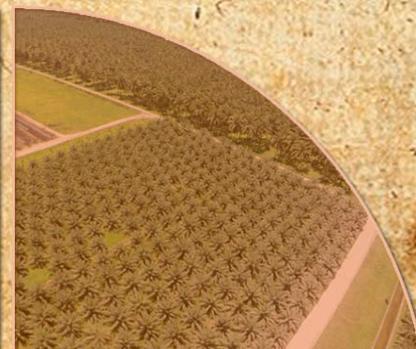
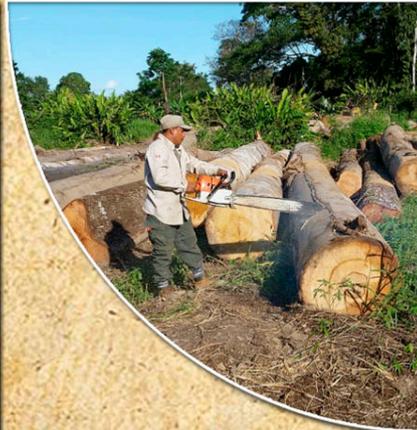
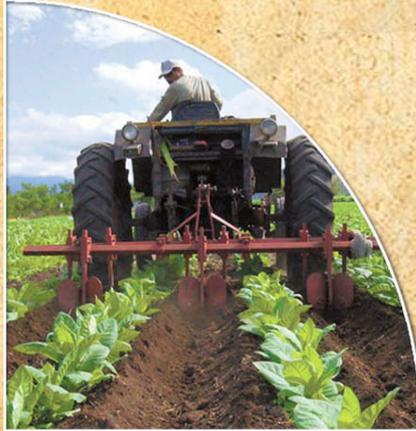
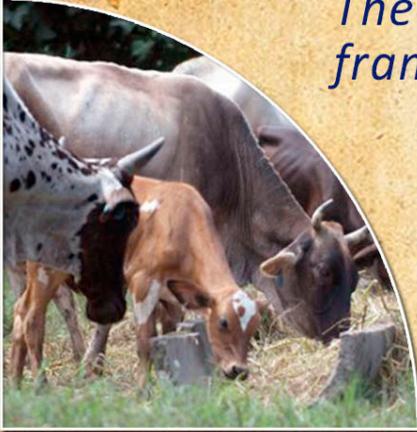


Study of the causes of deforestation and forest degradation

*The problem of forest carbon inventories in the
framework of the ENDE-REDD+ strategy*

Nicaragua



Ministry of the Environment and Natural Resources

“Project Support for the Preparation of the Strategy for Emissions Reduction by Deforestation and Forest Degradation (ENDE-REDD+) - TF099264 ”

Study of the causes of deforestation and forest degradation in Nicaragua

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May 2017

Managua, Nicaragua

Cite document as:

Study of the causes of deforestation and forest degradation in Nicaragua. “The problem of forest carbon inventories and the strategic focus of the ENDE-REDD+ Program to attend these causes on a national level”. Project Support for Strategy Preparation for the Reduction of Emissions by Deforestation and Forest Degradation (ENDE-REDD+) -TF099264. General Direction for Climate Change, Ministry of the Environment and Natural Resources. 2017. 125 pp.

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I. Abbreviations

BCN	Central Bank of Nicaragua
BM	World Bank
BOSAWAS	Bocay, Saslaya and Waspuk (Biosphere Reserve)
CATIE	Center for Tropical Agricultural Research and Education
CD-SINAPRED	Co-Direction of the National System for the Prevention and Mitigation of Disasters
CENAGRO	National Agricultural Census
CEPAL	Economic Commission for Latin America
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CRACCN	Regional Autonomous Council of the North Caribbean Coast
CRACCS	Regional Autonomous Council of the South Caribbean Coast
EAs	Agricultural Use by Surface
EESA	Social and Environmental Strategy
EDAN	Damage Evaluation and Needs Analysis
ENDE	National Deforestation Avoidance Strategy
ENL	National Fuelwood Survey
ER-PIN	Preparation of the Working Paper for the Emissions Reduction Program
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Statistics of the Food and Agriculture Organization of the United Nations
FUNICA	Foundation for the Agricultural Technological and Forestry Development of Nicaragua
GIZ	German Cooperation Agency
GRACCN	Regional Autonomous Government of the North Caribbean Coast
GRACCS	Regional Autonomous Government of the South Caribbean Coast
GTI	Indigenous Territorial Governments
IDR	Institute for Rural Development
INAFOR	National Forestry Institute
INETER	Nicaraguan Institute for Territorial Studies
INIDE	National Statistics Institute
INTA	Nicaraguan Institute for Agricultural Technology
INTECFOR	Technical Forestry Institute
IRENA	Institute for Natural Resources
MAG	Ministry of Agriculture
MAGFOR	Ministry of Agriculture and Forestry
MARENA	Ministry of the Environment and Natural Resources
MEFCCA	Ministry of Family, Community, Cooperative and Associative Economy
MEM	Ministry of Energy and Mines
MIFIC	Ministry of Promotion, Industry and Commerce
MYPIMES	Micro, Small, and Medium Businesses
NITLAPAN	Institute of Research and Development
ONG	Non-Governmental Organizations
PEF	Forestry Exploration Patrol
PIB	Gross Domestic Product
POF	Forestry Observation Posts
POSAF	Social-Environmental Forestry Program

PROCAFOR	Project Support to Forestry Activities
PROFOR	Forestry Program
PYMES	Small and Medium Businesses
PN	National Police
RACCS	Autonomous Region of the South Caribbean Coast
REDD+	Reduction of Emissions from Deforestation and Degradation
R-PP	Readiness Preparation Proposal
RSP	Private Wilderness Reserve
SINAP	National System of Protected Areas
SINIA	National Environmental Information System
TLC	Free Trade Agreement
UCA	University of Central America
UNA	National Agricultural University
UNAN	National Autonomous University of Nicaragua
VAN	Current Net Value
BEN	National Energy Balance
CCAD	Central American Commission for the Environment and Development
CIAT	Center for Tropical Agricultural Research
CONAFOR	National Forestry Commission
ENL	National Fuelwood Survey
FONADEFO	National Forestry Development Fund
FUNDENIC SOS	Nicaraguan Foundation for Sustainable Development
GOFO	Forestry Governance
GPC	Citizens' Cabinet of the People's Power
INAFOR	National Forestry Institute
INATEC	National Technological Institute
INETER	Nicaraguan Institute for Territorial Studies
INF	National Forestry Inventory
INIFOM	Nicaraguan Institute of Municipal Promotion
MARENA	Ministry of the Environment and Natural Resources
MEM	Ministry of Energy and Mines
MIFIC	Ministry of Industry and Promotion
ONG	Non-Governmental Organization
PAFNIC	Nicaragua National Tropical Forestry Plan
PNUD	United Nations Development Program
REDD	Emissions Reduction of Emissions from Deforestation and Forest
SINIA	Degradation
SSC	National Environmental Information System of Nicaragua
TEP	Solid without Bark
TM	Tons Petroleum Equivalent
TI	Metric Tons
AFOCNIC	Indigenous Territories
	Project Finnfor, Forests and Forest Management in Central
	Western Nicaragua Forestry Association
	Health Virtual Library

II. Introduction

The Government of National Reconciliation and Unity (GRUN), through MARENA, promotes various national strategies, with emphasis on prevention and adaptation to climate change, working in consensus with key national, regional, municipal, territorial and local actors. For this, a national strategy is being prepared, to reduce deforestation and degradation of forests, creating synergies among national policies to adjust to and to take advantage of international financing mechanisms for forests and that they be flexible for our national and regional circumstances.

This national strategy is the basis of the ENDE-REDD+ Program, whose horizon covers the period from 2018 to 2040. The program will focus on a national framework of effective and efficient execution of actions to reduce deforestation and forest degradation in Nicaragua, at the same time it will include a series of safeguards¹ to mitigate negative impacts, and permit among other things, to provide benefits to the communities that have protected and preserved their forests. Furthermore, the program will contribute to capacity building at all levels for those who are integrated in the system of natural resource governance, which will substantially improve the public and private institutional capacities to revert, in short, medium, and long term, the tendencies toward the destruction and loss of natural capital in the country.

Deforestation and forest degradation are phenomena that contribute most to the deterioration of the environment and natural capital in Nicaragua. MARENA initiated in 2013 the country preparation process named (Readiness), through a donation with technical and financial support from the FCPF². This REDD+³ Readiness preparation process is an initiative directed at countries whose tropical forests are threatened. The goal is precisely to promote the reduction of emissions produced by deforestation and forest degradation. To achieve this goal, it is necessary to define precisely the distribution and influence of the causes that provoke or exacerbate both phenomena.

To this end, MARENA presents the Study of the causes of deforestation and forest degradation in Nicaragua. This document identifies the historic and recent causes that provoke the loss of forests and forest degradation on a national level. Furthermore, it classifies the causes as direct, indirect and fundamental for both processes. Likewise, it determines the placement of the hot points of deforestation and forest degradation in the country, and presents an estimation of the relative weight of each cause contributes to net CO₂ emissions.

This study explores the relation among several socioeconomic, biophysical, and environmental aspects that are related with the identified causes and that influence the magnitude of deforestation and forest degradation nationally. After analyzing the causes (direct and indirect), a placement of these with the proposals of strategic lines and actions and the protagonists from diverse spaces mentioned as important from diverse consultation spaces to achieve mitigation of the advance of the deforestation and forest degradation. In conclusion, emphasis is made in

¹ [http://enderedd.sinia.net.ni/Docs/DocENDE/2.%20Estudio%20Causas%20Desforestaci%3%b3n%20y%20Degradaci%3%b3n%20Forestal%20\(English\).pdf](http://enderedd.sinia.net.ni/Docs/DocENDE/2.%20Estudio%20Causas%20Desforestaci%3%b3n%20y%20Degradaci%3%b3n%20Forestal%20(English).pdf)

² Financial support via FCPF came from a donation of US\$ 3.8 million that began in 2013.

³ REDD+ = Reduction of emissions derived from deforestation and forest degradation, protect forests, promote sustainable ordering of the forests and improve the carbon reserves in developing countries (REDD+ from English initials).

the problem of the forest carbon inventories and in the necessity to count on a strategic focus from the ENDE-REDD+ Program to attend to the causes in this country.

1.1 Antecedents and justification

Deforestation and forest degradation are key sources that contribute to climate change because they contribute significantly to the world emissions of GEI (15-25 % of the annual global GEI emissions) (Houghton 2005). The activities centered on reduction of emissions derived from deforestation and forest degradation are converted to essential parts of climate policy on a world level, as potentially efficient and low-cost options to mitigate climate change.

The third evaluation report of the Intergovernmental Panel for Climate Change (IPCC) concluded that the forest sector has a biophysical mitigation potential of 5.380 Mt CO₂ / year average until 2050, (Kauppi *et al.*, 2001), while the land-use sector, land-use change and silviculture presented a biophysical mitigation potential in all lands 11670 MtCO₂/year (IPCC, 2001, p. 110).

In the future, the effects of climate change and deforestation and forest degradation are anticipated to increase principally in tropical regions, with grave impacts on water, energy, food, health, and other social, environmental, and economic costs. For this reason, the strategies to reduce deforestation and forest degradation and its collateral negative impacts have to be addressed over the entire world, specifically in the hot points of deforestation and forest degradation.

Nicaragua is localized in the Mesoamerican region, which is considered a Biodiversity HotSpot, and paradoxically, is also a deforestation hotspot on a regional level. Part of this situation is due to extractive activities, which are reflected in high levels of deforestation and forest degradation and natural ecosystem losses. The tropical forests are disappearing as a result of a combination of local, as well as regional, pressures, which act together with several factors in different localities (Geist *et. al*, 2002).

In the last 50 years, the forest resources in Nicaragua have been subject to an accelerated process of deforestation and forest degradation, losing an average of 70 thousand hectares annually, which, in absolute terms, corresponds to the loss of more than 50 % of the existing forest cover in the country. Currently, el 30 % of the national territory is covered by natural forests (INAFOR 2009).

This situation has generated a loss of natural capital, deterioration and loss of soils, scarcity of underground and surface water due to the absence of rains, fragmentation of biological corridors, loss of native fauna, alterations of forest ecosystems, advance of the agricultural [FRONTIER], recurrent forest fires, appearance and expansion of blights and diseases, and modification of local microclimates, among others.

Even without considering the phenomenon of climate change, from the decade of the 1960's, there has existed an accelerated degradation of the natural resources, soil, water, and fore, which is attributed to the implementation of modes growth in extensive agricultural and ranching and in monoculture, which is highly dependent on external inputs; both at the expense of reduced forest areas and degradation of natural resources.

