	6.470	25.388	1.579	3.255	7	93	5.961	24.009
Cordobá	18.448	75.256	68	376	1.587	3.316	386	2.047	11.058	46.804
Cundinamarca	37.562	93.123	19.316	33.680	2.533	3.839	149	340	7.281	12.173
Chocó	17.452	37.099	184	500	3.841	5.847	131	184	26.188	31.966
Huila	87.436	233.774	54.070	136.853	5.433	13.591	5	1	13.454	23.511
La Guajira	5.266	11.869	2.121	5.538	699	981	0	0	3.321	6.314
Magdalena	8.573	64.045	4.183	16.917	559	1.199	3	15	5.677	19.079
Meta	11.313	264.936	1.157	2.536	1.901	6.260	537	12.133	9.604	90.078
Nariño	113.889	211.325	37.483	43.326	12.410	19.666	2.134	1.743	30.091	84.541
Norte de Santander	18.720	75.703	9.916	26.020	3.196	13.128	42	209	4.075	9.506
Quindío	4.931	26.766	3.481	20.908	43	156	0	0	5.065	25.139
Risaralda	18.290	65.666	12.510	48.356	3.463	4.059	10	17	3.651	10.119
Santander	81.396	273.324	26.677	46.177	15.605	46.767	1.456	6.809	6.866	18.691
Sucre	3.358	7.170	0	0	92	99	0	0	1.438	2.087
Tolima	58.019	164.659	37.983	109.843	6.719	15.415	178	365	28.104	95.516
Valle del Cauca	32.342	311.481	14.983	62.254	2.789	5.610	113	213	13.389	41.258
Arauca	4.352	17.880	0	0	3.383	13.730	11	2	4.275	13.694
Casanare	7.026	67.996	1.876	3.066	409	539	82	120	7.094	11.316
Putumayo	13.023	25.868	1.294	1.035	3.916	4.113	150	375	9.924	17.348
* SAC&SC	95	39	0	0	0	0	0	0	204	98
Amazonas	3.042	7.821	0	0	537	1.083	20	9	3.164	29.299
Guainía	1.984	12.039	0	0	89	349	14	22	1.444	9.510
Guaviare	1.935	3.093	0	0	487	453	367	792	3.759	4.596
Vaupés	2.135	1.780	0	0	92	22	5	2	2.597	3.308
Vichada	2.615	26.891	0	0	251	1.378	308	5.270	4.413	19.949

*San Andres, Providencia & Santa Catalina Archipielago

Arauca with 8.4% and 7.9% respectively (Figure 9) (DANE, 2014). Cocoa is considered to be a subsistence crop in Colombia which demands high labour inputs for its production. According to FEDECACAO farmers obtain about 75% of the household income from its commercialisation, and approximately 35,000 families in Colombia live from this activity.

By the year 2011, FEDECACAO had 15,885 cocoa producers registered in the country (SIC, 2011). Colombia had a total of 3 million hectares dedicated to agro-industrial crops, with a total of 860,000 agricultural production units (APU) associated. Then, agro-industry is occupying nearly 42% of total cropping area in the country and 9% of total agricultural and livestock production area.

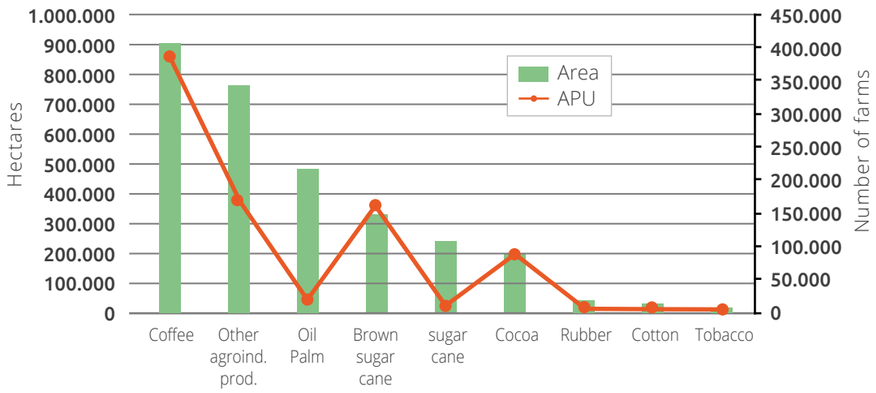


Figure 10.
Area and agricultural productive units by main agroindustry crops
Source: Adapted from DANE (2018)

In Figure 10 we can see that the main crop for agroindustry is coffee, with nearly 0.9 million hectares (30% of total agroindustry area) and 385,000 agricultural production units (45% of total agroindustry APU). Cocoa and rubber have a smaller share of agroindustry area: 10% (199,549 ha) and 1% (42,108 ha) for each crop. The mean size of the farms that produce coffee, cocoa and rubber are 2.34, 2.25 and 5.01 hectares.

Plantain is not included within the agroindustry crops. Plantain is grown for local consumption (nor for export) and occupied 915,000 hectares approximately, with nearly 319,000 APU.

Figure 11 shows the evolution of the planted area for coffee, plantain, cocoa and rubber for a the period 2007 and 2016.[4]

[4] Data used for historical evolution of crop's area is based on AGRONET, which reports information from the Ministry of Agriculture. Slightly differences exist between AGRONET and DANE's National Agricultural Census 2013-2014.

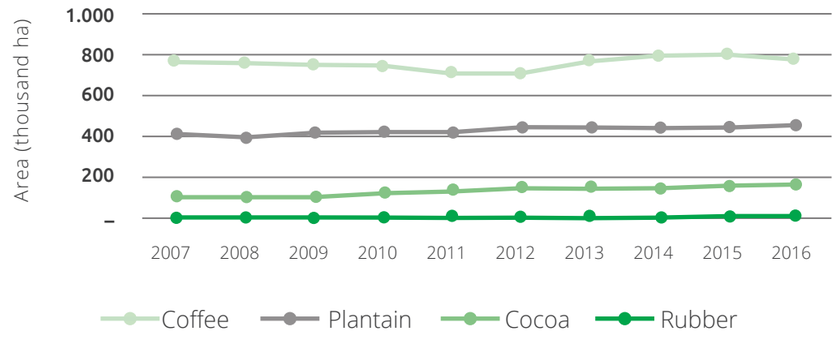


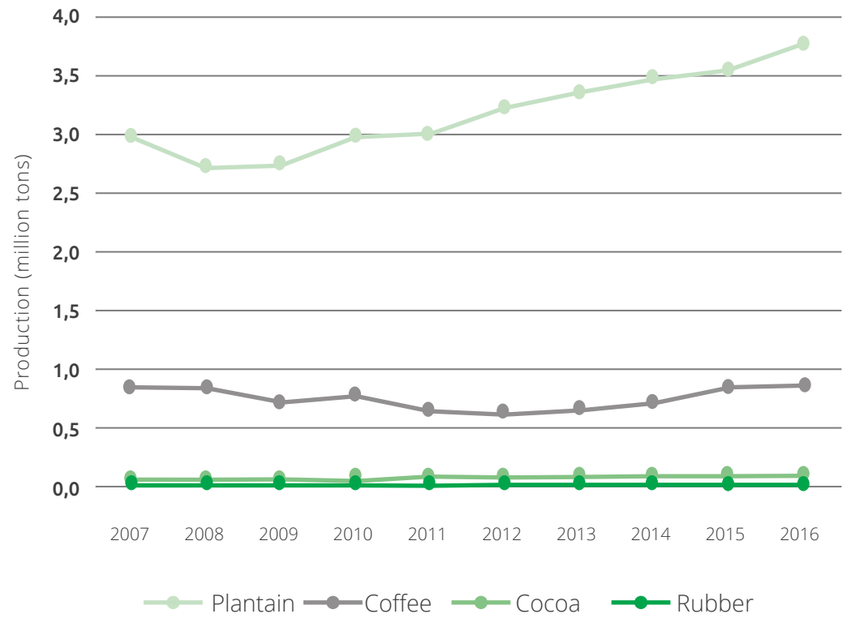
Figure 11.
Planted area for coffee, plantain, cocoa and rubber 2007-2016 (ha)
Source: MADR and AGRONET (2017)

In that ten-year period, the largest crop in the country was coffee, with nearly 766,000 hectares in 2007 and 777,000 hectares in 2016, with a mean annual growth of 0.2% (see Table A2 for details). In contrast, the rubber area showed the lowest planted area for the four crops, starting with nearly 3,000 hectares in 2007 and finishing with 18,432 hectares in 2016, with a mean annual growth of 24.3%. Plantain area showed a mean annual growth of 1.2% and the cocoa area had a mean annual growth of 5.4%.

Figure 12 shows that plantain had the most significant production from all analysed crops, reaching 3.7 million tons in 2016. Coffee had a production of 0.8 million tons for 2016 while, rubber and cocoa produced 87,000 and 23,000 tons each during 2016. This graph also shows that rubber presented the highest mean annual growth reaching 22.3% followed by cocoa with 4.8%. Plantain and coffee presented a lower mean annual growth for production: 2.7% and 0.3% respectively (see Table A3 for details).

Yield can be calculated as the relation between production and planted area. Yield for plantain, cocoa and rubber showed a decrease between 2007 and 2016. Yield mean annual growth for these crops was -0.9%, -0.6% and -1.6%. Coffee showed a positive mean annual growth of 2.5% (see Table A4 for details).

Figure 12.
Production for coffee, plantain, cocoa and rubber 2007-2016 (tons)
Source: MADR and AGRONET (2017)



3.4.2. Cattle ranching intensification

Livestock occupies 38% of the total area of the country (Figure 13), generates 3.5% of GDP and accounts for 7% of national employment and 28% of rural employment (MADS and PNUD, 2014). According to the National Agricultural Survey, there are more than 39 million hectares (35% of the territory) dedicated to the activity, although half of this area (53.8%) does not have the environmental characteristics which made it suitable for grazing.

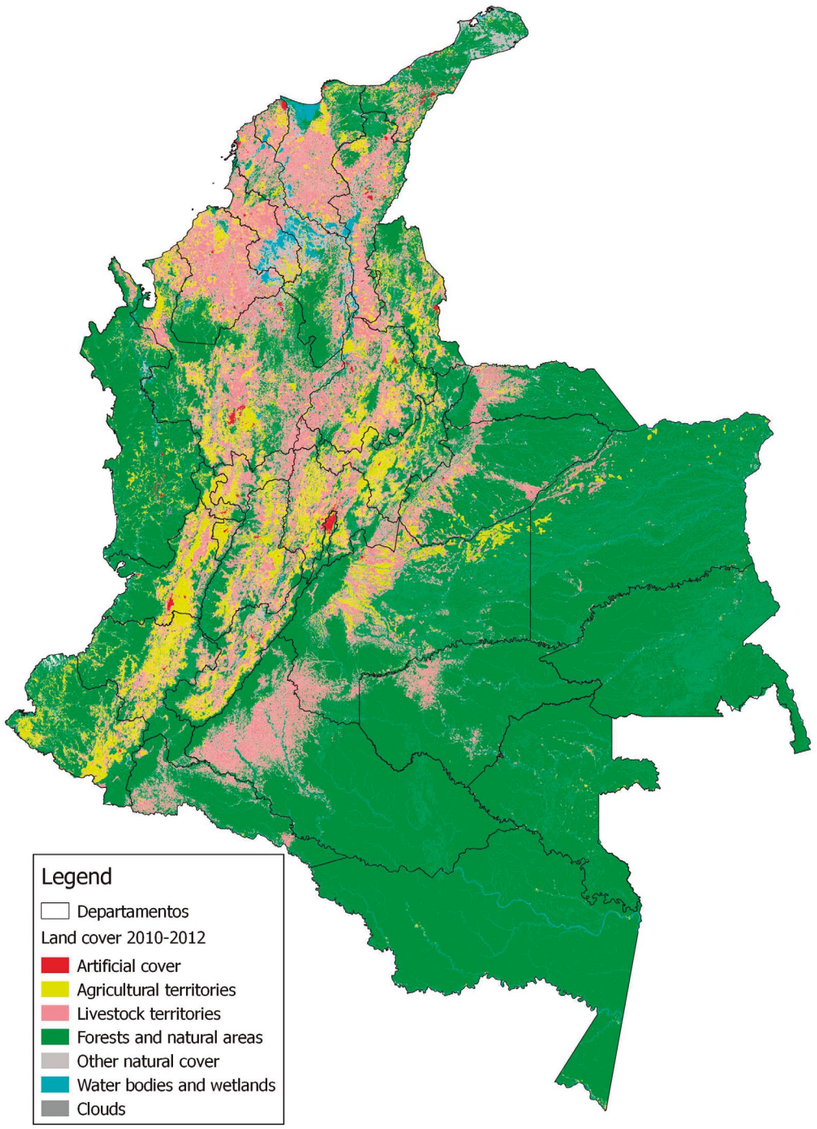


Figure 13. *Environmental Demand for Colombian Territory.* Source: adaptation from Colombia Corine Land Cover map 2010-2012 from IDEAM.

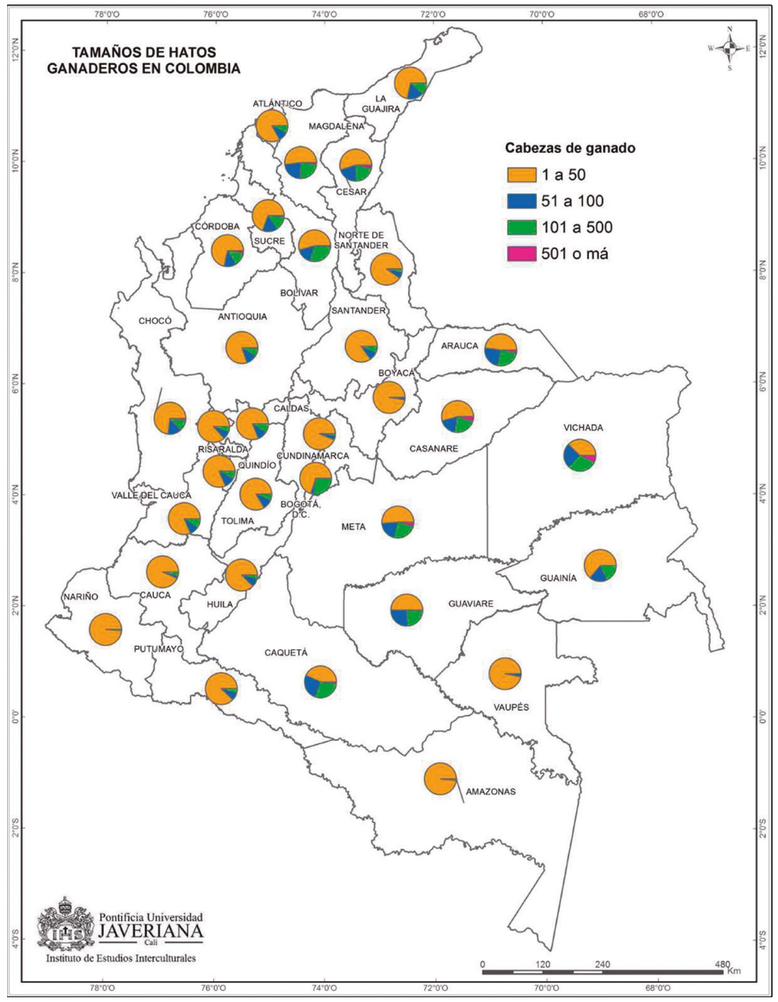


Figure 14. *Size of livestock herds in Colombia* Source: Pontificia Universidad Javeriana (n.d.)

There is approximately 23.5 million head of cattle in Colombia, and the number of cattle among regions is heterogeneous. However, the majority of the Colombian departments have at least 100 animals (see Figure 14). Extensive livestock farming is a determining factor in land degradation and deforestation and is considered to be the main engine of deforestation and loss of biodiversity in the country (Lerner et al., 2017). Livestock farming also contributes to the emission of greenhouse gases and water pollution (WWF-Colombia, 2017).

The rise of livestock farming activity has been at the expense of the tropical forest. Degraded pastures have replaced tropical forest. Livestock farming is the most important driver of land use change in wetlands since it affects 1.18 million hectares of permanent and temporary wetlands (WWF-Colombia, 2017).

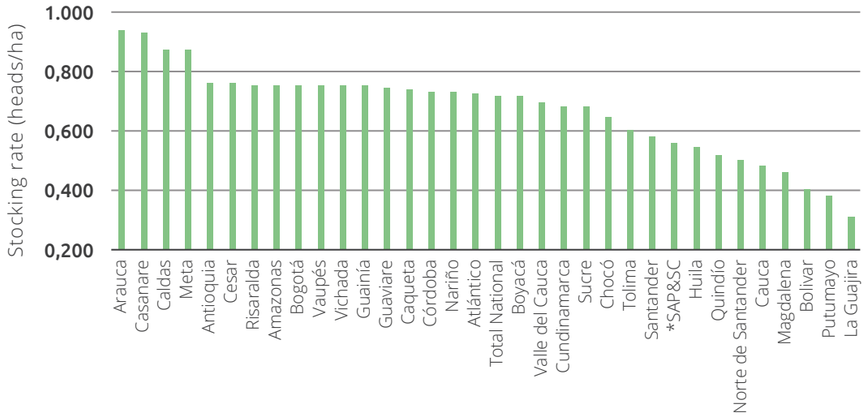


Figure 15. *Cattle ranching stocking rate (heads/ha)* Source: DANE (2018)

If we consider that cattle ranching activity can also be developed in resting areas, total cattle ranching area was 34.4 million hectares in 2013, including grasses (see Table 6 in the annex). The National Population Census (DANE, 2018) reported that 648,000 agricultural production units (APU) had nearly 21.4 million heads of cattle. That amount of cattle generated a national stocking rate of 0.72 heads/ha (see Figure 15).

Stocking rates in Arauca, Casanare, Caldas and Meta, were over 0.8 heads/ha, while Quindío, Norte de Santander, Cauca, Magdalena, Bolivar, Putumayo and La Guajira had a stocking rate below 0,52 heads/ha. That is, in those departments one head of cattle occupy more than 2 hectares for livestock production (see details of cattle ranching by department in Table A1).

Figure 16 shows that the largest cattle herds can be found in Antioquia, Córdoba, Casanare and Meta. That is, cattle ranching activities are developed in areas where there are low forest remnants like in the Andean area or the Caribbean coast but also has a presence in areas of agricultural frontier like Meta, Caquetá, Putumayo and Vichada.

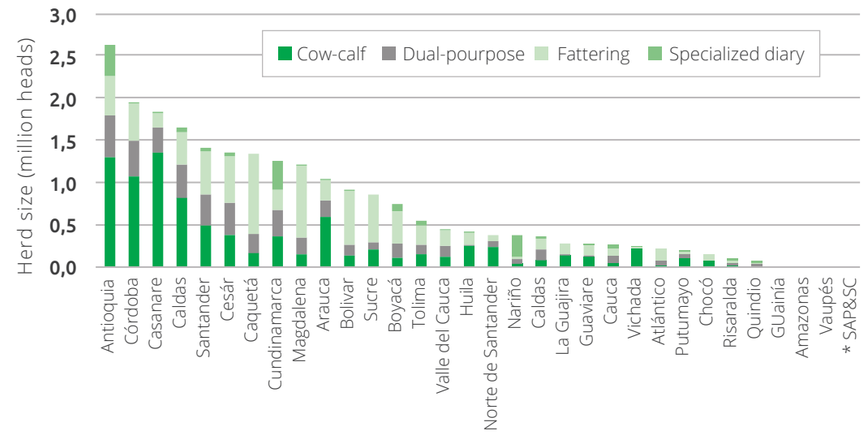


Figure 16. *Herd size by type of livestock production and departamento in Colombia (2016)* Source: FEDEGAN (2019)

Fedegan reported a total of 22.6 million heads for 2016[5]. In terms of the type of livestock production, cow-calf activities accounted for nearly 8.7 million heads, while dual-purpose accounted for 7.9 million heads. Fattening activities accounted for 4.5 million heads, while specialised diary accounted only for 1.4 million heads. Figure 16 and Figure 32 (see annex) show that cow-calf activities are mainly developed in the foothills of the Eastern mountain range, in Meta, Casanare and Arauca but are also taking place in Vichada and Guaviare, departments that belong to the Amazon biome. Dual-purpose activities are developed in the North and Centre of the country, in Cesar, Bolivar and Santander but it also has an essential share in departments that are in the agricultural frontier like Caquetá, Meta and Guaviare, associated with the Amazon tropical rain forest and also Valle del Cauca and Chocó in the Pacific Coast forests. The specialized diary is developed at high altitude, so, departments that presented this activity are Antioquia, Cundinamarca, Boyacá, Nariño and Cauca.