The threat of climate change is growing, becoming evident in severe, negative impacts on the forest resources and populations, and affecting significantly the development and welfare of

families and rural communities in the country that are highly dependent on forests and are direct users of their goods and environmental services. Nonetheless, the loss of natural capital in its totality increases vulnerability not only in the minority populations, but in the entire country.

For this reason, Nicaragua has committed to reduce emissions by deforestation and forest degradation. For this, the process of preparation of the Reduction of Deforestation and Forest Degradation (REDD+) for the country is being performed, for which it is in the formulation phase of the National Strategy for REDD+ (named ENDE-REDD+). Part of this national effort includes the Emissions Reduction Program Design (ERPD) in the Caribbean Coast. Both initiatives receive financial support from the World Bank through the donation TF 099264/Project No. P120657 of the Forest Carbon Partnership Facility (FCPF).

Part of the process of Readiness preparation of the country implies good definition of the causations and issues of forest loss and degradation; it is imperative to evaluate the issues to design strategies that combat the true causes in the territories, and at the same time reverse the tendencies effectively.

1.2 Study objectives

The principal objective was to identify the nature, extension, and tendencies of the causations of deforestation and forest degradation in the country, with emphasis on the period 1983-2015.

The specific objectives were:

1. Identify the principle direct and indirect causes of deforestation and forest degradation and estimate the contribution and weight that these factors have in the emissions derived from the loss of forests in Nicaragua.
2. Identify the hot spots of deforestation and forest degradation on a national scale.
3. Define the political, social, economic, biophysical, and environmental aspects that influence the tendency toward deforestation and forest degradation in the country.
4. Place the direct and indirect causes of deforestation and forest degradation with strategic lines and actions that permit the mitigation of the advance of deforestation and forest degradation in the country.

1.3 Country context

Nicaragua is localized in the Central American isthmus. Its northern border is shared with Honduras, its southern with the Republic of Costa Rica; to the east and west are the Atlantic and Pacific Oceans, respectively. The continental surface is 130,373.47 km², with 8 % occupied by continental water, in 26 lagoons and 3 lakes (MARENA 2007).

The principal economic activities are mainly in the primary sector, based on agricultural activity. The secondary sector is composed of commerce and industrial manufacturing. Nicaragua is considered a country of middle-low income (World Bank, 2015).

Jurisdictions in Nicaragua

Nicaragua possesses four types of jurisdictions, according to the extension and mandate of each, in order of greater to smaller scale: National, regions, departments, and municipalities.

There are three well-defined regions: Pacific, North-Central, and Caribbean Coast (North and South), in each of which different jurisdictions are found.

Nicaragua has 15 departments, and two Autonomous Regions of the Caribbean Coast, and 153 municipalities. Each municipality is a jurisdiction with local government. Furthermore, the Autonomous Regions have their own, respective, Regional Government of the North Caribbean Coast (GRACCN) and Regional Government of the South Caribbean Coast (GRACCS).



Figure 1 Departments y regions (Pacific, North-Central, North Caribbean Coast, South Caribbean Coast) of Nicaragua.

Multiethnic population

Nicaragua is a country with high cultural and multiethnic diversity. The population is characterized by Mestizos, Miskitos, Ramas, Creoles, Afro-descendants, Mayagnas, Ulwas, Nahoas, Xius, Cacaotera and Chorotegas.

The total population is estimated at 6 million people, of which 70 % are considered mestizos and 30 % of other ethnic origins. In Figure 2 the official territories where the ethnic groups are found and have land-use and natural resource rights are presented. The white color is of majority mestizo-origin population.



Figure 2 Localization of the indigenous peoples and afro-descendants in Nicaragua.

Protected Areas

The National System of Protected Areas (SINAP) consists of 72 protected areas, which represent 17 % of the national territory (approximately 1.7 million hectares).

The protected areas are classified in 9 classes according to the respective conservation objectives. The areas merit special mention: BOSAWAS Biosphere Reserve, San Juan River Biosphere Reserve, and Ometepe Biosphere Reserve. Furthermore, there are 47 Private Wildlife Reserves that cover 6868 ha, and 60 % of these are found in Jinotega, Matagalpa, Rivas, and RACCS.



Figure 3 Localization of protected areas in Nicaragua

Climate and precipitation

Precipitation is characterized by a variety of levels or ranges. In total, some 12 well-defined ranges exist, that vary from < 800 mm to > 5000 mm yearly.

This broad of ranges in precipitation contributes to a diversity of climates, forest formations, and ecosystems in the country. In the Pacific Region, the ranges vary from < 800 mm to 1800 mm yearly. In the North-Central Region, the ranges vary from 800 mm to 2500 mm yearly. In the Caribbean Coast Region, the ranges vary from 2000 mm to > 5000 m yearly.

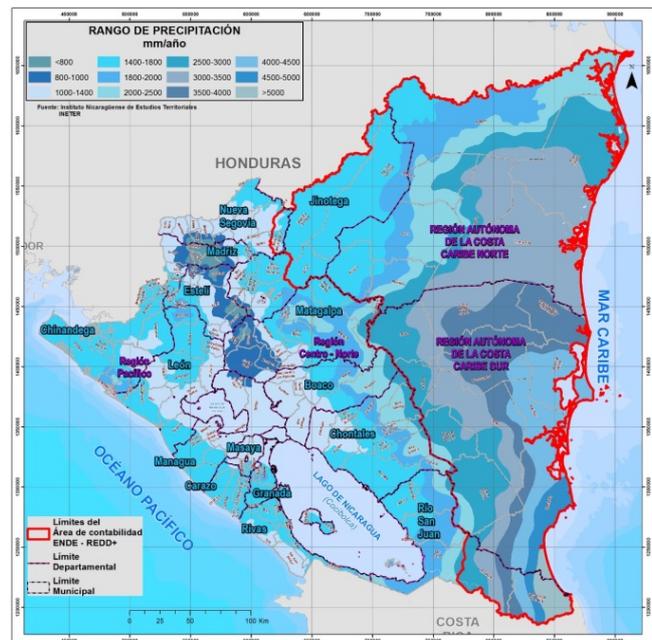


Figure 4 Distribution of ranges of precipitation in Nicaragua.

Elevations

The elevations present ranges from 0 to 2200 masl.

This breadth of ranges in elevations is markedly distinguished within the regions of the country.

In the Pacific Region, the ranges vary from 0 to 500 masl. In the North-Central Region, the ranges from 500 to 2020 masl.

In the Caribbean Coast Region, the ranges vary from 0 to 1100 masl.



Figure 5 Distribution of the ranges of elevation in Nicaragua.

Climatic vulnerability

Nicaragua is the fourth most-affected country by climatic events during 1994-2013 (German Watch 2014).

During that period, there were 49 climate events registered in the country, which generated economic losses of US\$301 million and 2.98 deaths per 100,000 inhabitants.

For the country, the development of strategies and actions to reduce vulnerability is imperative. Adaptation to climate change based on the ecosystems present in Nicaragua can be key to increase its resilience to the effects of climate change.

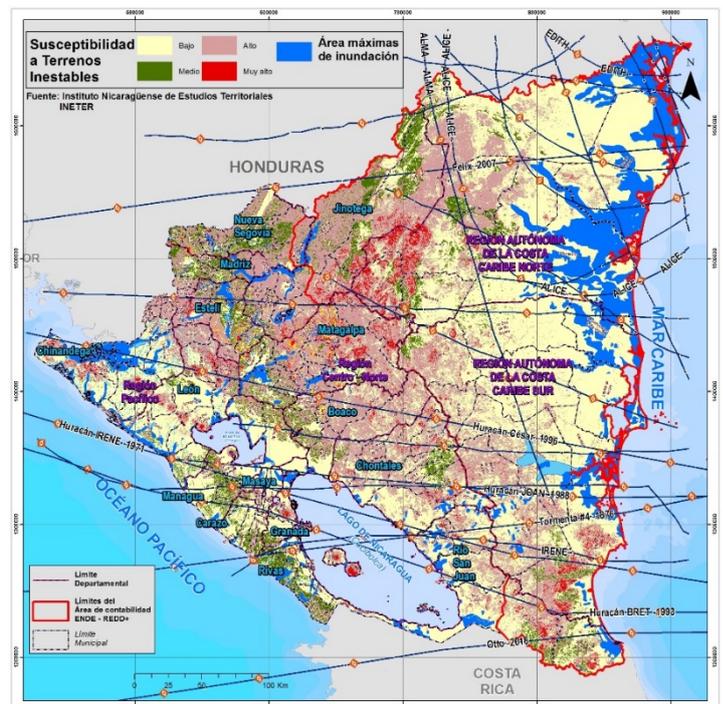


Figure 6 Distribution and extension of the sites vulnerable to floods, hurricanes, and landslides in Nicaragua.

1.4 Scope and limitations of the study

This study is a reference for the historical analysis of the causes (both direct and indirect) of deforestation and forest degradation, moreover it can be considered to be a point of departure to make current the national and regional causes, that is, to review the causes on a more local scale in future updates.

The particularities and limitations of this study are:

- It is based principally on secondary data to define the historic causes of deforestation and forest degradation, although a variety of national sources were considered, which permit the creation of an ample vision of the historical and current situation.
- To complement the review of literature sources, the meeting notes from the ENDE-REDD+ events were taken into account (i.e., EESA workshops and work sessions) in which the causes and effects of deforestation and forest degradation were mentioned.
- The principal direct causes of deforestation and forest degradation were reviewed, taking as a basis, the maps of forest cover, and intrinsic errors of classification in the use classes made to the date of presentation of the present version of the document.

II. Data and methods

2.1 Production of the national report

The study of the causes of deforestation and forest degradation and the dilemma of the forest carbon inventories in the framework of the ENDE-REDD+ strategy contemplated the use of diverse sources and types of descriptive, qualitative, quantitative, and spatial analyses. The process of development of this report included feedback from participants in the territories and fundamental adjustments that emerged from the review of the preceding versions that were considered preliminary working drafts. In Figure 1, the process of the study and the preparation of the final report are described. In the following paragraphs, the process is synthesized in four steps.

Step 1: First, the information presented in the documents RPP⁴, ERPIN⁵, and the EESA⁶ workshops, performed in 2012 and 2015, respectively. Based on this information, a preliminary version of this study was made, which included a description of the status of the forests and deforestation during the 2000 to 2010, as well as a systematization of the direct and indirect causes reported to date, the driving forces and the places of incidence. Furthermore, the legal and institutional aspects, and the efforts of the country in reducing the identified causes, were described.

Once the secondary information was compiled and analyzed, the team of specialists of the ENDE-REDD+ Project constructed a proposal for the contents of the report and planned both formal and informal consultations on the causes of deforestation in the territories, with

⁴ https://www.forestcarbonpartnership.org/sites/forestcarbonpartnership.org/files/Documents/PDF/June2012/R-PP_Nicaragua_versi%c3%b3n_%20formal_junio0112_cerrado.pdf

⁵ https://www.forestcarbonpartnership.org/sites/fcp/files/2015/September/Nicaragua_ERPIN_Sept%2021%202015_final_Sp.pdf

⁶ A total of 10 workshops were conducted.

community members, GTI, inter-institutional technical personnel, universities, national and regional political authorities, which participated in the sessions of the EESA table.

Step 2: After receiving multiple commentaries and identifying the weaknesses and absences of information, the second stage of internal review of the study was begun, which included the broadening of the literature review to include more recent sources and plan a methodology of prioritization of the causes of deforestation and forest degradation. Informal interviews with key actors and local workshops in RACCN y RACCS were conducted in which the topic of the causes of deforestation and forest degradation (DandD causes) were addressed, and with this information another, improved version of the report was made. Additionally, numerical and spatial data from diverse sources was obtained, among them from: FAOSTAT, BCN, INAFOR, INETER, MARENA-SINIA, among others.

In parallel, the process of preparation for the country report continued and in the aspects of the construction of the Reference Scenario and the National System of Monitoring, Reporting and Verification (Components 3 and 4), an update on the base information for the national analysis of forest cover, land use and land-use changes was planned, with the objective to improve the estimates of the rate of deforestation, forested areas, and deforested areas.

For this reason, in June 2016, the task of revising the national maps for years 1983, 2000, 2005, 2010, and 2015 was begun, including: the development of a protocol for the validation of these national maps, the homologation of methodologies to classify forest cover in the country, estimation of classification errors, and validation of the maps with primary and secondary data (i.e., control points), to have at the end, an official publication of these maps. Drawn from these maps was an analysis of several periods, 1983-2000, 2000 and 2010, 2005-2015, 2000-2015, which was included in the Report on the causes of deforestation and forest degradation.

Step 3: After a round of internal reviews and reviews with members of FCPF, the need to improve the presented analyses was established, principally regarding the information on the nature of the causes, spatial distribution, and relative importance of the causes of total emissions derived from the deforestation and forest degradation. In this step, a method of qualitative and quantitative evaluation of the D and D causes was developed, and a round of consultations to receive feedback on the report was made.