[5] DANE's national agricultural census does not provide information for cattle ranching activities, then we used the National Cattle Ranching Association (FEDEGAN) data.

3.4.3. Deforestation and degradation of forest

It is reported that 68.7% of Colombia's surface is covered by natural ecosystems concentrated in the lowlands of the Amazon, Orinoco and the Pacific as well as the Andean slopes. Approximately 50% of the Colombian forests have a collective form of management with 45.4% managed by indigenous, 7.3%

Cocoa plantation along forest remnants and a walking palm (Socratea exorrhiza) (Photo taken by Jaime Erazo during the CacaoBio Expedition in Chocó in March 2019)

by Afro-descendant communities and 1.9% by traditional farmers (MADS and PNUD, 2014).

Deforestation has been responsible for most of the alterations to Colombia's natural capital. In the last 50 years, there has been an increase in the number of hectares used for livestock (from 14.6 million to 39 million hectares) where pastures replace forest ecosystems (Lerner et al., 2017). The Andes and the Amazon regions presented the highest rate of deforestation (Figure 17) between the years 2005 and 2010, which represented a loss of 41% of the natural forests (WWF-Colombia, 2017).

Legal and illicit activities drive deforestation. The legal forestry industry represents 0.21% of the GDP. The illegal deforestation is a significant issue in the country since 40 to 50% of the total timber extraction has been classified as illegal (WWF-Colombia, 2017). It has been suggested that 58% of deforestation that took place in the year 2014 happened in the municipalities with the highest levels of conflict (Pineda Giraldo, 2017).

The development of illicit crops is also linked to the degradation of the forest (Rincón-Ruiz and Kallis, 2013) and has an impact on deforestation of tropical rainforests. Tumaco (Chocó), Puerto Asis (Putumayo), Tibu (North of Santander), Valle de Guamuez (Putumayo) and El Tambo (Cauca) are the municipalities with the highest concentration of coca crops (Figure 18), with respect to their area. Finally, the design of the road system is generating deforestation associated with the change in land use (Armenteras et al., 2013)

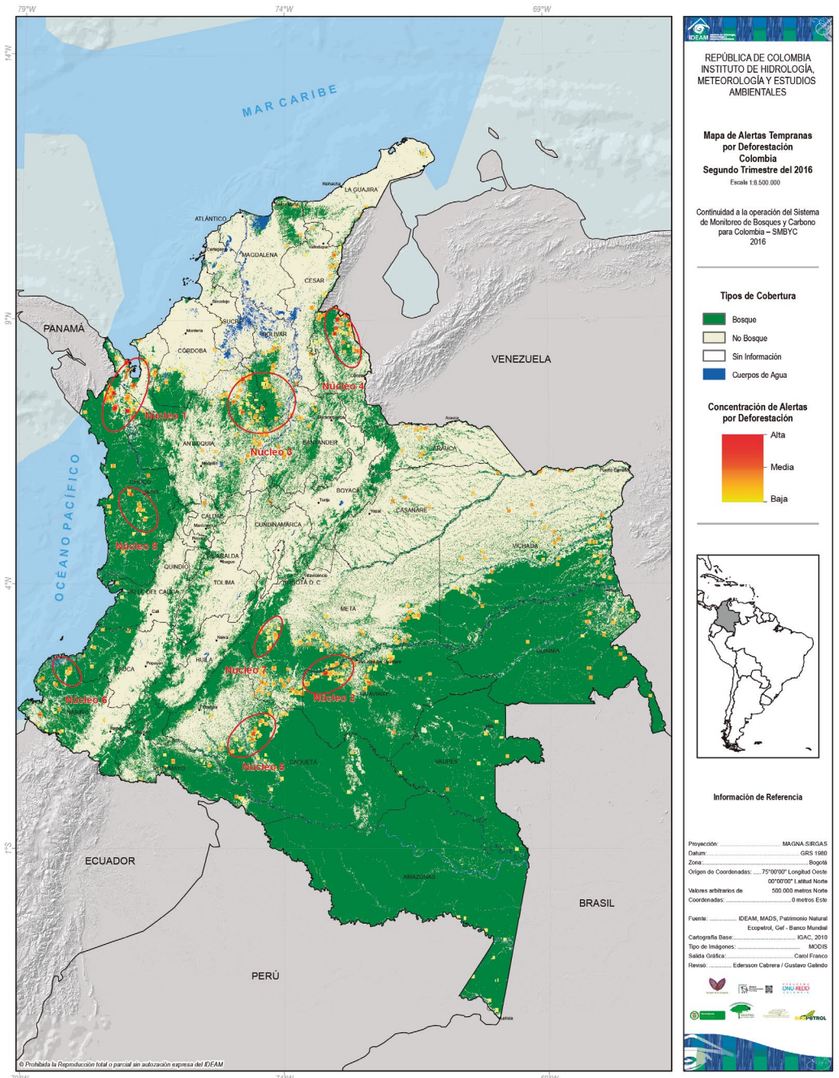


Figure 17.
Deforestation map
Source: IDEAM, MADS, Patrimonio Natural, Ecopetrol and Gef - Banco Mundial (2010)

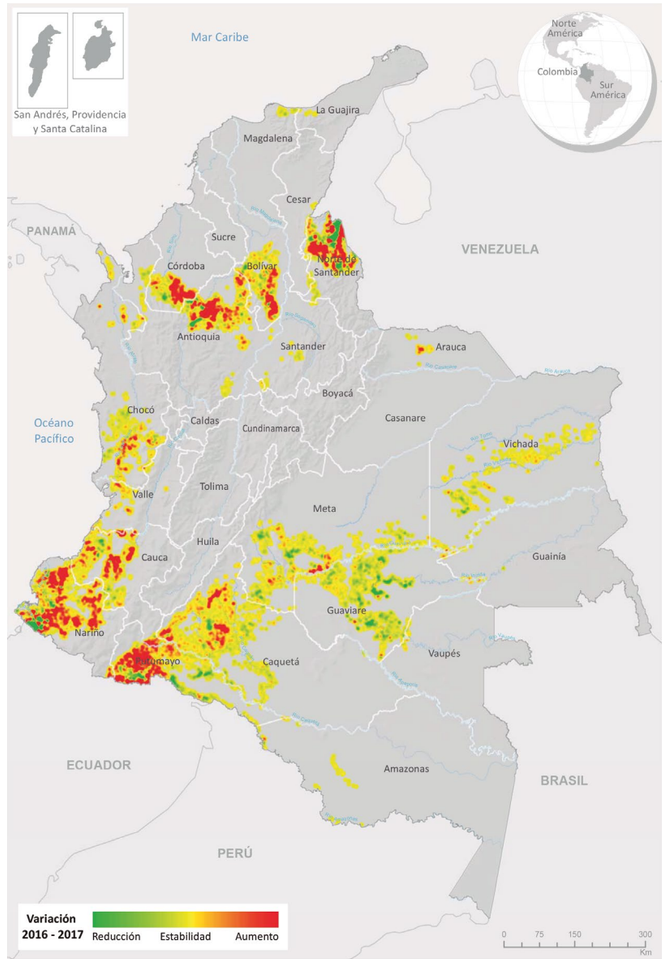


Figure 18.
Variation of coca cultivation
Source: UNODC (2017)

3.4.4. Overfishing

At the national level, continental wild fishing is in decline. In 1972, the catch of fish in Colombia was 83,000 tons, and by the end of 2010, the country only produced 25% of that amount. The fall of the fishery is attributed to the deterioration of its ecosystems in combination with overexploitation (WWF-Colombia, 2017). Freshwater species are threatened by persecution and accidental capture. The main threat to species living in marine environments is their overharvesting combined with bycatch in trawling operations (WWF-Colombia, 2017).

In marine-coastal ecosystems, it is estimated that a considerable part of all Colombian coasts are facing erosion; in the Caribbean at least 50% (1182 km) of the coast is facing severe coastal erosion (more than 1.5 m/yr) (Rangel-Buitrago et al., 2017). The Magdalena, Orinoco and Amazon river basin have suffered an alarming decline (above 80%) of their commercial fisheries (WWF-Colombia, 2017).

3.4.5. Mining and oil extraction

Colombia has one of the largest open-pit coal mines in the world in the region of Cerrejon in the Guajira Peninsula (belongs in equal parts to BHP Billiton, Anglo American and Glencore). Colombia also has oil rigs and natural gas extraction in the eastern plains. Colombia is the leading producer of emeralds and has an important share in the production of gold, silver, iron, salt, platinum, petroleum, nickel, copper, hydropower, as well as uranium extraction. Colombia has experienced a rapid expansion of the mining sector in recent years. The titles for the extraction of coal increased by 87% between the years 2004 and 2007. Similarly, the titles for gold are five-times higher (Salamanca et al., 2013). According to Salamanca et al., (2013), by the year 2012, 9,400 mining titles were covering 5.6 million hectares of the country. Currently, there are more than 19,000 mining applications to be resolved. In total the declared strategic mined areas found in the Amazon and the Pacific, account for 40 million hectares of the continental territory (Figure 19) (MADS and PNUD, 2014).

According to Martínez, A. UPME (2015) the mining and hydrocarbon sector represented 8% of GDP for the year 2011. These sectors present the highest growth rate in the Colombian economy and they represent 70% of the total value of the country's exports. Nonetheless, it has been estimated that from the total gold production only 11% complies with all associated legal processes, which emphasise on the need to improve the effectiveness on which the government regulates this activity (MADS and PNUD, 2014).

Overlap of land used for mining and oil extraction with land for farming and conservation generates land-use conflicts and affects their provision of ecosystem services (MADS and PNUD, 2014). Similarly, the mining concessions affect the natural and cultural capital and commonly overlap with protected areas and the territory where indigenous communities reside. According to the third National Agricultural Census developed in 2014, the territory of ethnic groups in the country corresponds to 39.9 million hectares. The proportion of natural forest in the indigenous territory is 93.0%, whereas in the black/Afro-descendant and ancestral raizal territory[6] the proportion is 79.4% and 66.0%, respectively. When considering the total area occupied by these ethnic groups, 6.9% of it has agricultural use (2.8 million ha), 0.1% corresponds to non-agricultural use (0.03 million ha) and 2.2% to other uses (0.9 million ha). Even though the non-agricultural land use of the indigenous territory only occupies 2.3% of the indigenous territory, this represents 0.93 million hectares which are at risk of losing the vast natural capital that these ethnic communities have preserved for many generations.

[6] Ethnic group who are descendants of Amerindians, Africans and Europeans who populated the Archipiélago de San Andrés, Providencia y Santa Catalina y the Caribbean, and who built a society with its own language and culture.

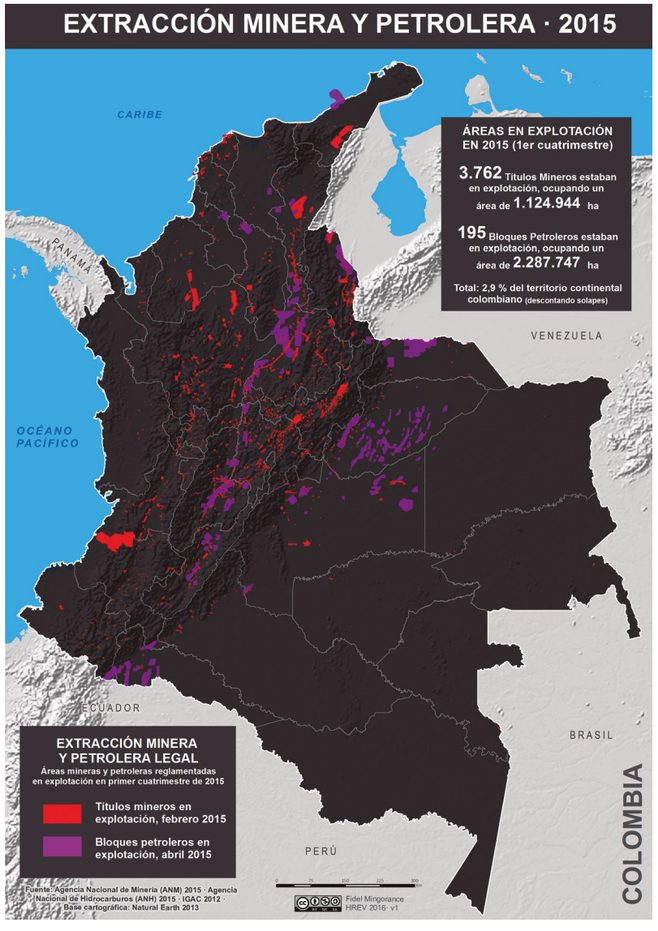


Figure 19. *Mining and oil extraction* Source: Agencia Nacional de Minería and Agencia Nacional de Hidrocarburos (2015).

State and impact: Natural capital and ecosystem services

4 State and impact: Natural capital and ecosystem services

Within the D-P-S-I(W)-R framework it is also relevant to assess the current state of the natural environment in Colombia. The *state* of the environment is understood as the combination of the physical, chemical and biological conditions in a country. This *state* or quality of the various natural assets (e.g. air, water, soil) is directly affected by the pressures on the environment. Similarly, changes on the state may have impacts which affect human wellbeing, when they reduce ecosystems capacity of providing benefits (ecosystem services) flowing to society.

This section of the report starts by explaining some key concepts which are going to be used in the next sub-sections, to afterwards present a review of the current *state* of the natural environment in Colombia, as well as describes they ways on which the natural environment has been *impacted* by the economic activities developed in the Colombian territory.

In this document, we refer to the term natural capital as the *stock* of biotic and abiotic elements of nature, such as ecosystems, flora and fauna species, land, minerals, air, freshwater and oceans "that directly or indirectly produce value for people" (Blicharska et al., 2017, p. 113). These biotic and abiotic components of Colombia's natural capital interact to generate a *flow* of benefits (i.e. ecosystem services) to society. The management of natural capital and ecosystem services is intrinsically connected (see Figure 20) since complex links exist between the attributes of the stocks of resources and the flow of benefits (Balvanera et al., 2006; Blicharska et al., 2017; Harrison et al., 2014) In this sense, the unsustainable use of ES may lead to the depletion of stocks of natural capital, which are necessary for maintaining the provision of these benefits flowing to society over time.

Although the processes and functions of ecosystems exist irrespective to their absorption into the socio-economic system; additional investments of energy, labour and management are often required so that their services impact society's utility and wellbeing. Different ecosystem services may make a variety of contributions to society's welfare and therefore need to be valued differently (Fisher et al., 2009). Ecosystem services are also valuable because they can provide considerable financial and economic gains. Augmenting natural capital with other capital components to create, among others, tourism complexes, or water resource storage systems, looks like a promising investment strategy in the Colombian context.

The majority of ES are non-marketed and have no observable price from which it is possible to assess the value society attaches to it[7]. Environmental economic studies often apply economic valuation techniques to calculate the 'zero price' of the environment and to determine the value that society assigns to different ES. The environmental valuation framework for projects /policies options is focused on valuing the so-called "final ecosystem services", which are understood as the flows between ecosystem units and economic units including households, firms and government (Fisher, Turner and Morling 2009). However, if the focus is on natural capital accounting, this framework can also be interested in valuing the flows happening between ecosystems units (i.e. "intermediate services") such as pollination.

Final ES have been categorised according to the needs they fulfil. This report uses the TEEB

[7] Market prices can be value proxies for some provisioning goods, once the prices has been corrected for market distortions (e.g. taxes and subsidies) and/or non-competitive practices.

Figure 20. *Natural capital and ecosystem services* Source: Natural Capital Coalition (2016)

classification system, which is used by the Millennium Ecosystem Assessment and has been extensively used in valuation studies worldwide (De Groot et al., 2012). This classification considers the following four categories:

- Provisioning Services (PS) refers to all the products that society obtains from the environment, such as water, food or fuel.
- Regulating services (RS) relate to ecosystems capacity to act as regulators in natural processes (e.g. flood control, climate regulation, soil formation, disease control).
- Cultural services (CS) are non-material benefits that people obtain from ecosystems while doing recreation tourism, cognitive and research development, as well as aesthetic and spiritual enjoyment.
- Habitat or Supporting Services (SS) refers to ecosystems capacity of sustaining all previous ecosystem services, by maintaining genetic diversity, as well as providing habitat for aquatic and terrestrial species.

The ecosystem services approach links nature with Society. Nature, through wellbeing, calls for a further understanding of the diversity of benefits (economic and social) provided by the natural assets in a country, and the ES they can generate. Therefore, the following subsections of this report are used to describe the current state of Colombia's natural capital stocks.

4.1. Biodiversity of biomes and ecosystems

The country has five terrestrial ecoregions: Chocó biogeographic; Plains of the Caribbean; Amazon; Orinoquia and the Andean Region. In addition to this, there are two marine – coastal regions: the Pacific Ocean and the Caribbean Sea.

Colombia has 34 types of biome and 311 ecosystem types (Figure 21). According to MADS (2018b) the ecosystem types are distributed as follows: 92,691,148 ha of terrestrial ecosystems, 8,475 ha of Island ecosystems: 8,475 ha, 472,773 ha (0.51% of the total marine area) of marine ecosystems, 767,499 ha of coastal ecosystems and 20,528,919 of aquatic ecosystems.

The three most essential biomes are the tropical desert, the tropical dry forest and the humid tropical forest (IDEAM, IGAC, IAvH, INVEMAR, 2007). Half of the ecosystems in Colombia are under threat with 20 Colombian ecosystems (25% of the total for the country) being characterised as Critically Endangered and 17 ecosystems (21% of the total for the country) as Threatened (WWF-Colombia, 2017). On the other hand, 2.22% of the country's species (665 plant species, 284 terrestrial animals, 79 species living in freshwater, 97 species living in marine environments) fit into one of the three threat categories defined by the International Union for Conservation of Nature (WWF-Colombia, 2017).

Ecosystem provisioning is important in Colombia. In 2014, it was estimated that there were 45,000 m3 of water available per person, with 11.3% of the national water being supplied by the national natural parks (PNN, 2017). The hydropower development in Colombia is relevant for the population since 70% of the electric energy used in Colombia in 2015 comes from hydroelectric plants (WWF-Colombia, 2017). Colombian ecosystems are relevant because of the food provision services they provide. In this regards, the Agricultural Census indicates that

Figure 21. *Continental and coastal ecosystems* Source: IDEAM, IGAC, IAvH, INVEMAR, Sinchi e IIAP. (2007)

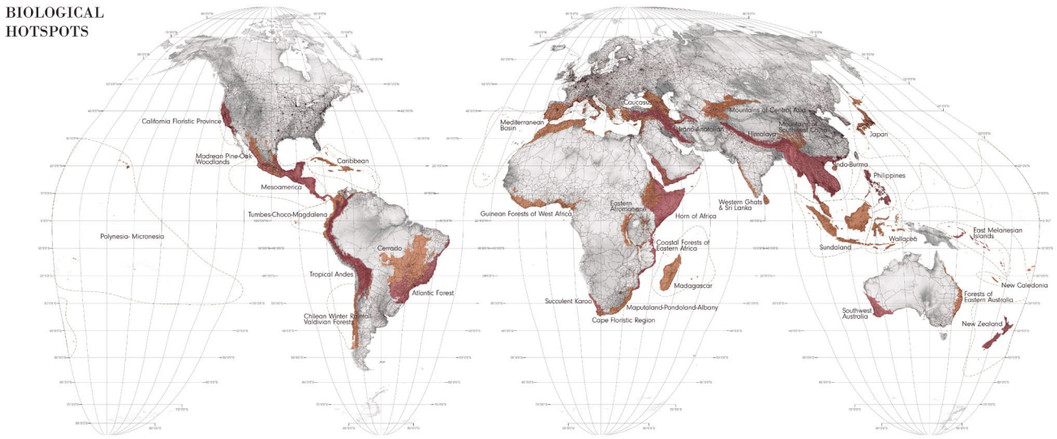


Figure 22. *Biological hotspots.* Source: Weller et al. available at https://atlas-for-the-end-of-the-world.com/world_maps/world_maps_biological_hotspots.html

in 2014, 42.3 million hectares have been destined to agricultural uses in Colombia, out of which 8.4 million are being used for growing crops and 33.8 million for raising livestock (DANE, 2014).