Step 4: Finally, with the feedback received, the new version of the report was focused on improving aspects of the presentation of the causes and their prioritization, as well as to include the spatial analyses and statistics that demonstrate the multifactorial relation with process of deforestation and forest degradation nationally, regionally, and by municipality. To strengthen the study, secondary sources were consulted in publications by GIZ, CATIE, INAFOR, INETER, MARENA, GRACCS, GRACCN, MEFCCA, INTA, GTI, MAG, academic publications, and information contained in the minutes of different activities of the EESA process that the ENDE-REDD+ project had directed, principally in the Autonomous regions of the Caribbean Coast, although also in some sites in the Pacific and North-Central regions of the country.

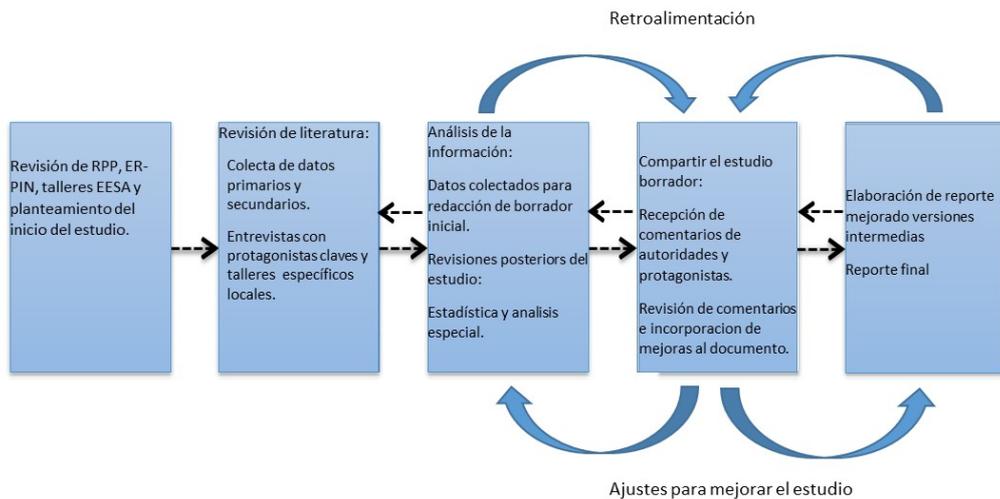


Figure 7. Steps to develop the study of the causes of deforestation and forest degradation in Nicaragua.

2.2 Methods

In this section are described the procedures followed to place in context the D and D causes, analysis their spatial distribution, and estimate the impact on emissions nationwide.

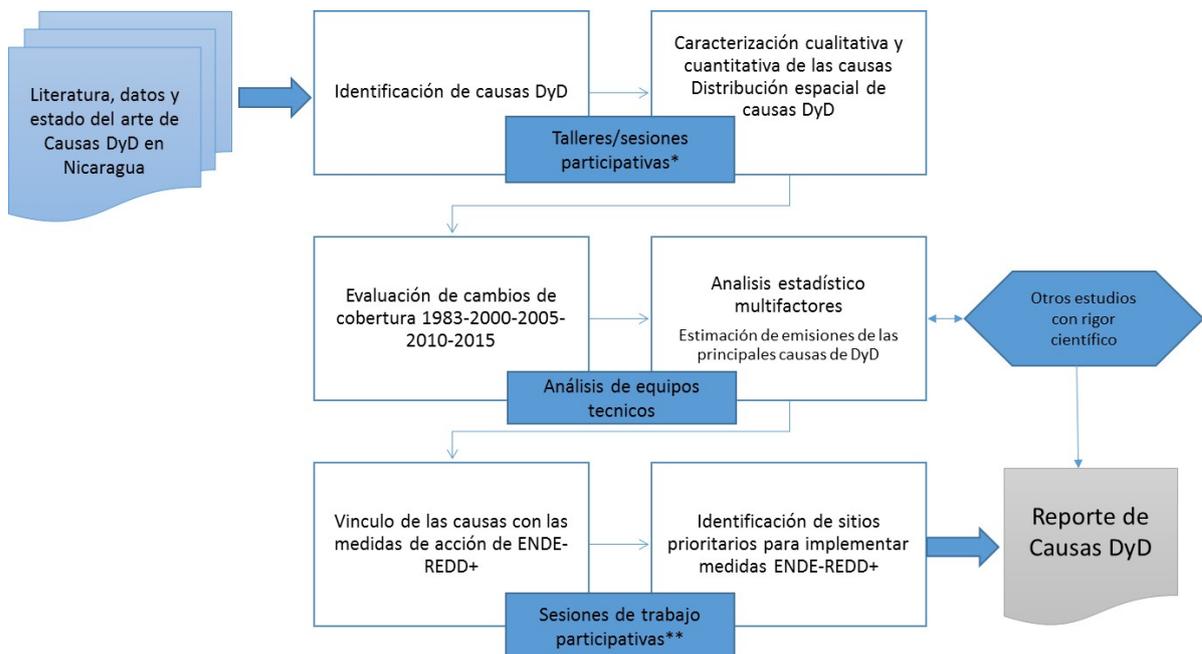


Figure 8 Methodological process of the study of the causes of deforestation and forest degradation in Nicaragua.

*Six participative sessions with actors were executed (RACCN = 2, RACCS = 2, Managua = 2).**Three participative work sessions with the ENDE-REDD+ technical team were executed.

2.2.1 Search for information

An exhaustive review of the digital and printed publications (i.e. reports of local studies, documents of projects and/or consultancies, institutional reports, news reports, etc.) related to the status of the forests, land use, forestry, livelihoods, types of land ownership, and adaptation and mitigation of climate change, was performed. Furthermore, inter-agency and inter-institutional documents of different periods (1980s, 1990s, 2000s, and the last five-year period), as well as policy and law documents that dictate the management and conservation of natural resources in Nicaragua, with greater emphasis on strategies, national plans, decrees, procedures, technical norms, and sectorial aspects, from the forestry sector as well as the agricultural sector. After completing this review, information useful for the report was selected, the principal sources and missing information were revealed.

Figure 9 presents the diversity of information sources that were reviewed in each methodological step, that is: for the identification of the historic causes of D and D, the identification and localization of the historic and current causes of DandD during the EESA workshops and other ENDE-REDD+ events, the validation and prioritization of the DandD causes via the homologation and participative mapping, as well as the adjusted spatialization of the DandD causes, the statistical analyses, and the placement of the D and D causes and necessary measures to mitigate them.

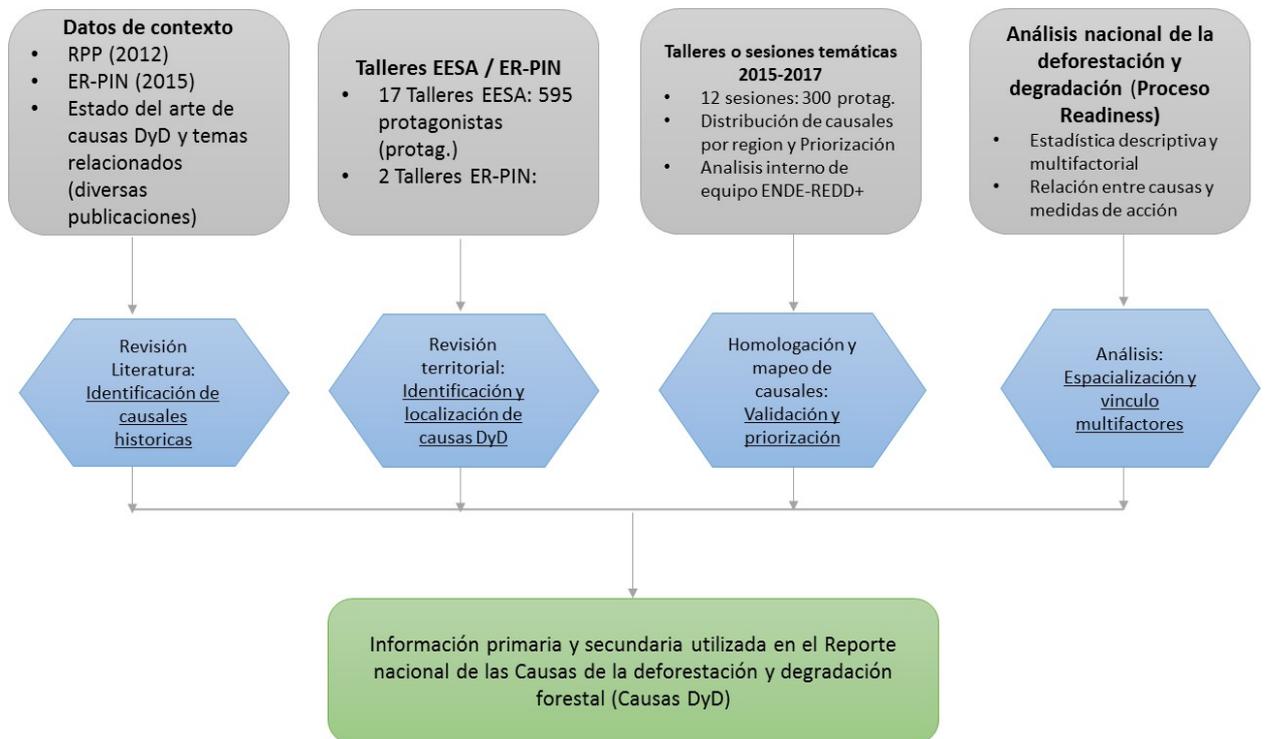


Figure 9 Primary and secondary information utilized in the national study of the causes of deforestation and forest degradation in Nicaragua.

2.2.1.1 EESA / ER-PIN workshops

During the process of country Readiness preparation, several events for the development of the Social and Environmental and Social Evaluation Strategy (EESA)⁷ on a national level, as well as for the development of the Profile of the program for the reduction of emissions in the Caribbean Coast (PRE-Caribe), which included the regions RACCN and RACCS, and the municipalities El Cuá, San José de Bocay, and Wiwilí de Nueva Segovia, Wiwili de Jinotega, El Castillo y San Juan de Nicaragua .

The EESA⁸ events were focused on socializing and consulting with the platform of multiple actors, all the pertinent information to ENDE-REDD+, with the objective to obtain feedback on the strategy, assuring the inclusion of opinions, perspectives related to the functionality of the Social and Environmental Safeguards in the framework of the ENDE-REDD+. This EESA process included about 15 workshops, in which the compliance of environmental and social operation policies of the World Bank was undertaken.

Instead, the events of the PRE-Caribe process were two workshops that were characterized by setting a dialogue to socialize the inputs for the preparation of the Working Paper of the Emissions Reduction Program (ERPIN)⁹.

2.2.1.2 Consultations and meetings with the actors

Various consultations and meetings were organized with the actors to treat key themes with respect to the causes of deforestation and forest degradation. In different moments, the actors expressed their understanding about the origin, magnitude and localization of the identified causes. As a set, the meetings were analyzed together, and information was systematized from 19 workshops (595 persons).

Additionally, to evaluate the relative importance of the causes, two participative workshops were also conducted, one in each autonomous region, in total participating 40 persons (the method is presented in section 2.2.3.2).

2.2.1.3 Home inquiries / National censuses

The results of the home inquiries and national censuses published in the National Institute of Development (INIDE) were reviewed. These inquiries and national censuses provided an adjusted base of information in all the municipalities and on a national level. Specifically, the information reviewed was: Agricultural Census of reference years 2005 and 2010 (INIDE & MAGFOR 2011), and Home and Living Space Inquiry (INIDE 2010).

⁷ EESA is a process of participation and feedback among the actors, not of decision-making.

⁸ EESA is a methodology that provides a participative process that is developed during the design of the ENDE-REDD+ strategy, integrating social and environmental considerations and identifying benefits and risks, proposing actions to strengthen these identified benefits and reduce the risks. EESA assures the analysis and compliance of the Safeguards, the OP and the World Bank, concluding all of it in the definition of a framework of environmental and social management (EMFS) that must be applied during the stage of implementation ENDE-REDD+.

⁹ The Profile document of the Program of reduction of emissions of the Caribbean is known ER-PIN, from its initials in English, *Emission Reduction Profile Idea Note*.

2.2.1.4 Forestry statistics, productivity, supply and demand of forest products

Secondary information was reviewed on the status of managed forests and forestry plantations on a national level. These statistics contributed to the support of the evaluation of productivity or yield, and the current and future supply and demand for forest products from the country. Also the studies on use and management of wood and non-wood products were taken into account for this study. This collected information served in the analysis of deforestation and forest degradation on a national level.

2.2.2 Identification of DandD causes

The results of the regional workshops, where the local, historic and present causes of deforestation and forest degradation, were systematized. Additionally, after conducting the review of secondary information, material from the principal publications on the topic which are found in the country, were extracted.