4.2. Biodiversity of species

The continental area of Colombia covers 1.1 million km^2. The high variance in topography (altitude ranging from 0 to 5775 m) and climate (temporal and spatial distribution of rainfall caused by the migration of the Intertropical Convergence Zone – ITCZ and of the El Niño Southern Oscillation – ENSO) provides the environmental conditions for a megadiverse country (Mittermeier et al., 2011).

Colombia has 10% of the biodiversity held by the 17 megadiverse countries (Figure 22) in the world (PROCOLOMBIA, 2018). Within the country there are two biodiversity hotspots: the Tropical Andes and the region of Tumbes-Chocó-Magdalena (Myers et al., 2000). By the year 2016, there were 56,724 species registered in the country, of which 9,153 are considered endemic species (IDEAM, 2018).

The estimated number of species in Colombia is 56,343 (Figure 23), and this estimation does not consider the enormous diversity of existing microorganisms.

Globally the country is ranked in first place in terms of the number of birds and orchid species, second in the world in the richness of plants, amphibians, butterflies and freshwater fish, third in number of species of palms and reptiles and fourth in mammals (IAvH, 2017).

According to the criteria of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (IAvH, 2017), a total of 1503 species are internationally traded. In Colombia, from 293 introduced species, 96 species have been identified at High Risk of Invasion. Additionally, the Ministry of Environment and Sustainable Development recognised another 22 invasive species of fauna and flora (IAvH, 2017). The list of exotic species in the country includes some of the worst invasive species in the world, such as the common gorse (*Ulex europaeus*), tilapia (*Oreochromis spp.*), rainbow trout (*Oncorhynchus mykiss*), bullfrog (*Lithobates catesbeianus*) and lionfish (*Pterois volitans*) (WWF-Colombia, 2017).

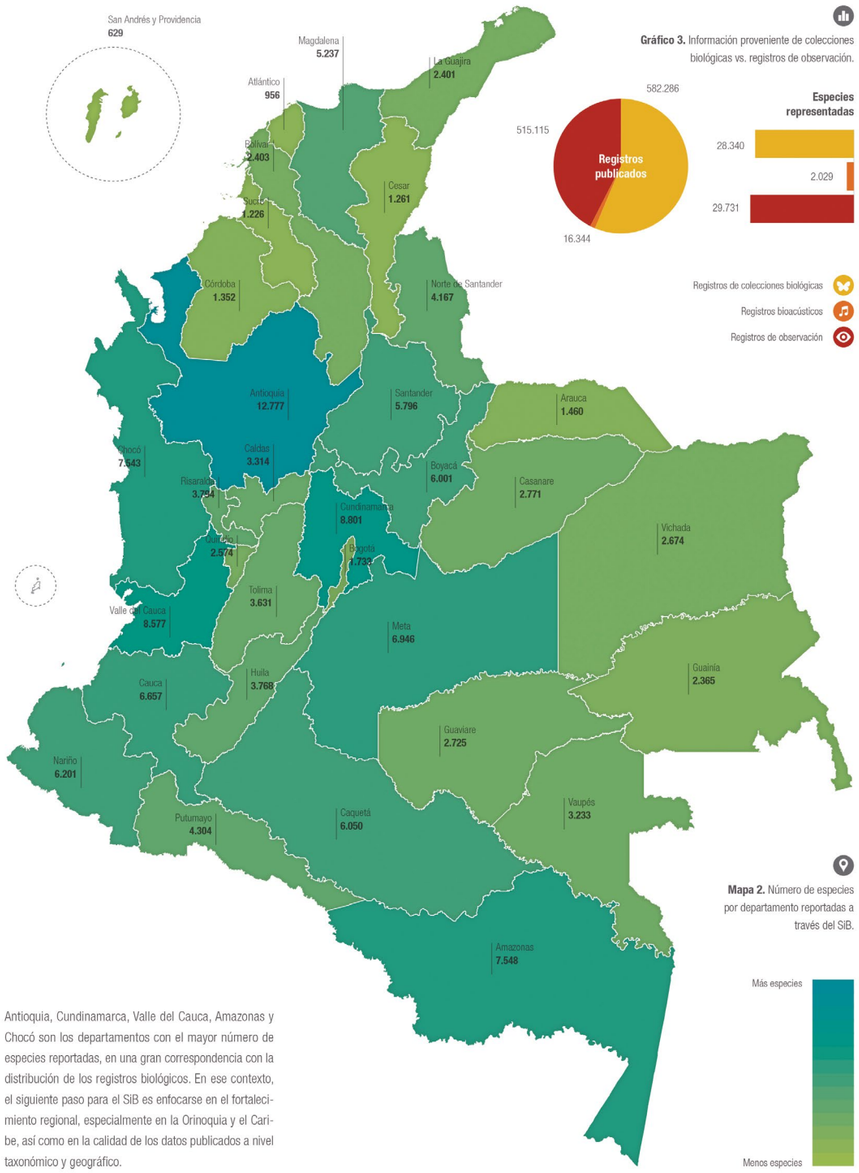


Figure 23. *Number of species* Source: IAvH (2014)

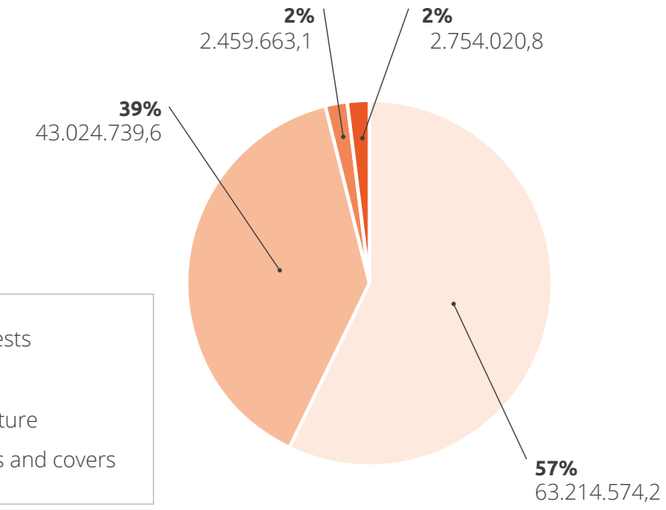


Figure 24. *Disperse rural area land use and cover for Colombia by 2013 (Adapted from: DANE ,2014). Agriculture includes livestock production*

4.3. Forests and land use

Colombia has a total land area of 111.4 million hectares (DANE, 2018). Figure 24 shows the distribution of land use and cover for the rural areas. According to this figure, approximately 57% (63.2 million hectares) of the total land area corresponds to natural forests, while the area associated with agricultural and livestock activities is nearly 39% (43 million hectares).

The forest areas are not evenly distributed. The states with highest forest areas are located in the Amazon, including Amazonas, Guainía, Caquetá, Vaupés and Guaviare. Also states located in the transition zone between Orinoco Grasslands and the Amazon, like Meta and Vichada contain large quantities of forests. The Pacific Coast, also presents some significant forest remnants, in states like Chocó. There are some forest remnants in Andean states, but smaller than in the Amazon or the Pacific areas, like Santander, Norte de Santander and Antioquia (see Fig. A1 in Appendix for details about the distribution of forested land by departments).

Nearly 58% (24.7 million hectares) of agricultural and livestock production areas are covered with grasses, mainly associated with livestock production, while 22% (9.6 million hectares) correspond to agricultural activities (see Figure 25).

Although pasture areas are used for livestock production, it is possible that other types of land are used to raise cattle (e.g. recovery areas where the cows can spend time feeding from the growing vegetation). Therefore DANE (2018)reports that for a total of 108.9 million hectares for agriculture and livestock production, there are approximately 30.2 million hectares with predominant livestock use.

For areas that relate only to agricultural production, 7.1 million hectares are used for crops (84%), while resting areas account for 1.1 million hectares (14%) and fallow areas account for 0.2 million hectares (2%) (see Figure 26).

The majority of Colombian land is appropiate for cultivation but part of this land is not efficiently utilized (DANE 2018).

Traditional agriculture practices usually involve a mix of crops, trees and animals, but agriculture

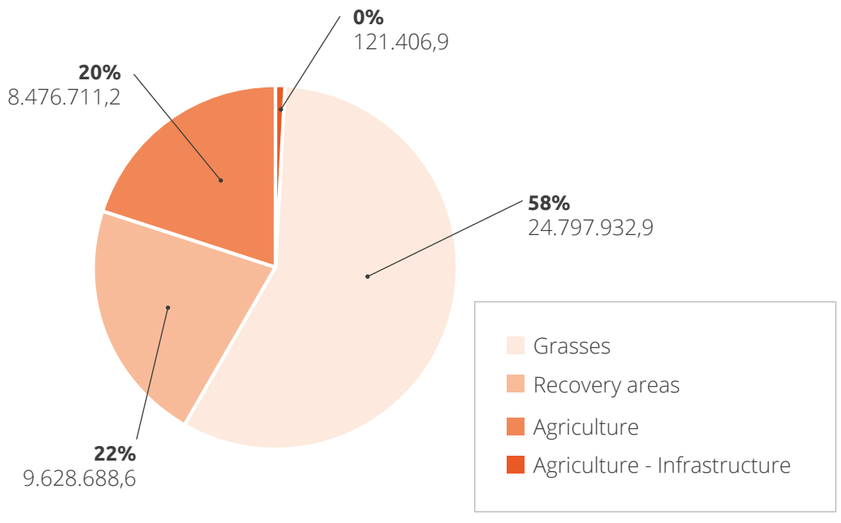


Figure 25. *Agricultural and cattle ranching production area land use*
Source: Adapted from DANE (2014)

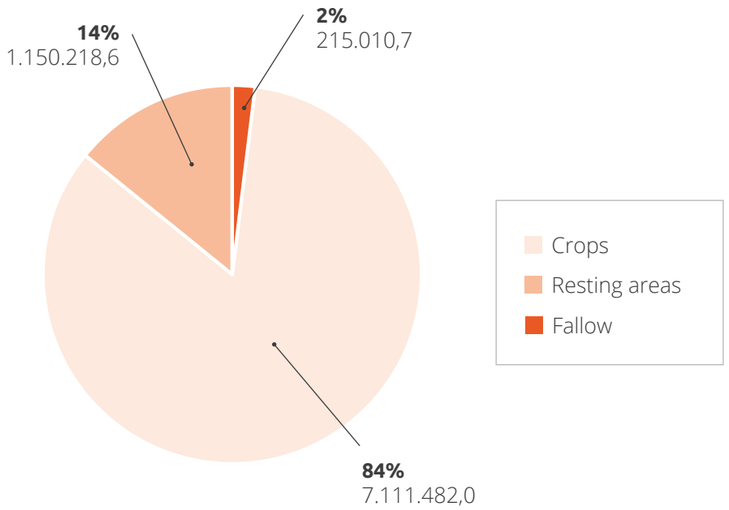


Figure 26. *Only agriculture area land uses and covers*
Source: Adapted from DANE (2014)

modernization has introduced monoculture with possible detrimental ecosystem effects. Cattle ranching, coffee, banana, palm oil and other agriculture practices are currently primarily monoculture and therefore a switch into agroforestry can represent an alternative which reduces biodiversity loss.

"Agroforestry is the collective term for land-use systems and technologies in which woody perennials (e.g. trees, shrubs, palms and bamboos) are used deliberately on the same land-management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between the different components" (Hillbrand et al., 2017).

Learning about agroforestry systems (Photo taken by Jaime Erazo during the Peace with Nature workshop in Caquetá in July 2019)

There are three types of agroforestry systems (FAO, 2019):

- Agrisilvicultural: a combination of crops and trees
- Silvopastoral systems: a combination of forestry and grazing of domesticated animals on pastures, rangelands or on-farm
- Agrosilvopastoral systems: is the combination of trees, animals and crops.

Examples of agroforestry systems exist in Amazon for coffee, cacao, rubber, plantains and cattle ranching (Barrera et al., 2017; Calderón et al., 2016).

4.4. Fisheries

The fishing industry is not a significant part of the Colombian economy (0.36% of the national GDP and 3.46% of the agricultural GDP)(MADS and PNUD, 2014). Nonetheless, inland artisanal fishing is a relevant economic activity and source of food security for more than one million Colombians (Moreno et al., 2018). The yield for inland fishing in Colombia is 17,644 tonnes, 90,294 tonnes for maritime fishing and 92,002 tonnes for aquaculture (WWF-Colombia, 2017). About 95% of the country's marine catches are made along the Pacific coast.

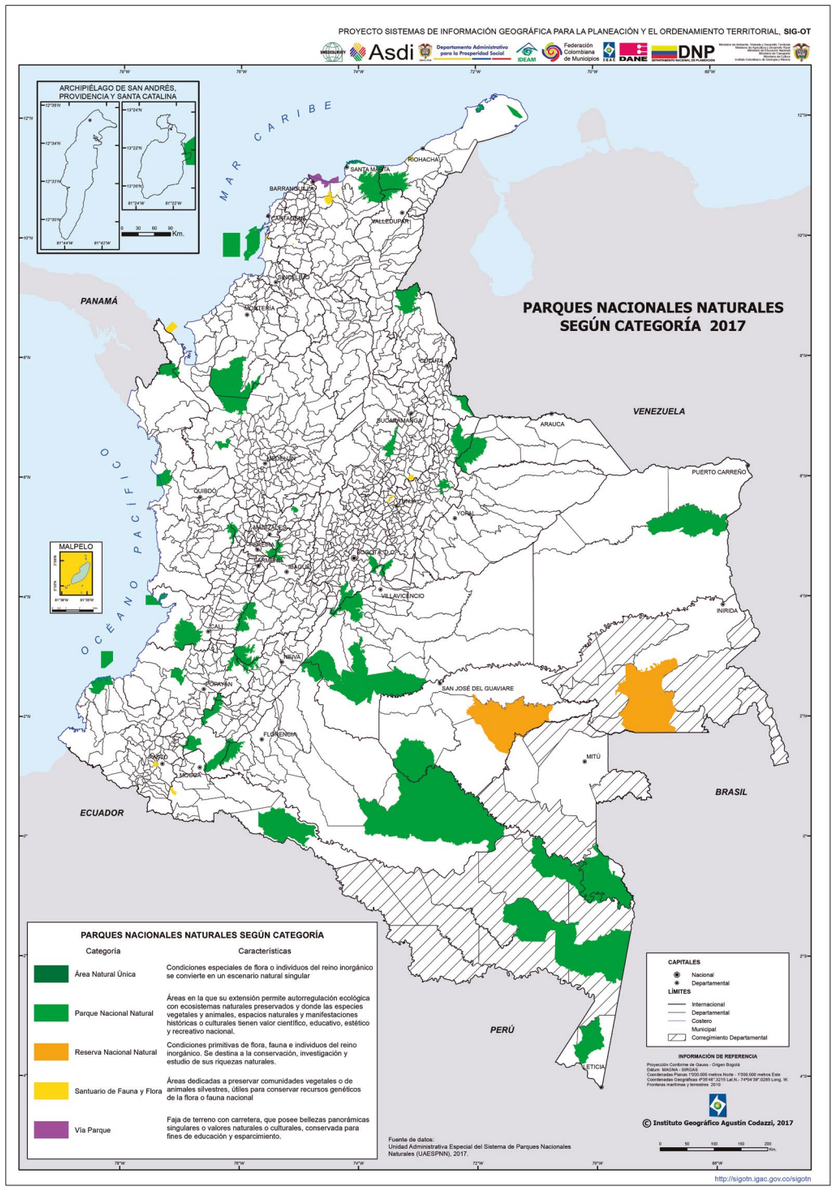


Figure 27.
National Natural Parks
Source: SIG-OT (2017)

4.5. Nature-based tourism

Colombia's biodiversity is represented in multiple natural areas (Figure 27) belonging to the National System of Natural Parks that represent 14.268.224 hectares (142,682 km2) of the national surface (11.27% constitutes the continental area and 1.5% the marine area). Nearly half of these areas have the presence of indigenous and Afro-descendant communities (PNN, 2018).

The Ministry of Commerce, Industry and Tourism of Colombia (MCIT, 2010) reported 557,280 international tourists in the year 2000 and estimated the arrival almost four times this figure (2,288 million foreign visitors) in 2014. The World Travel and Tourism Council reported that this sector contributed with 5.8% of Colombia's GDP in 2016 (COP 51,050.5bn~USD16.7bn) and is forecasted to rise by 3.4% per annum (COP73,243.8bn~USD24.0bn) to generate 6.0% of GDP by the year 2027 (WTTC, 2017).

The Colombian Government has implemented concession schemes to facilitate the linkage of a specialised operator, to make the necessary investments, to improve the quality of services. The aim is to optimise the use of the installed capacity, to reduce the maintenance and operation costs and to generate higher revenues for developing conservation and control activities of the protected areas. This program currently works in the National Parks Tayrona, Gorgona and Los Nevados, as well as in the Vía Parque Isla de Salamanca (MADS and PNUD, 2014).

Colombia's natural capital has great potential to generate recreational services. Currently, the coffee region is the second tourist destination in the country and the natural parks showed an increase in tourism activity of 27% between the year of 2011 and 2013 (MADS and PNUD, 2014).

Policy Response

5 Policy Response

The final section of this report refers to the last component of the D-P-S-I(W)-R framework, which are the *responses* formulated by society and policy makers in order to lessen the undesired impacts of a causal chain of environmental changes. Even though societal responses to environmental change can play a significant role, this section focuses on policy and academic *responses* that have taken place in Colombia.

It is relevant to mention that political responses to environmental change in a country might not only be influenced by the geographic context of it, but also feedback from the process of evidence-gathering developed by scientists, as well as the implementation of pressures to act from the general public. The historical processes can have a critical role, as well. In this sense, the peace process could have relevant implications for the design of the environmental agenda in Colombia which considers sustainability as a central objective of development.

5.1. Environmental networks and institutions

In 1993 the Colombian senate issued the *Law 99 of 1993* to create the Ministry of Environment and the National Environmental System (SINA). The SINA is *"a comprehensive set of regulation, activities, resources, programs and institutions in charge of Colombia's environmental policy and management"* (Sierra et al., 2017, p. 42). The SINA is composed by the Ministry of Environment (central institution in charge of developing environmental law), 5 governmental research institutions, 4 urban environmental units, 34 regional environmental authorities (corporaciones autónomas regionales), the national natural park system, community and non-profit organisations with an environmental focus, public and private research organisations. Table 2 lists and describes some of the most active organisations producing and managing ecological information, often made available through the System of Environmental Information of Colombia (SIAC).

Colombia is now transitioning to a more stable social and political climate due to a series of peace agreements between the government and different armed groups. Consequences of these socio-economic and political changes on ecosystems are largely uncertain, but there is growing concern about derived increases in environmental degradation. Here, we review the capacity of Colombia to monitor the state of its ecosystems and their rate of change over time.

Table 2. *National Environmental System Institutions* Source: Adapted from Sierra et al. (2017)

Institution	Acronym	Mission
Ministry of Environment and Sustainable Development	MADS	Define the national environmental policy. Promote the recovery, conservation, planning, management, use, and extraction of renewable natural resources. Guarantee sustainable development and the civil right to a healthy environment.
Institute of Hydrology Meteorology and Environmental Studies	IDEAM	Provide technical and scientific support to the SINA through knowledge creation and production of reliable information that is consistent and timely. This knowledge should facilitate the definition or modification of environmental policies and decision making.
Research Institute on Biological Resources Alexander von Humboldt	IAvH	Promote, coordinate, and develop research that contributes to conservation and sustainable use of biodiversity for the well-being of the Colombian population.
Environmental Research Institute of the Pacific	IIAP	Develop research in the Chocó biogeographic region to support decision making and public policies on the environment that promotes sustainable development of the inhabitants of this region.
National Natural Parks	PNN	Administer the National Natural Park system and coordinate the National System of Protected Areas with the aim to preserve biological diversity and ecosystem representativeness. Provide and maintain ecosystem services, protect cultural heritage and the natural environment where traditional cultures developed.
Institute of Marine and Coastal Research	INVEMAR	Develop basic and applied research on marine and coastal resources with the aim of developing policies and supporting policy making. Research is directed toward sustainable management of resources, restoration of marine and coastal environments, and improvement of life quality of citizens.
Amazon Institute of Scientific Research	SINCHI	Generation of knowledge, innovation, and technology transfer on biological, ecological and social aspects of the Amazon region.
National Authority on Environmental Licenses	ANLA	Guarantee the transparent evaluation and control of projects and activities subject to environmental licensing or permitting. Contribute to an equilibrium between environmental protection and societal development.