2.2.3 Qualitative and quantitative characterization of the DandD causes

After compiling the primary and secondary information on the causes of deforestation and forest degradation, a qualitative and quantitative characterization of the causes was undertaken, for this analysis were used the results of the events (workshops and work sessions) executed in 2015, 2016 y 2017.

2.2.4 Evaluation of changes in use

Part of this study included the evaluation of the changes in land use from 1983 to 2015. With the results of this evaluation it was possible to estimate the rate of change in land use and the rate of deforestation on a national level. In the process of country Readiness preparation, are contemplated the updating and validation of the national forest cover maps for the years 1983, 2000, 2005, 2010, and 2015. These maps are based on LandSat imagery, which permits comparison across various time series.

Table 1. General characteristics of the national forest cover maps to evaluate the changes.

Years	Images	National use classes
1969	LandSAT 1968, 1969, 1970	<ul style="list-style-type: none">• 17 national use classes• 6 standard use classes following IPCC• National classes reclassified to estimate losses by degradation.
1983	LandSAT TM (1981, 1982, 1983)	
2000	LandSAT TM, ETM, LandSAT 7 (1999, 2000, 2001)	
2005	LandSAT TM, ETM, LandSAT 7 (2003, 2004, 2005)	
2010	LandSAT TM, ETM, LandSAT 7 (2009, 2010, 2011)	
2015	LandSAT TM, ETM, LandSAT 7 (2013, 2014, 2015)	

2.2.4.1 Participative mapping

The participative mapping activities were derived from the workshops as well as from work sessions during 2015-2017. At least 4 regional workshops were conducted in which the actors contributed to the construction of maps with areas of higher land use conflicts, and where, mostly, the deforestation and forest degradation are observed. The workshops were conducted principally in RACCN y RACCS.

2.2.4.2 Construction of thematic maps

To evaluate the factors associated with deforestation and forest degradation, thematic maps regarding several variables or factors were prepared, such as, among others: roads, slopes, soil types. Tools and data that were used in the development of the maps:

- **Use of Software:** ArcGIS versions 10.2 y 10.3 were utilized to process spatial data and the development of thematic maps. LandSat images were processed to obtain historical and current forest cover maps, as well as changes in forested areas and other land uses.
- **Management of spatial data:** official spatial data of Nicaragua, such as digital elevation models, municipal boundaries, placement of cities and settlements, roads, among other variables already published by the Nicaraguan Institute for Territorial Studies (INETER). In the Annex, a complete list of the thematic maps that were used for the analysis of DandD is presented.

2.2.4.3 Concepts utilized

For the process of review and validation of the national maps, within the Technical Monitoring Table, the concepts to be utilized for the development of maps as well as for land-use changes were reviewed. To this end, basic concepts of specialists were taken into account. In the following text, are presented the concepts that were utilized for various analyses within the study of the causes of DandD.

Table 2. Principal concepts utilized in the study of land-use change.

Term	Definition	Source
Deforestation	Open and closed forests (broadleaf and conifer) that are converted to other land uses	MRV Table
Forest degradation	Open or closed forest, whether broadleaf or conifer	MRV Table
Gain	Whatever land use that converts to open forest or secondary growth forest. Any land use that changes to palm forest or mangrove.	ENDE-REDD+ Team
Recovery	Whatever land use that converts to open forest or secondary growth forest. Any land use that changes to palm forest or mangrove.	ENDE-REDD+ Team
Active	Pastures that convert to crops (whatever kind:	ENDE-REDD+ Team

Term	Definition	Source
Potential	annuals or perennials). Crops (whatever kind: annuals or perennials) that convert to pastures Secondary growth areas that convert to pastures. Herbaceous plants that convert to pasture or crops.	
Rate of deforestation or rate of change		ENDE-REDD+ Team
Forest Duration	Forests of year t1 that are maintained as forests to the final year	ENDE-REDD+ Team
Non-Forest Duration	Other uses of the non-forest that endure as non-forest.	ENDE-REDD+ Team
	Crops to other uses	
	Pastures to other uses	
	Lands without vegetation to other uses	
	Brush cover to other uses	
	Vegetative cover to other uses	
	Secondary growth to other uses	

2.2.5 Multifactorial analysis

All the variables and collected information from the national censuses and home inquiries were compiled, processed, and analyzed. The programs Infostat v. 2016e, Excel y ArcGis were used to analyze the relation between various factors with the rates of change in land use, principally with the changes required by deforestation. The results were synthesized in simple Tables and Figures, as in maps of release of this information.

Table 3. Scale and general characteristics of the multifactorial analysis.

Scale of analysis	Type of analysis	Units of analysis	Dependent variable (Y)	Independent variables (X _n)
National	Border-to-border review	Pixel	Areas of change	Biophysical, socioeconomic, productive, and technological variables
Regional 1. Pacific 2. North-Central 3. Caribbean Coast (PRE-Caribe)	Review of land use change matrices by region, Spatial regression	Polygons and municipalities by region	Rate of change	

Process - Deforestation - Recovery of forested areas	Spatial regression	Municipalities by region	Rate of change	
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2.2.5.1 Identification of deforestation hot spots

The analysis of deforestation hot spots was conducted to identify the sites where deforestation has occurred recently or in the period evaluated 2005-2015. The scale of analysis was regional and municipal.

For the national scale, the forest-cover maps of 2000, 2005, and 2015 were used to evaluate the periods 2000-2015, 2000-2005, 2005-2015; the overlap in these maps permitted the localization of sites and regions that affect both processes.

For the municipal scale, the following layers were used: Municipal boundaries, rate of estimated municipal change. The method 'Hot Spot Analysis (HAS)' from the tool Map Cluster Analysis by ArcGIS was used. Following, are summarized the most important aspects.

The HAS is a spatial statistical technique that tests in which regions are grouped the values of the evaluated variable, and determines which of these groups are statistically significant or not. In the present study, with HAS, the spatial clusters that were statistically significant for the variable Rate of change during the period 2005 to 2015 (TAC05_15) were identified, called "hot spots", and "cold spots", or values statistically high or low, respectively. The requisites to conduct this test were: conceptualization of the Spatial Relations, Distance Method, Standardization, Band Distance, and Shadow Distance (ESRI 2017¹⁰).

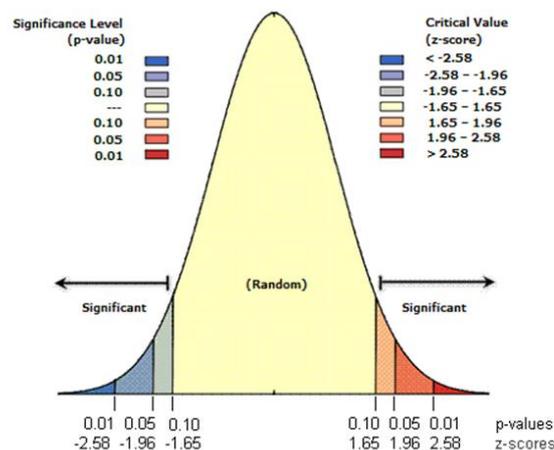


Figure 10 Punctuations of z and p values, and their level of significance related to the normal standard distribution.

¹⁰ <http://resources.arcgis.com/es/help/main/10.2/index.html#//005p00000010000000>

The punctuations z and the p values are measures of statistical significance that indicate if the null hypothesis is rejected, for each entity. Effectively, they indicate if the spatial cluster of high or low observed values is distinguished from that expected in a random distribution.

2.2.5.2 Qualitative analysis of the causal factors of deforestation and forest degradation

To make a qualitative evaluation, the methodology called CaDFa (causes of deforestation and the affected environmental variables) was taken into account, applied in the North and South Caribbean regions (based on two regional workshops). The objective of CaDFa was to estimate an index of strategic sequence of attention to the causes of deforestation and forest degradation. One limitation to this method is that it was not possible to make a deeper prioritization in the index, according to the impacts or contribution to emissions for each evaluated cause.

The methodology proposes a crossed consideration of the causes of deforestation and forest degradation and the representative environmental factors that integrate into the ecosystem sustainability, extracted from the methodology that MARENA (Ministry of the Environment and Natural Resources) utilizes for the valuation of environmental damage after natural and anthropogenic events, named EDAN (evaluation of damage and analysis of necessities), and which was approved in Ministerial Resolution No. 029-2008 and published in La Gaceta No. 21 on 02 February, 2009.

This analysis gives us qualitative information based on a scale of values or ranges among which the DandD causes were classified, and those values indicated the level of priority of attention and was needed, according to the perceptions of the actors. The participants took into account the level of effect that the causes provoke on nine (9) aspects of the ecosystems and environment in Nicaragua.

2.2.5.3 Spatial analysis of the causes of deforestation and forest degradation

For the spatial analysis of the DandD causes, Geographic Information System (SIG) tools were used to project the sites with deforestation and related factors (direct and indirect). In this study are presented two studies of factors or variables associated with deforestation: Spatial regression and Random forest.

2.2.5.3.1 Spatial Regression

The exploratory regression is considered a spatial exploration of the variables of interest. This analysis provides valuable information on the relationships among the variables. ER is a tool of data mining, which tests all the possible variable combinations explainable to see which models pass the minimum necessary ordinary diagnosis. The ER results are multiple, linear regression equations, that fit the data and that pass various statistical criteria.

Nonetheless, one valuable part of these analyses is the result of data exploration of the data, in which the relationships are investigated between the explanatory or independent variables is evaluated, and a response or dependent variable. In this study, the explanatory variables are referred to as variables of the types socio-economic, demographic, productive, technical, and biophysical, among other categories (Table 5). The response variable utilized was the rate of change in each municipality in Nicaragua ($n = 153$).

Table 4. Categories and types of data collected, descriptions of the variables and the sources of information utilized (Taken from: Zamora 2017¹¹).

Categories	Years	Type of data	Source	Description
Socio-economic, demographic, and land-tenure	2001, 2005, 2010	Non-spatial	INEC 2005	National Institute for Development Information (INIDE) 2005. Third National Population Census and Fourth Census of Housing. www.inide.gob.ni
Production and technology	2001, 2011	Non-spatial	INEC 2003	National Statistical and Census Institute (INEC) 2003. Third National Agricultural Census in 2003 (III CENAGRO) and www.inec.gob.ni
Biophysical, soil, climate	2008	Spatial	INETER 2005 Zamora 2008	Slope National Map and Altitude National Map. Scale: 1: 100000 Classes of Soils and Climate zones based on IPCC classification from Zamora 2008 ¹²
Agro-ecology, ecosystems, potential use	1998	Non-spatial	MAGFOR 2002	Agro-ecological national map. Scale 1:100000
	2006	Spatial	MARENA 2000	Map processed according to Holdridge 1972. Scale 1:150000
			MARENA 2006	Map of ecosystems at national level. Scale 1:50000
	1998	Spatial	MAGFOR-MARENA 2010	Map of Soils' potential at national level. Scale 1: 50000
Proximity	2014	Spatial	INETER 2000, MAGFOR 2000, MARENA- MAGFOR 2011	Proximity data were processed using a GIS tool for distance calculations (Near).
				Rivers: Hydrological map (INETER 2000)
				Forest, crops, grasslands 1983: Forest map 1983 (MAGFOR 2000)
				Forest, crops, grasslands 2011: Forest map 2011 (MARENA-MAGFOR 2011)
	2001, 2005,	Spatial	NOAA	Cities: Towns map (INETER 2000)
2001, 2005,	Spatial	NOAA	Hot points or fire points collected during the dry season in Nicaragua	
Soil cover	1983, 2011	Spatial	INETER 1983, MAGFOR- MARENA 2012	Land covers maps in 1983 and 2011. Scale: 1:250 000

2.2.5.3.2 Random forest

Random Forest is a predictive algorithm that uses the technique called 'Bagging o Bootstrap' to combine different trees, where each tree is constructed with randomized observations and variables¹³. Each tree depends on the values of a randomized vector independently sampled and with the same distribution for all the data¹⁴. This method was applied to a set of 10 variables

¹¹ Zamora Lopez, S.E. 2017. Doctoral Thesis, in press. Hamburg University.

¹² Processed or derived from IPCC reference during the preparation of Second GHG Inventory in LULUCF Sector in Nicaragua (Zamora 2008).

¹³ <http://apuntes-r.blogspot.de/2014/11/ejemplo-de-random-forest.html>

¹⁴ Ver más detalle metodológico en: Breiman L: Random forests. Machine Learning 2001; doi:10.1023/A:1010933404324

that helped to explain the relations between the variables and deforestation on a national level (Table 6).

Table 5. Variables evaluated (predictive) for the spatial model (Taken from: Giulio et al. 2017¹⁵)

Variables considered	Units	Source	Variables utilized in this model	Units	Source
Distance to degraded areas a	metros	MAGFOR 1983, 2000	Altitude	meters (masl)	Lehner B, Verdin K, Jarvis A. 2015
Population Density	Personas/km ²	MARENA 2011	Distance to roads	metros	INETER 2000, OMS 2015
Distance to crops	metros	CIESIN, CIAT 2005	Distance to urban centers	metros	INETER 2000
Protected Areas	Protected/ Not protected	MAGFOR 1983, 2000	Slopes	degrees	Lehner B, Verdin K, Jarvis A. 2015
Types of Forests	Broadleaf/Conifer	IUCN, UNEP-WCMC, 2014	Distance to pastures	metros	MAGFOR 1983, 2000

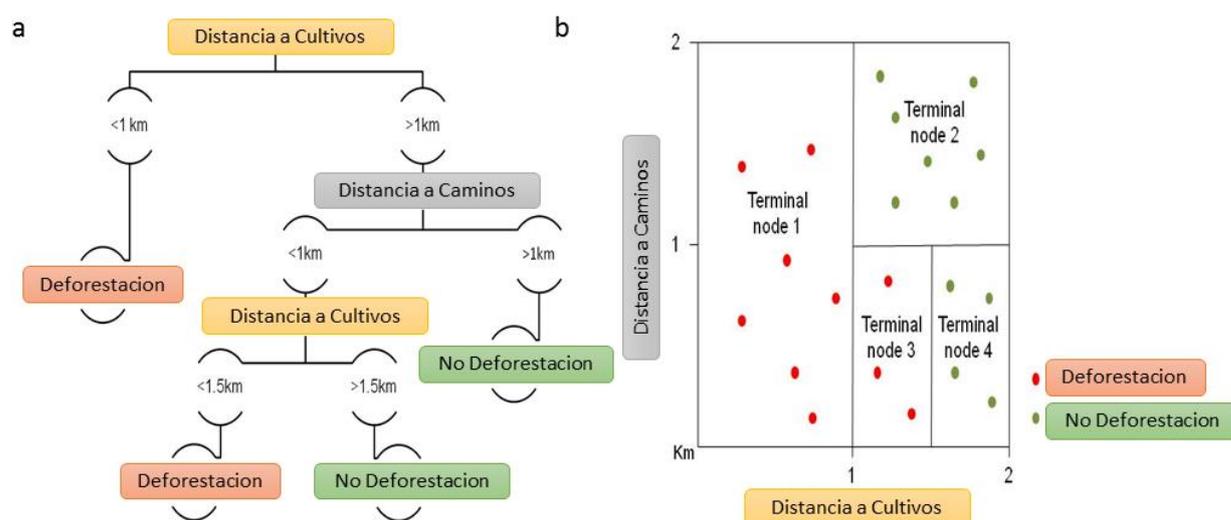


Figure 11 Punctuations of z and values of p, and their levels of significance, in comparison to a normal standard distribution. Taken from Di Lallo et al. .2017.

Figure 11. Shows by an example, how the forest cover from a use map is classified, according to the predictive variables, in this case, the distance to crops and distance from the highways. Both graphics show the same problem using different representation systems: a) showing the classification tree with three internal nodes and four terminal nodes; b) shows the partition of the bi-dimensional predictive space. This is an example of the classification that results from the application of Random forest to the forest cover map (in raster format, pixel analysis units).

2.2.6 Placement of the causes of DandD and ENDE-REDD+ action measures to mitigate them

¹⁵ Di Lallo, G.; Mundhenk, P.; Zamora López, S.E.; Marchetti, M.; Köhl, M. REDD+: Quick Assessment of Deforestation Risk Based on Available Data. *Forests* 2017, 8, 29. <http://www.mdpi.com/1999-4907/8/1/29z>

To place the DandD causes and the ENDE-REDD+ action measures, a structured analysis of the country was applied, which contemplates three principal aspects: problem analysis of the problem, analysis of the objectives, and analysis of the alternatives¹⁶. The scope of this study at the moment was focused on points 1 and 2 of the figure.

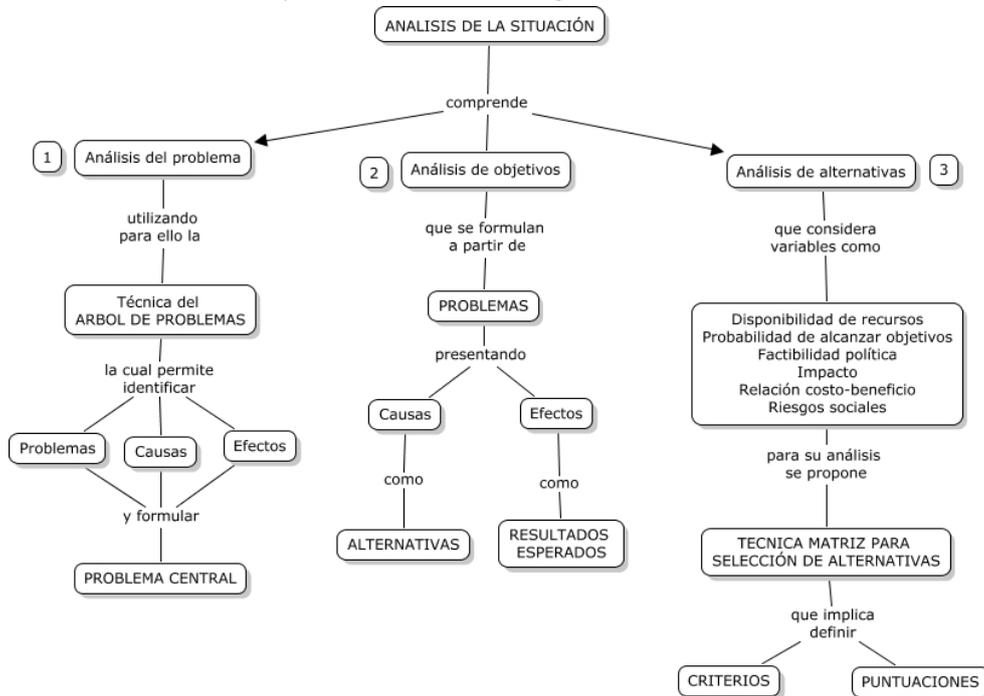


Figure 12 Method of Analysis of the Situation.

2.2.7 Identification of potential sites to implement ENDE-REDD+ measures

To identify the potential sites for the implementation of ENDE-REDD+ measures, the Multicriteria Spatial Models (MEM) were applied, these consisting of the gathering, review and preparation of spatialized information for each of the “motors” or proxies¹⁷ of these motors that are related with the processes of deforestation and forest degradation.

Each spatial model contemplates each of the variables in a Multicriteria matrix, in which weights are applied, according to the level of participation of each of the variables in the processes of deforestation and forest degradation. For example, variables were considered that describe the spatial aspects of land use, vegetable cover, dendrometric characteristics of the forest, socio-economic aspects and environmental and biophysical variables, among others, over all the national territory.

This methodology is based on the integration of SIG and spatial analysis with the Multicriteria Evaluation (EMC) techniques, and from it was acquired: models of the capacity of thematic selection and localization of the areas with potential for application of the ENDE-REDD+ measures.

¹⁶ Source: Learning process, Google images

¹⁷ Proxy: is a secondary variable that is utilized to evaluate the effect of the principal variable about which information may not be available.

This focus of the Multicriteria Model permits the establishment of fitted criteria to explore multiple alternatives and improve the decisions taken to define:

- Historical point of reference in a determined area
- Measure the future reduction of emissions caused by deforestation and forest degradation
- The potential compensation in a region

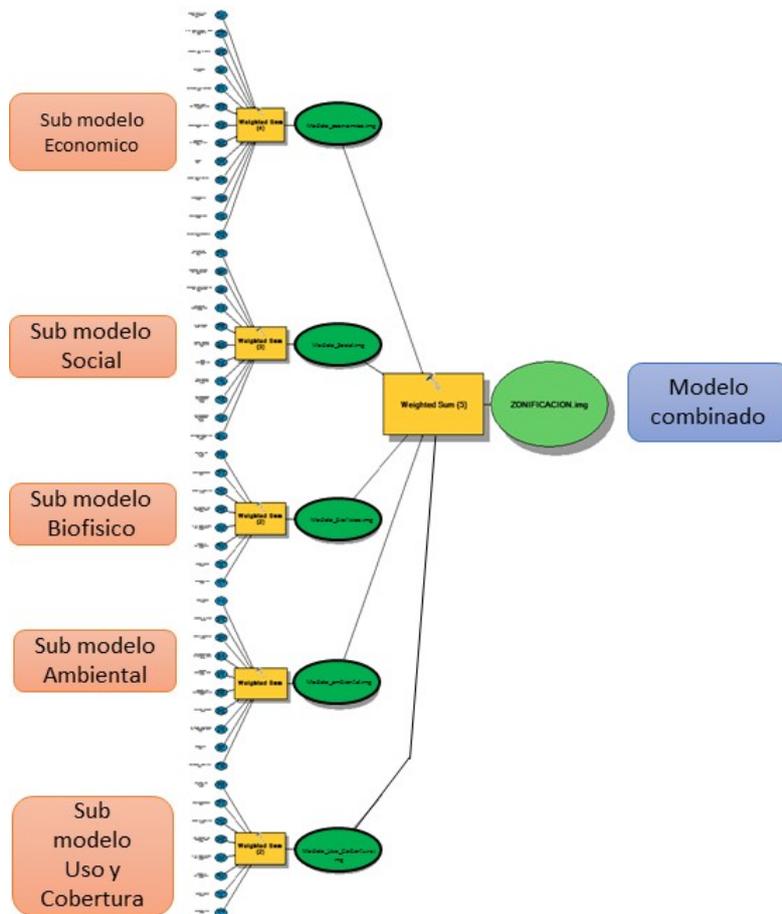


Figure 13 Schematic of the multicriteria model and the sub-models created to identify the potential sites to implement ENDE-REDD+ measures on a national level.

III. Status of the forests and land-use changes in Nicaragua

This section mentions briefly the physiographic and ecologic regions of the country. Afterward, it describes the historical and current changes reported from 1983 through 2015. Furthermore, a map of current land use for 2015 is presented. The recent changes in land use are described, for the period 2005-2015.

Furthermore, where the hot spots of deforestation and forest degradation were located, on national and local scales, is explained. The deforestation within protected areas and indigenous and afro-descendent territories is shown. Finally, a brief description of the principal impacts

caused by the deforestation and forest degradation is presented.

3.1. Physiographic and ecological regions of the country

To explore the phenomena of deforestation and forest degradation, the country was divided into three physiographic regions: The Pacific Region, the Central-North Region, and the Caribbean Region¹⁸. The Pacific Region encompasses the departments of Chinandega, León, Managua, Masaya, Granada, Carazo and Rivas. The Central-North Region, the departments of Estelí, Madriz, Nueva Segovia, Matagalpa, Boaco, Chontales and Río San Juan (El Almendro, Morrito, San Carlos and San Miguelito). These regions have been defined as *PCN Region* when considered together.

The Caribbean Region encompasses the South (RACCS) and North (RACCN) Autonomous Regions of the Caribbean Coast. Additionally, this Caribbean Region, together with other municipalities, is part of an initiative, together with the Government of Nicaragua through MARENA, with FCPF and the World Bank, that is known as the Program for Reduction of Emissions in the Caribbean (PRE-Caribe), or Area of Accounting.

For this reason, from here forward, in the document the PRE-Caribe Region will be discussed to allude to the areas occupied by RACCN y RACCS, plus four municipalities in the department of Jinotega and Nueva Segovia: Wiwilí of Jinotega, Wiwilí of Nueva Segovia, El Cuá, San Juan de Bocay, and two in the department of Río San Juan: El Castillo and San Juan de Nicaragua (Figure 14).



Figure 14 Physiographic regions and municipalities of Nicaragua.

Nicaragua forms part of the Mesoamerican region and its geographic position offers advantages for the hosting of a high richness of biodiversity and of natural ecosystems. In the country, there

¹⁸ This region is known as the Area of accounting or the area of the ERP, for its initials in English, Emission Reduction Program Development.

have been four ecological zones determined (Figure 15), which are: Pacific, Central-North, Central-Bocay, and Caribbean; within these has been identified 21 zonal tropical forest formations, and 6 azonal forest formations (Salas 1993).