We found several important programs currently set in place by different institutions as well as by independent groups of scientists that address different aspects of environmental monitoring.

5.2. Environmental policy and Payment for Ecosystem Services (PES)

For several decades environmental law has been developed in the Colombian territory. It dates from the creation of INDERENA[8] in the year 1968. As a result of the Stockholm Conference, the Law 23 of 1973 was issued. This law granted an extraordinary authorisation to the President of the Republic for the creation of the Natural Resources Code, which effectively materialised in the year of 1974 with the issuance of *Decree Law 2811 of 1974* (better known as the National Code of Renewable Natural Resources and Protection of the Environment).

The first sketches relating to payments for environmental services are found in *Law 23 of 1973*, which states that *"the National Government should create incentives and economic stimuli, in order to promote programs and initiatives aimed at the protection of the environment and the country's natural resources"*. Similarly, the *Decree 2811 of 1974 (article 13)* established the possibility for the Government to create economic incentives, in order to promote the conservation, improvement and restoration of the environment and renewable natural resources.

Seventeen years later, all those environmental postulates were recognised and elevated to constitutional rank with the *Political Constitution of 1991* ("The Ecological Constitution") where 34 articles with environmental content were established. This constitution recognised the right of all people to enjoy a healthy environment in its Article 79 and recognised (Article 80) the State's responsibility for planning the management and use of natural resources, to guarantee sustainable development, conservation and restoration. It also established the States responsibility for preventing and controlling environmental deterioration and imposing the legal sanctions and requirements for the repair of the damages caused. Finally, the constitution also refers to society's duty to manage natural resources. In the article 95, it is established that the people have the duty to protect the cultural and natural resources of the country and to watch over the conservation of a healthy environment.

After the 1992 United Nations Conference on Environment & Development in Rio de Janeiro, Colombia issued the *Law 99 of 1993.* This law created the environmental constitutional and the Ministry of Environment, Housing and Territorial Development (Ministerio de Ambiente, Vivienda y Desarrollo Territorial, currently called Ministerio de Ambiente y Desarrollo Sostenible). The MADS is created as the institution in charge of formulating national policies in relation to the environment and renewable natural resources.

The *Law 99 of 1993* established that: *"The State shall encourage the incorporation of environmental costs and the use of economic instruments for the prevention, correction and restoration of environmental deterioration and the conservation of renewable natural resources"* and that the President of the Republic was also authorized *"to establish an incentive regime which includes economic incentives, for the adequate use of the environment and renewable natural resources and the recovery and conservation of ecosystems by private owners"*.

The *article 111 of Law 99 of 1993* established that the departments and municipalities must devote 1% of their current income to "finance payment schemes for environmental services".

After the Development Plan of 1993, some shallow stipulations were established for generating PES schemes which resulted in the adoption of The National Strategy for Payments for environmental services by the national Government in 2008.

The Law 1450 of 2011 (Article 210) extended the article 111 of Law 99 (1993) to indicate that it was the responsibility of the environmental authorities to *"define the priority areas to be acquired with these resources and define where the schemes for payments of environmental services must be implemented"*. This law allowed municipalities and departments to purchase land, the financing of payments for environmental services, in order to preserve the areas of strategic importance for the conservation of water resources that supply municipal and district aqueducts with water.

The only regulation that Colombia has to date on PES is found in Decree 953 of 2013, which regulated Article 111 of Law 99 of 1993 (already modified by the Article 210 of Law 1450 of 2011). This Decree establishes the guidelines for the identification, delimitation and prioritisation of strategic areas by environmental authorities. It defines technical criteria for selecting the properties and establishes mechanisms for the articulation of funding sources for the conservation of these strategic areas. It allows the participation of environmental authorities, such as the Ministry of Environment and Sustainable Development and research institutes interested in the conservation of water resources. Moreover, it assigns the responsibility to report their annual expenditures to the environmental authorities of their jurisdiction, so that these can be considered within the investment budget of the entity (MADS, 2013). Regarding the PES design, the

A switch to bio-economic strategies requires changes in current agriculture and economic activities

[8] Instituto Nacional de Recursos Nacionales, which used to manage the natural resources and the environment at the national level, but was subsequently liquidated with the issuance of Law 99 of 1993 in which the Ministry of the Environment was created.

Decree 953 of 2013 also defined that the value of the incentive is based on the estimation of the opportunity costs of the most representative productive activities for the strategic area. This estimation may use the net profit method or the rent of the land via leasing. The maximum value of the incentive will be the lowest average opportunity cost of these activities and may not exceed 15% of the commercial value. The incentive can be applied for up to 50 hectares, but it can be applied in more extensive areas if the incentive complies with numerals 1 and 2 of Article 9 of the Decree. The PES scheme may not have a temporality greater than five years (MADS, 2018b).

Afterwards, the Article 174 of the Law 1753 (2015) established that it was the obligation of the environmental authorities, in coordination with the institues territorial to co-finance the acquisition of strategic areas or ecosystems for the conservation, preservation and recovery of natural resources and to implement payment for ecosystem services schemes or other economic incentives to protect the wellbeing of the area of interest. Although the payment for environmental services has existed since the 1993, it is not until 2015 the Decree 1753 that specific rules to implement PES schemes were defined. The Law 1753 (2015) established that the ways to finance these economic instruments must be in agreement with the regulations issued by the National Government and be regulated by the Ministry of Environment and Sustainable Development. By the provisions of the Peace Agreement signed in 2016, the Decree 870 issued on March 21 (2017) is the current standard that regulates the PES in Colombia. This Decree establishes different guidelines for the development of PES and other incentives that allow environmental conservation, and it is now directed to public, private and non-governative organizations that can promote the PES using public and private financial resurces.

The Decree 870 is the first that recognises indigenous peoples and other ethnic groups as public subjects of a special nature. Therefore the interpretation and application of the decree within these territories will be governed by the precepts of "The Major Law, the Own Law and the Law of Origin" (the traditional science of wisdom and indigenous ancestral knowledge for the management of everything material and spiritual) and the functions of their indigenous authorities. Similarly, this decree indicates that entities interested in designing PES must respect the rights of prior consultation, effective participation and cultural identity, among others (MADS, 2017: Sierra Vásquez, 2017).

The way on which the Decree 870 of 2017 defines PES is consistent with the structure that has been used internationally, where there is a service provider (what in the decree is called *"beneficiary"*), a beneficiary of the service (called *"interested parties"* in the Decree) and a payment (i.e. the *"incentive"*).

The novelty of the Decree 870 is that it defines that the incentive can be given voluntarily or within the framework of compliance with the obligations deriving from environmental authorisations. As in the previous decrees, the value of the incentive that is granted to the beneficiaries (in cash or kind) will be anchored to the opportunity cost of the productive activities of the area and its ecosystems. However, in the indigenous territories, cultural and spiritual intangibles will be considered additionally to estimate the value of the incentive. Moreover, this decree recognises that there are other relevant ecosystem services, in addition to the hydric, as the cultural and spiritual services, the reduction and capture of greenhouse gases and the conservation of biodiversity (Sierra Vásquez, 2017).

The most recent regulation related to PES in the country is the Decree 1007 of 2018. This Decree uses the MADS definition of PES, which are *"the economic incentive in money or in kind that the interested parties of the environmental services recognize to the owners, possessors or occupants in good faith exempt from fault by the actions of preservation and restoration in strategic areas and ecosystems, through the conclusion of voluntary agreements between the stakeholders of the environmental services and beneficiaries of the incentive"*. The Decree declares that PES schemes should focus on the strategic areas and ecosystems identified in the Single Registry of Ecosystems and Environmental Areas[8], or the National Registry of Protected Areas[9]. Moreover, it states that areas or strategic ecosystems with the risk of degradation of the natural cover and strategic or degraded areas and ecosystems in conflict with land use, will be predominantly addressed, with emphasis on those located in priority municipalities for the post-conflict. On top of the services related to regulation of water quality, conservation of diversity, reduction and capture of greenhouse gases, and cultural and spiritual services, this Decree also recognises recreational environmental services. Finally, it indicates that it is up to the competent environmental authority to carry out the evaluation, follow-up and monitoring of the application of PES in Colombia (Sierra Vásquez, 2017).

5.3. Other initiatives for biodiversity conservation

In order to protect forests and biodiversity, promote sustainable rural development in 2017 and fight climate change the government launched the Sustainable Colombia Fund with $US 1,900 million to finance actions aimed at achieving these objectives (APCI, 2018).

Norway, the United Kingdom and Germany pledged to contribute $US 5 million (between 2015 and 2020) to finance projects that reduce greenhouse gas emissions (GHG), deforestation and forest degradation. International funds are conditioned on the delivery of measured results with 300 million dollars allocated to Colombia to reduce deforestation and the scope of the goal of zero deforestation in the Amazon in 2020 (SEMANA, 2018).

[9] Registro Único de Ecosistemas y Áreas Ambientales (REAA)

[10] Registro Único Nacional de Áreas Protegidas (RUNAP)

The Ministry of Environment and Sustainable Development (MADS), National Natural Parks (PNN), the Gordon and Betty Moore Foundation, the World Wildlife Fund (WWF), the Fund for Biodiversity and Protected Areas - Natural Heritage, Wildlife Conservation Society (WCS) and Conservation International (CI), signed a historic Memorandum of Understanding in which they commit to working in the team to improve the management of the National Parks System. In addition to implementing financial mechanisms for the long-term conservation zones, the signatories intend to make efforts to declare 3.5 million hectares of new protected areas (Pineda Giraldo, 2017).