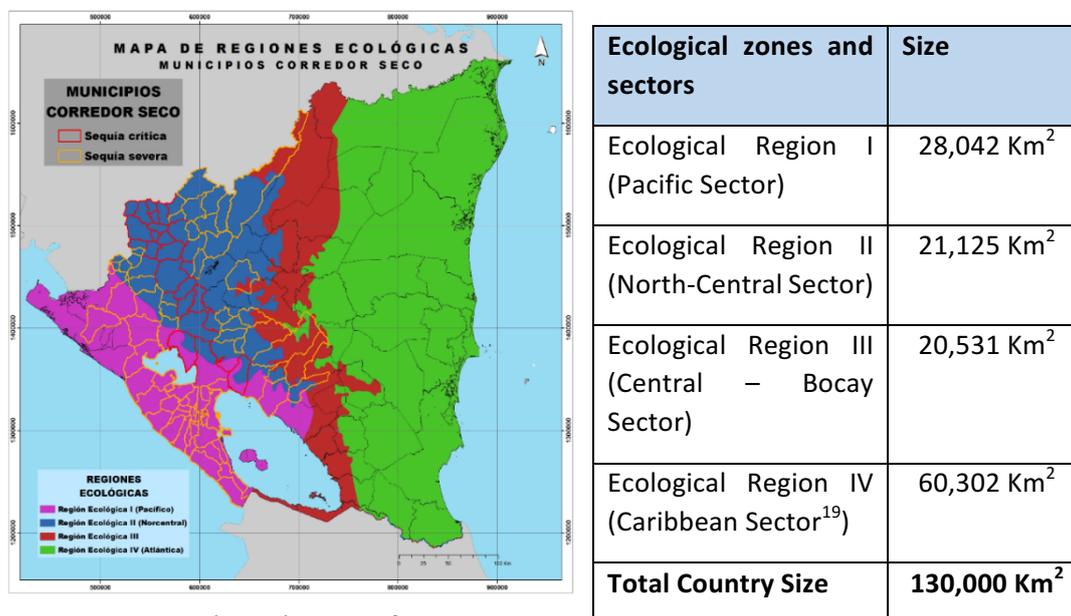


Figure 15 Ecological Zones of Nicaragua

Ecological Zone I (Pacific) is inhabited by 64.3 % of the population (3,957,017 inhabitants). Historically, the population has been concentrated in this region because it presents the best conditions for agro-industrial development. At the present, this region continues to be attractive because it possesses the best roads, connections to ports, airports, basic services, and in general, a better climate for business. It presents an average of 31.41 % poverty index and 87 % of the homes consume fuelwood in the region.

The Ecological Zones II and III (North-Central) are characterized as a region with mountains and valleys and the greatest variations in elevation, from 300 to 2000 masl, in which 30.7 % of the live (1,886,088 inhabitants). It presents an average 52.65 % poverty index and 94 % of the homes consume fuelwood in this region.

The Ecological Zone IV (Caribbean) is characterized by lowlands, plains, and areas subject to flooding. It is estimated to host 5 % of the population (307,309 inhabitants), making it the least populated zone in Nicaragua. On average, it presents a 65.22 % poverty index, and 86 % of the homes consume fuelwood in the region.

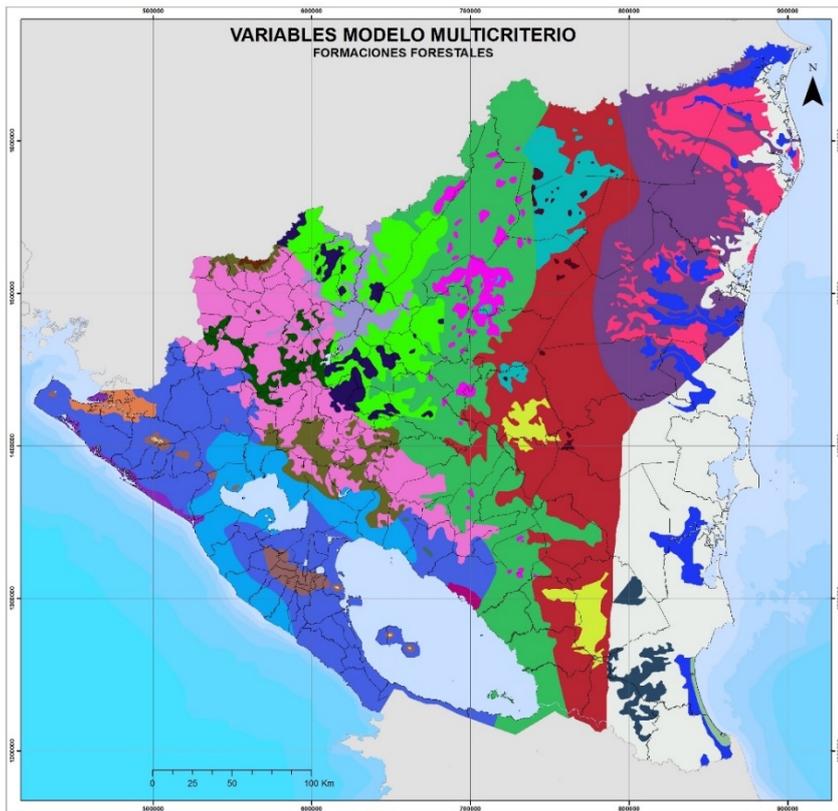
¹⁹ The Caribbean region was previously known as the Atlantic region.

Table 6. Principal crops and area occupied by farms in the regions of the country.

Values	Ecological Zones				Total
	Ecological Zone I (Pacific)	Ecological Zone II (Central-North)	Ecological Zone III (Central-Bocay)	Ecological Zone IV (Caribbean ²⁰)	
Corn Areas	88,293.54 mz	212,261.03 mz	61,818.98 mz	60,928.32 mz	423,301.87 mz
Red Bean Areas	29,927.36 mz	179,486.47 mz	41,998.77 mz	32,659.95 mz	284,072.55 mz
Total Basic Grain Areas	178,592.64 mz	438,341.61 mz	151,391.51 mz	112,675.34 mz	881,001.10 mz
Bean Production	206,573.09 qq	1580,924.45 qq	303,759.05 qq	288,193.38 qq	2379,449.97 qq
Bean Yield	10.66 qq/mz	9.30 qq/mz	10.73 qq/mz	8.70 qq/mz	9.85 qq/mz
Farms²¹	67,968	115,980	40,619	30,153	254,720

²⁰ In the references to these regions, the Caribbean region appears as the Atlantic region. Currently, only the term Caribbean is used in official documents.

²¹ According to CENAGRO 2011, farms dominate the Agricultural Economic Activities.



Nicaragua has 21 identified forest formations.

Figure 16 Zonal and Azonal forest formations of Nicaragua.

3.2 Historic land-use changes during 1983 to 2000

Nicaragua historically was considered a country with forest vocation, in 1969 there were 8 million hectares registered with natural forests, representing 60 % of the total area of the country. Nonetheless, between 1983 and 2015, Nicaragua lost 4.32 million hectares of forests, which represented more than half its historic forest area.

These land-use changes are reflected in the latest report on land use, mentioning that land had changed to 33.83 % forests and agroforestry systems, 25.98 % forests (protection, conservation), 20.33 % silvo-pastoral specialty crops, 11.8 % agriculture (intensive, restricted, and animal husbandry) (INETER 2015).

The current maps demonstrate the forest cover went from 63.3 % (of the total area of the country) in 1983 to 30.2 % in 2015. This represented a reduction of 50 % of the forest areas. Instead, in the areas not forested, a continuous increase is observed over the entire period 1983-2015, and it is reported that the total estimated area quadrupled from 27.8 % to 60.31 % during the same period (Table 8).

Table 7. Forest areas and areas not forested, registered from 1983 to 2015 in Nicaragua.

Categories of Use	1983	% of total	2000	% of total	2005	% of total	2010	% of total	2015	% of total
Forests	8255,861	63.3	5449,384	41.8	4545,859	34.8	4049,257	31.0	3938,669	30.2
Areas not forested	3633,030	27.8	6438,935	49.3	7366,782	56.5	7863,379	60.31	7969,569	61.1
Water	1148,449	8.8	1149,021	8.8	1124,698	8.6	1124,705	8.6	1129,101	8.6
Totals	13037,340	100.0	11888,319	100.0	11912,641	100.0	11912,636	100.0	11908,239	100.0

Figure 17 shows the changes in natural forest cover that occurred in each year it was evaluated; the loss and recovery of forests in various sites in the country from 1969 to 2015 are observed. The process of preparation of the country (*Readiness*) has been the bridge to improve the national level information on the national maps and to bring to the political agenda the importance of improving the forest cover evaluations on a national level.

The loss of broadleaf forests (approximately 4 million ha²²) represented close to 93 % of the deforestation registered in that period, and almost all of the remaining deforestation was due to the loss of dense pine forests (approx. 320,000 ha). The smaller land-use changes were registered in open forests, whether of broadleaf, conifers, mangrove, or palms.

²² The forest-cover maps are in the process of validation in INETER, for which, these estimations of areas could vary, once the process is finalized.

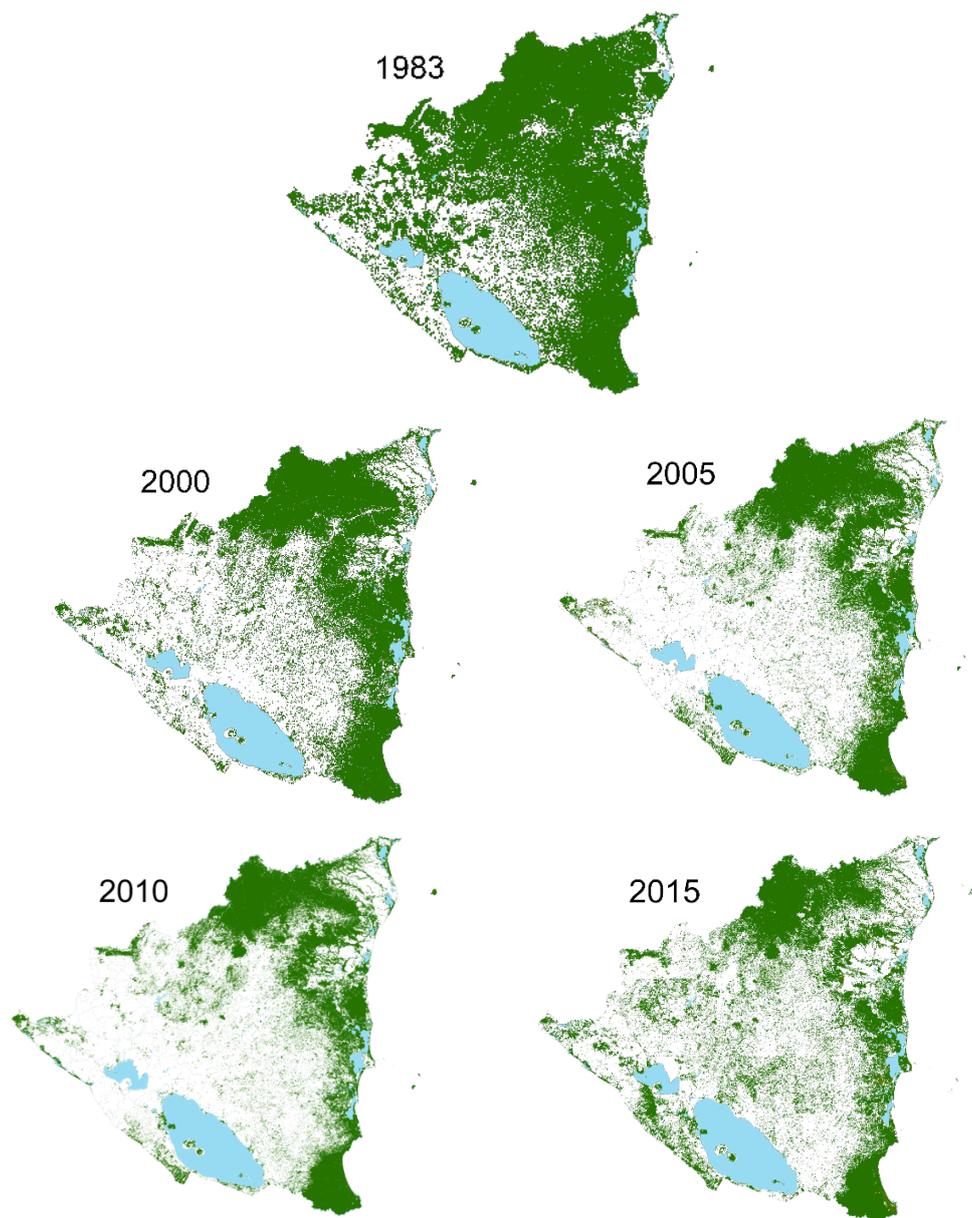


Figure 17 Forest-cover changes from 1983 to 2015 in Nicaragua (Green color indicates the area occupied by closed and open forests, broadleaf, conifers, natural palm forests, and mangroves).

The tendency in the rate of deforestation has been variable among periods (Figure 18). The period 1969 to 1983 was characterized by the establishment of large forestry concessions, principally of foreign businesses, with changes in land use toward agriculture principally. It was a period of economic boom for the productive sector, but the large forested areas were isolated by the limited access and infrastructure in rural areas of the country.