Sustainable Cattle ranching is a project co-financed with contributions from the Global Environment Fund (GEF), administered by the World Bank (WB), and with financial and in-kind contributions from the four allies. It generates a strategic alliance between the Colombian Federation of Cattle Ranchers (FEDEGÁN-FNG), the Centre for Research in Sustainable Systems of Agricultural Production (Cipav), the Fund for Environmental Action and Childhood (Fondo Acción) and The Nature Conservancy (TNC). This project aims to improve the production and sustainability of the livestock business through the use of different types of trees integrated to livestock production (i.e. adoption of silvopastoral systems). The project will benefit around 2,000 livestock families distributed in 83 municipalities in five areas of the country (FEDEGAN, 2006).

Riqueza Natural is a five-year program, funded by the United States Agency for International Development (USAID) with activities in the post-conflict areas. In this context, the project assumes a commitment to conserve the country's biodiversity and at the same time promotes compliance with national rural development goals (USAID, 2018).

The project Programa Ambientes para La Paz of the United Nations Development Programme (UNDP) is also relevant, as it promotes the transformation of territories and reconciliation with the environment, with a lasting focus on peace. The initiative develops actions to prevent and mitigate deforestation, adaptation to climate change and promotes the well-being and good living of communities and is developed in the areas with the greatest biodiversity (PNUD, 2018).

The SULU project is an initiative led by the WWF network with the support of the German Ministry of Environment (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, BMU) implemented in Colombia, Brazil and Indonesia. The main objective of the SULU project at a global level is the reduction of GHG emissions and the loss of biodiversity caused by changes in land use in relation to unsustainable biomass production (WWF-Colombia, 2018). Project Vida Silvestre is another project funded by WWF focused on finding solutions to preserve the incredible biodiversity of the country.

The complex ecosystems of the Paramo

Some other national initiatives for biodiversity conservation include:

i) Vision Amazonia, which is an initiative of the national Government that seeks to reduce emissions by deforestation in the Colombian Amazon, through a model of sustainable development (MADS, 2018a).

ii) GEF Corazon de la Amazonia, which is a program seeking to respond to the current rate of deforestation that impacts the ecological connectivity between the forests of the Andes and the Colombian Amazon (Patrimonio Natural, 2018).

iii) Proyecto Paramos, aiming to restore and conserve the ecosystem services and biodiversity associated with the paramo and high Andean forest complexes located in the Central Region of Colombia (Proyecto Paramos, 2018).

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Annexes

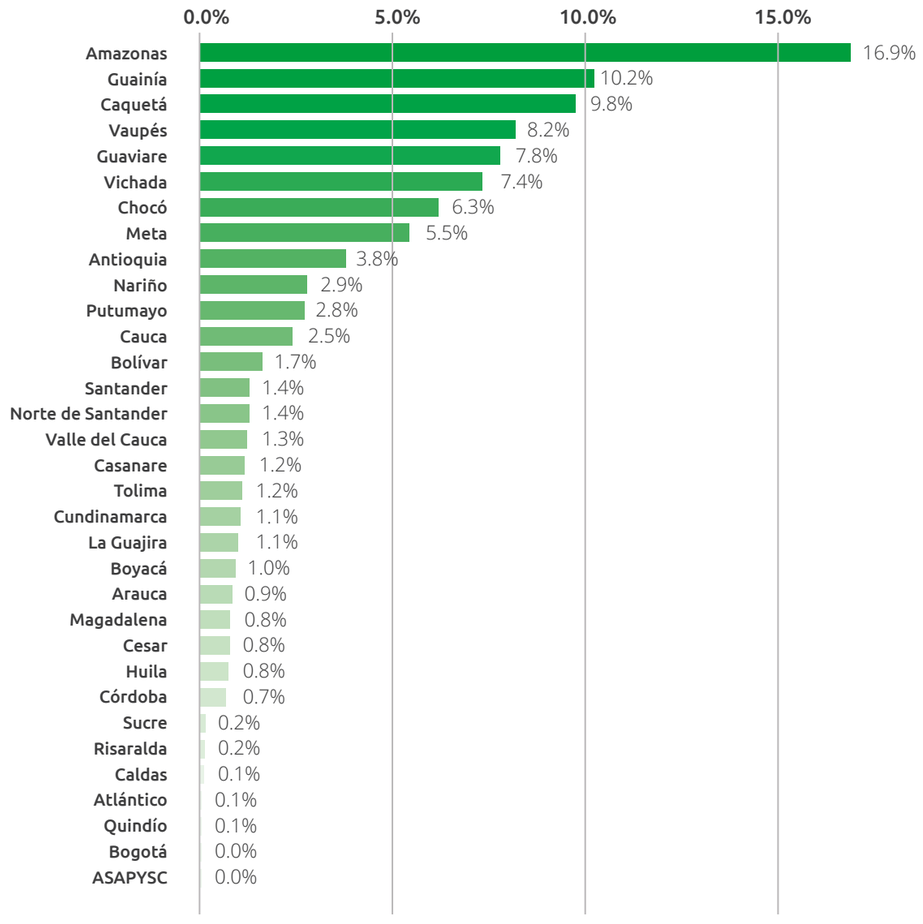

Figure A1.
Distribution of forest areas among Colombian departments by 2013
Source:
DANE (2018)

Left photo:
Neil Palmer (CIAT).

Product	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Mean annual growth
Coffee	766,477	758,306	754,651	744,318	712,387	707,797	771,800	795,563	801,082	777,705	0,2%
Plantain	413,030	398,163	420,398	424,464	422,636	447,333	447,548	448,904	448,969	460,724	1,2%
Cacao	106,050	107,773	109,446	126,804	133,228	151,845	150,224	154,648	166,785	170,106	5,4%
Rubber	2,598	2,919	4,039	5,118	7,488	5,991	8,932	12,927	15,573	18,432	24,3%

Table A1.
Planted area for coffee, plantain, cacao and rubber between 2007 and 2016 (hectares) Source: MADR and AGRONET (2017) for coffee, cacao and rubber; MADR (2017) for plantain

Product	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Mean annual growth
Coffee	828,898	828,586	708,891	779,235	640,432	622,283	652,052	728,400	850,500	853,920	0,3%
Plantain	2,968,116	2,726,564	2,744,224	2,976,687	3,001,195	3,218,822	3,353,156	3,477,897	3,534,103	3,757,859	2,7%
Cacao	57,467	58,755	58,531	69,023	75,212	83,473	78,132	81,406	86,871	87,266	4,8%
Rubber	3,727	3,411	4,697	6,165	9,631	8,842	11,508	16,521	20,130	22,857	22,3%

Table A2.
Production for coffee, plantain, cacao and rubber between 2007 and 2016 (tons)
Source: MADR and AGRONET (2017) for coffee, cacao and rubber; MADR (2017) for plantain

Product	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Mean annual growth
Coffee	3,87	3,60	3,64	4,00	4,21	4,55	4,34	4,37	4,41	4,83	2,5%
Plantain	2,01	2,08	1,69	1,84	1,52	1,39	1,46	1,62	1,89	1,85	-0,9%
Cacao	0,54	0,55	0,53	0,54	0,56	0,55	0,52	0,53	0,52	0,51	-0,6%
Rubber	1,43	1,17	1,16	1,20	1,29	1,48	1,29	1,28	1,29	1,24	-1,6%

Table A3.
Yield for coffee, plantain, cacao and rubber between 2007-2016 (ton/ha)
Source: MADR and AGRONET (2017) for coffee, cacao and rubber; MADR (2017) for plantain

DOMAIN	# APU with cattle presence	# of heads	Pastures area (ha)	Recovery area (ha)	Total Recovery +pastures (ha)	Stocking rate (heads/ha)
Total National	648,199	21,502,811	24,797,933	9,628,689	34,426,622	0.625
Antioquia	50,092	2,289,770	2,003,164	623,648	2,626,812	0.872
Atlántico	7,095	215,509	129,410	49,285	178,695	1.206
Bogotá	1,220	22,395	55,180	17,889	73,069	0.306
Bolívar	20,880	885,113	409,330	606,095	1,015,425	0.872
Boyacá	122,503	750,187	881,383	351,472	1,232,855	0.608
Caldas	10,123	377,240	249,144	35,411	284,555	1.326
Caquetá	12,582	708,238	1,092,223	390,939	1,483,162	0.478
Cauca	26,830	276,111	348,565	370,619	719,184	0.384
Cesar	11,932	1,446,184	957,942	305,213	1,263,155	1.145
Córdoba	24,982	1,956,117	1,008,130	366,949	1,375,080	1.423
Cundinamarca	76,307	1,058,090	628,784	289,376	918,159	1.152
Chocó	2,558	162,454	196,498	107,284	303,782	0.535
Huila	14,931	462,580	406,047	334,229	740,276	0.625
La Guajira	13,073	329,571	326,240	732,454	1,058,693	0.311
Magdalena	18,178	1,138,740	537,308	621,548	1,158,856	0.983
Meta	17,297	1,620,187	3,688,831	537,394	4,226,226	0.383
Nariño	50,868	325,821	332,157	121,580	453,737	0.718
Norte de Santander	16,573	438,932	288,045	281,655	569,700	0.770
Quindío	2,874	83,767	23,617	21,709	45,325	1.848
Risaralda	4,406	95,147	59,163	19,087	78,250	1.216
Santander	58,090	1,404,461	836,694	598,352	1,435,046	0.979
Sucre	17,340	823,131	363,803	170,385	534,189	1.541
Tolima	22,540	623,424	600,869	394,430	995,298	0.626
Valle del Cauca	11,597	453,930	318,214	138,883	457,096	0.993
Arauca	7,802	1,043,517	1,525,311	102,352	1,627,663	0.641
Casanare	13,258	1,826,783	2,737,903	199,049	2,936,952	0.622
Putumayo	6,662	195,446	215,564	347,251	562,815	0.347
* SAP&SC	64	1,046	718	560	1,278	0.819
Amazonas	135	1,393	44,005	14,257	58,262	0.024
Guainía	108	4,009	342,490	111,109	453,598	0.009
Guaviare	3,099	265,335	408,884	141,220	550,105	0.482
Vaupés	68	1,434	66,647	21,609	88,256	0.016
Vichada	2,132	216,749	3,715,672	1,205,398	4,921,070	0.044

Table A1.
Cattle ranching heads, farms, pastures, recovery area and stocking rate by department (2013).
Source: DANE (2018)

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