The period 1983 to 2000 was characterized by an opening in the areas for production and exploitation of forests following the war of the 1980s, and the re-initiation of the market economy starting in the 1990s. To this phenomenon, must be added that during the civil war in Nicaragua (decade 1980), many zones of the country were considered very dangerous and even

there were land mines, contributing to make the natural forested areas inaccessible to use and exploitation. The greatest levels of deforestation occurred beginning in the years 90 with the end of the war in Nicaragua, time at which were assigned areas for farming to demobilized forces from the war, and titles of the agrarian reform. Nonetheless, it should be noted that much of the closed forest at 1983, was converted to open forest by 2000, for this there is observed an increase of 600 thousand ha of open forest in this same period (Figure 18).

This is confirmed because it was obtained that prior to the year 2000, the rates of deforestation were maintained high, above 165,000 ha/year, and the forest losses occurred principally in the Central region of the country as well as in the pines of the North Caribbean Coast and in areas to the west of Prinzapolka. Furthermore, in the 1980s, part of the deforestation was caused by Hurricane Joan in 1988, which affected a half-million hectares (Ruiz *et al.* 2001).

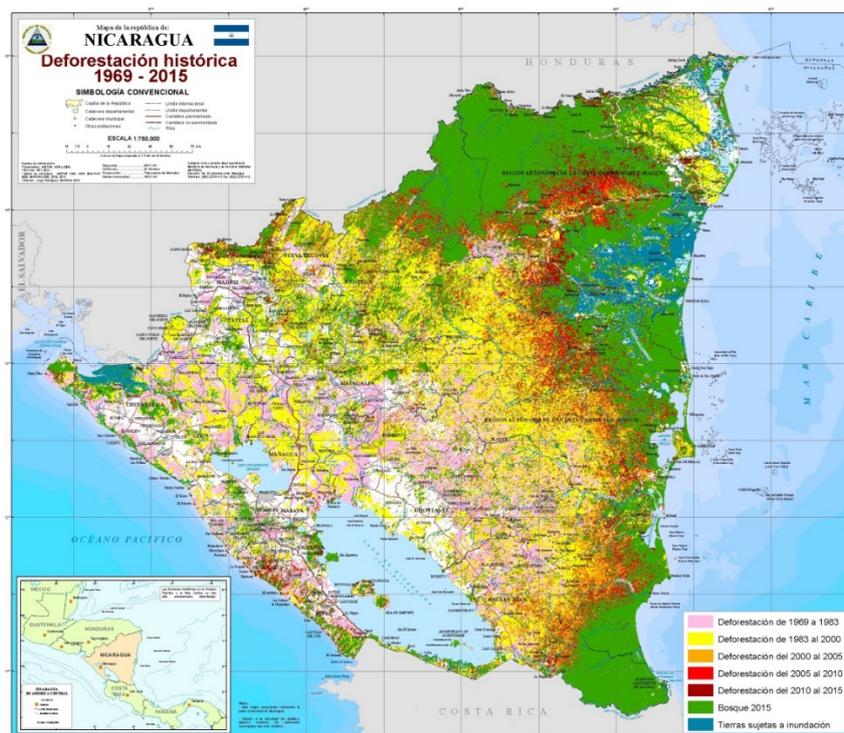


Figure 18 Changes in the forest cover from 1969 to 2015 in Nicaragua (Color Green indicates area occupied by closed or open forests, whether broadleaf, conifers, natural palm forests, or mangroves).

From 2005, it is noted that there was a marked reduction in the annual losses on a national level, as well as in the Caribbean. This reduction is due to the lower access to the remaining forests and could be due to the impact of the national programs of reforestation and regeneration promoted by the government, with areas reforested 161,178 ha and regenerated 187,000 ha, between 2007 and 2016. The data of rates of change in forest cover for the periods 2005-2010 and 2010-2015 suggest that there is a recovery of forests outside of the Caribbean Coast, nonetheless, this region is considered the main front of current deforestation in the country. In Section 3.4, there is more detailed information with respect to this.

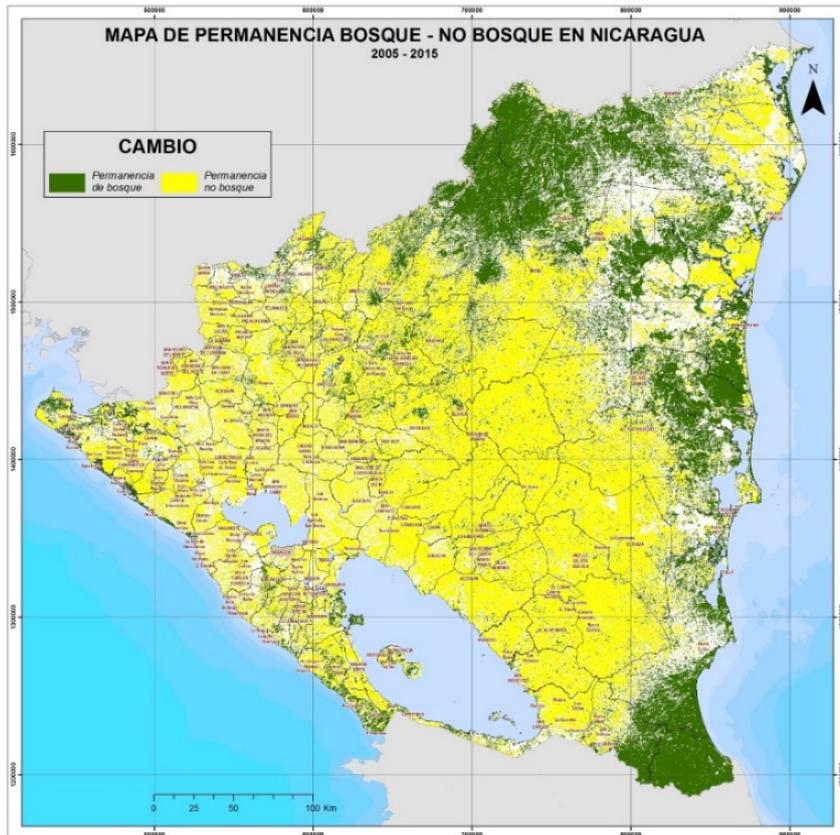


Figure 19 Permanence of forested areas and of areas not forested in Nicaragua during 2005-2015.

Table 8. Land use registered from 1983 to 2015, rates of change (%), and deforestation (ha/year) in Nicaragua.

Land Use Categories	Areas in hectares (ha) ²³					Rates of change (%) & Annual deforestation (ha/year)							
						1983-2000		2000-2005		2000-2010		2005-2015	
	1983	2000	2005	2010	2015	%	ha/year	%	ha/year	%	ha/year	%	ha/year
Closed broadleaf forest	6189,436	3056,482	2626,253	2286,964	2166,721	-0.041	-251632.38	-0.030	-78487.32	-0.029	-87376.79	-0.019	-50031.46
Open broadleaf forest	1282,639	1870,726	1435,261	1306,262	1317,414	0.022	28793.52	-0.052	-74082.74	-0.035	-65996.20	-0.009	-12244.17
Closed pine forest	460,087	136,828	68,432	51,282	100,177	-0.069	-31676.90	-0.129	-8855.34	-0.093	-12790.12	0.039	2658.29
Open pine forest	133,328	171,216	198,486	185,376	163,663	0.015	1976.09	0.030	5954.50	0.008	1365.84	-0.019	-3792.30
Mangroves	95,030	103,454	111,451	111,343	98,186	0.005	475.96	0.015	1671.96	0.007	763.09	-0.013	-1403.39
Palm forests	95,340	110,678	105,978	108,030	92,509	0.009	840.27	-0.009	-915.81	-0.002	-267.71	-0.014	-1430.75
Second growth	8,575	616,188	1100,471	1162,797	1061,883	0.286	2451.507	0.123	135338.99	0.066	40399.00	-0.004	-3921.09
Bushy vegetation	649,349	1045,39	674,714	514,642	1074,690	0.028	18445.708	-0.084	-56572.75	-0.068	-71520.48	0.048	32150.33
Natural savannas	35,862	299,594	302,529	322,954	269,432	0.133	4769.60	0.002	590.42	0.008	2257.90	-0.012	-3484.92
Pastures	1886,614	3480,374	4290,318	4934,174	4347,027	0.037	69196.41	0.043	183333.82	0.036	123625.90	0.001	5637.51
Annual crops	577,226	434,259	486,791	520,220	509,442	-0.017	-9582.73	0.023	11245.45	0.018	7914.42	0.005	2219.07
Perennial crops	83,594	116,195	126,728	134,450	233,003	0.020	1635.00	0.018	2218.70	0.015	1708.00	0.063	7957.69
Population centers	10,901	43,278	41,947	73,080	75,913	0.084	920.98	-0.006	-261.33	0.054	2327.82	0.061	2563.47
Lands subject to flooding	329,767	152,183	261,614	139,830	385,947	-0.044	-14664.512	0.114	29940.91	-0.008	-1282.87	0.040	10372.69
Other lands	1199,591	1400,491	1206,369	1185,937	1141,333	0.764	484.249	-0.341	-15775.562	-0.275	-53143.473	-1.132	-37150.807
Total area: 13,037,340	Averages:					0.077	-11100.054	-0.017	8759.144	-0.019	-6847.537	-0.060	-3146.210

²³ All the forest cover maps, 1983, 2000, 2005, 2010, and 2015 currently are in the process of validation by INETER, for which the areas and estimations of rates of change may change when these maps are validated and officially published. Source: Produced by the ENDE-REDD+ team.

3.2.1 Current Land Use in 2015

Currently, the forest cover maps for the country are in the final process of validation²⁴. Nonetheless, in this document, we present the values according to the latest results of this process, not without mentioning that the absolute values could vary when the official data will be published.

The current 2015 land use is distributed in the following manner: 39 % of the country (5,089,472 ha) is dedicated to farming (annual crops, perennial crops, and pastures), 30.2 % (3,938,670 ha) is covered by forest, 18.5 % (2,406,005 ha) corresponds to secondary vegetation (scrub/bushy vegetation, natural savannas, and secondary growth), 9 % (1,129,101 ha) is covered by water (which includes lakes, lagoons and crater lakes, and rivers) and 4 % (474,092 ha) corresponds to other uses (Figure 20).

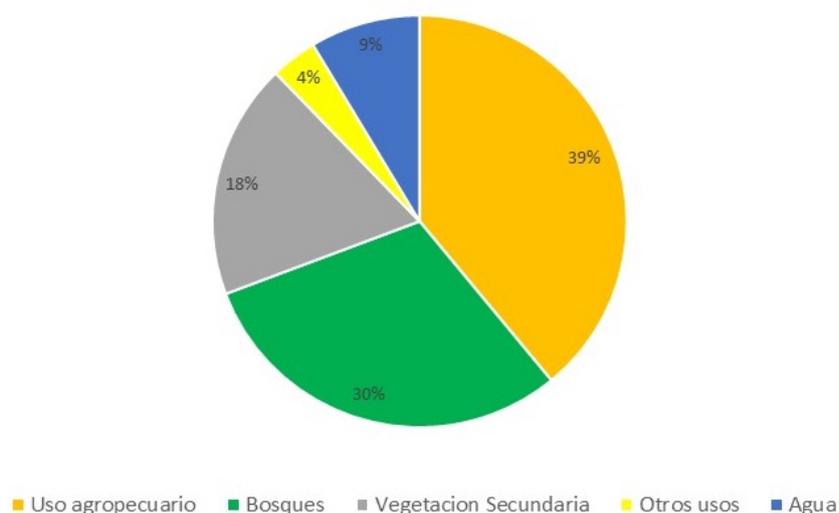


Figure 20 Land uses in Nicaragua, year 2015.

3.2.2 Current Land Use in the PRE-Caribe Region

With respect to the current land use in the PRE-Caribe (Zone of accounting) Region, the forests are of larger size, 3.19 million ha that represent 82 % of the national forests (Figure 21). These forests are, in the majority, composed of broadleaf forests (2,852,392 ha) and pine forests (185,618 ha), while other forest ecosystems, such as mangrove and palm, have a lower representation. In the Autonomous Region of the North Caribbean Coast (RACCN) there is a total of 2,054,573 ha of forests and in the Autonomous Region of the South Caribbean Coast (RACCS) 1,134,293 ha. In the BOSAWAS Biosphere Reserve, the remaining forest in the nuclear zone is

²⁴ The forest cover map 2015 currently is found in the process of validation in INETER, for which the total areas could vary when the process is finalized. Source: Development Causes DandD for the PRE-Caribe Region or the Area of Accounting.

487,769.24 ha and in the buffer zone is 292,570 ha. Indio Maíz still conserves 280,689.46 ha and in its buffer zone, 49,368.56 ha²⁵.

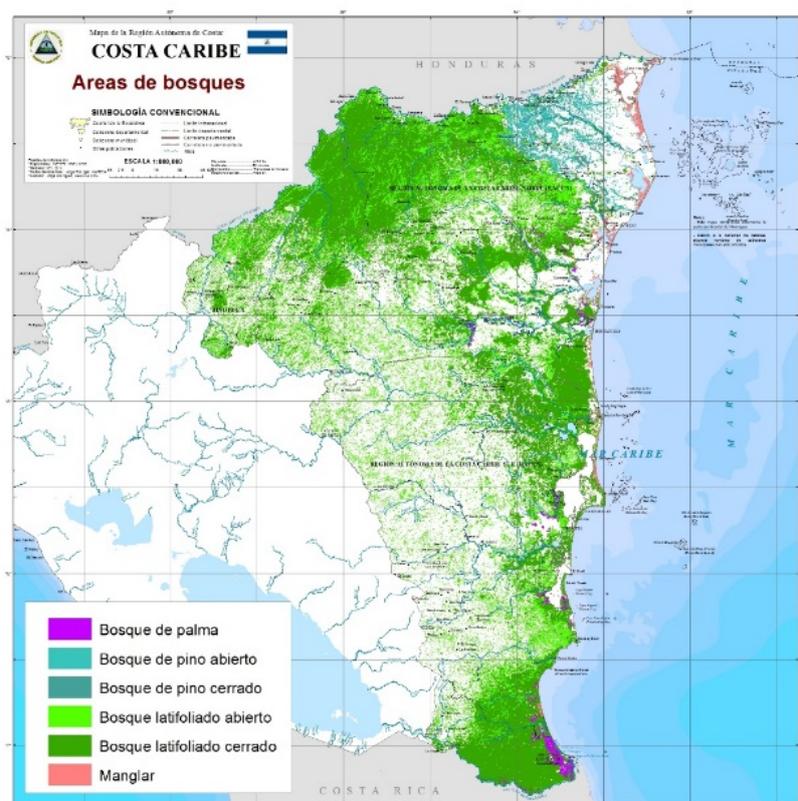


Figure 21 Forest cover in the Accounting Zone (PRE-Caribe Region) in 2015.

The pastures are the second-most important land use. In 2015, they covered an area of 2,100,375 ha (30 % of the Accounting Zone) of 365,739 ha was inside indigenous territories and 1,734,636 ha outside of them, or 82 % of the pastures in the Accounting Zone are concentrated in areas that are not belonging to the indigenous or afro-descendent communities.

Another use that should be mentioned is crops, which cover an area 214,795 ha (3 % of the Accounting Zone). Of the crops, 69 % are annuals and 31 % are perennials. There exist 73,907 ha of crops (35 % of the total area) in indigenous lands; among these crops, 94 % are annuals.

With respect to the secondary growth, its presence is significant, with 613,478 ha. It should be pointed out that the secondary growth areas are not considered as forest, because of its rotation during young growth, back into crops, pastures, or other uses, nevertheless, due to its great amount of area, it is an ecosystem that will be considered in the chapter on interventions.

The BOSAWAS Biosphere Reserve is divided in a protected area zone (AP) and a buffer zone. Approximately half the Reserve is covered by forests, inside the AP it is estimated two-thirds of the area, while one-third of the area is found in the buffer zone.

²⁵ It should be stated that the BOSAWAS Biosphere Reserve and the Indio Maíz Biological Reserve have areas inside RACCS and RACCN, but also in other regions of the country.

Table 10. Forest cover by region and type of property in the Accounting zone.

Type of property	Forests at 2015 (ha)		
	North	South	Total
Protected area	771,168	638,372	1,409,539
Indigenous territory	586,061	470,175	1,056,235
Outside of indigenous territory	185,107	168,197	353,304
Outside of protected area	1,283,406	495,922	1,779,327
Indigenous territory	995,128	265,765	1,260,892
Outside of indigenous territory	288,278	230,157	518,435
General total	2,054,573	1,134,293	3,188,867

Source: ENDE REDD team and MARENA.

3.2.2 Current state of forests

Between 2000 and 2010, the closed broadleaf forest diminished by 3.0 million ha to 2.2 million ha, and from 2010 to 2015, the open broadleaf forests diminished from 1.8 million ha to 1.2 million ha. This indicates a strong deforestation process.

Closed pine forests were reduced by more than half during the decade 2000 to 2010, going from 136 thousand to 51 thousand ha, although a slight increase in the areas was noted in 2015 with 100 thousand ha. The greater part of this loss is presented in the pine savannas in the north Caribbean region (see Figure 21). Meanwhile the open pine forests were maintained from 2000 to 2010 with 171 thousand ha, and 185 thousand ha, respectively. Nevertheless, in the latest years, there has been seen a reduction, leaving only 163 thousand ha by 2015. The increase in open pine forests for this period is 20,300 ha, or the majority of the change in closed pine forests was by deforestation and less by forest degradation. The mangrove forests and palm forests have been suffering a slight decrease in their areas from 2000 to 2015, having passed from 103 thousand and 110 thousand ha to 98 thousand and 92 thousand hectares, respectively .

Table 11. Forested areas and rates of change registered from 2000 to 2015 in Nicaragua.

Types of Forests	Rates of change (%) & Annual deforestation (ha/year)							
	Areas (ha)				2000-2015		2005-2015	
	2000	2005	2010	2015	%	ha/year	%	ha/year
Closed broadleaf forest	3056,482	2626,253	2286,964	2166,721	-0.023	-49131.723	-0.019	-50031.46
Open broadleaf forest	1870,726	1435,261	1306,262	1317,414	-0.023	-30440.082	-0.009	-12244.17
Closed pine forest	136,828	68,432	51,282	100,177	-0.021	-2060.739	0.039	2658.29
Open pine forest	171,216	198,486	185,376	163,663	-0.003	-491.536	-0.019	-3792.30
Mangroves	103,454	111,451	111,343	98,186	-0.003	-341.539	-0.013	-1403.39
Palm forest	110,678	105,978	108,030	92,509	-0.012	-1099.329	-0.014	-1430.75
Averages	778,769	649,695	578,752	562,955	-0.014	-13,927	-0.006	-11,041
Totals	5449,384	4545,859	4049,257	3938,669	-0.085	-83,565	-0.034	-66,244
% area of the country	41.80	34.87	31.06	30.21				

On a municipal scale, the values of forests give knowledge about the natural capital still present in each jurisdiction in the country, in this case the municipalities are the minimum unit of scale of local government.



Figure 22 Types of forests in Nicaragua in 2015.

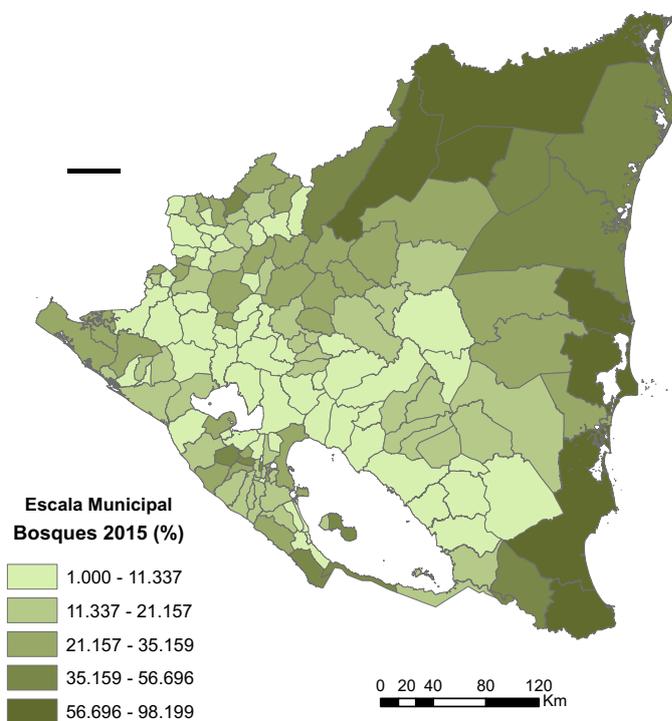


Figure 23 Percentage forests on a municipal level.

The municipalities with greater percentages of forests are mentioned in each region.

In the Pacific, they were: San Jorge, Rivas, Jinotepe, La Conquista, Moyogalpa, Santa Teresa, Belen, Tola, Diriamba, Altagracia, Granada, and San Juan del Sur.

In the North-Central, they were: Dipilto, Ocotal, Macuelizo, Ciudad Antigua, Santa Maria, El Jicaro, Mozonte, and Jalapa. In the North Caribbean Coast, they were: Rosita, Prinzapolka y Siuna, and Bonanza.

In the South Caribbean Coast and Rio San Juan, they were: Corn Island, San Miguelito, La Cruz de Rio Grande, El Tortuguero, Nueva Guinea, and Kukra Hill.

3.2.3 Land-use changes during 2005 to 2015

The period 2005-2015 was very dynamic, particularly at the beginning of the period (2005-2010), but by the end of the first half of this period (2010-2015), there were more stable rates of change, in some places of the country the tendencies of land-use change were maintained (Caribbean Coast and North-Central), but in other sites, there was a slight change (Pacific).

The distribution in the municipal rates of change (%) shows us the dynamic of changes in land use occurring during 2005-2015. Rates of change with negative values (-) represent deforestation, and positive rates of change (+) represent recovery or maintenance of the land use. The horizontal line in the figure represents zero change.

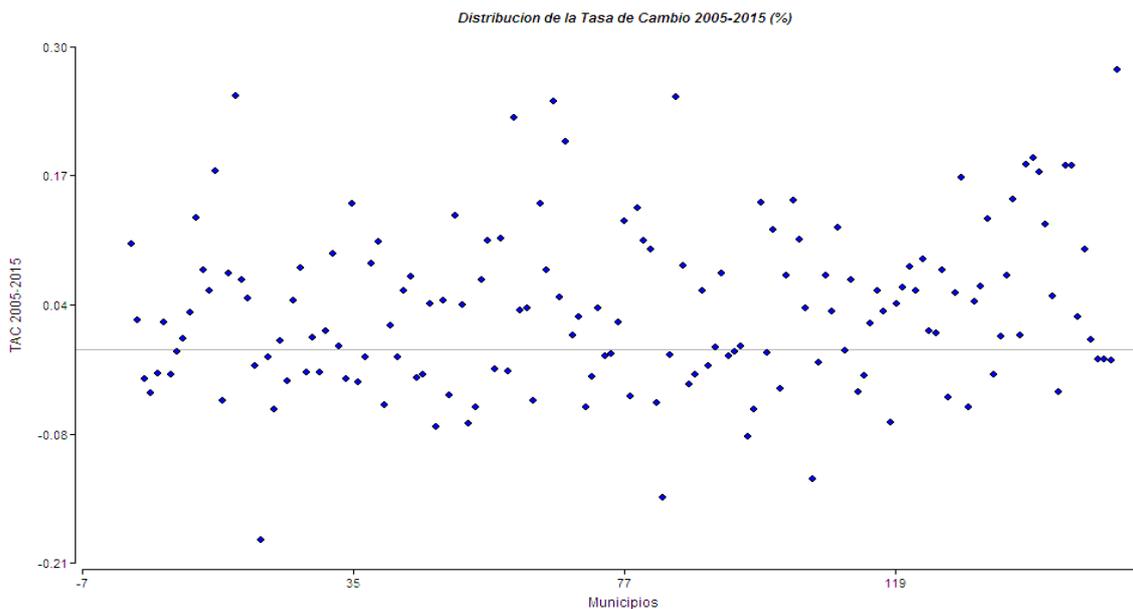


Figure 24 Distribution of the rates of change (in %) in the municipalities during the period 2005-2015 (N=153).

The changes were classified in eight categories with the results given in detail on the transitions of forest to areas of no forest.

In 2005-2015 the deforestation represented 8.3 % and forest degradation 4.1 % of the area of the country.

The highest values represented the permanence of non-forest uses, and the forests with 40.3 and 20.5 %, respectively.

Note: These maps of land use are in the process of validation, for which the official, final values can vary.



Figure 25 Overview of the land-use changes registered in the period 2005-2015.

Cambios de uso	% del area total
Deforestación	8.3
Degradación	4.1
Ganancia	9.5
Otros cambios	1.7
Permanencia de bosque	20.5
Permanencia no bosque	40.3
Potencial activo	2.9
Recuperación	3.8
Agua	8.8
Total general	100

3.3 Hot Spots of deforestation and forest degradation

In addition to analyzing the historical changes in land use from 1983 to 2015, the Hot Spots of deforestation and forest degradation, on a national level, were identified.

3.3.1 Hot Spots of deforestation on a national scale

Deforestation

The trajectory of deforestation has moved from West to East, for Northwest to Southeast from the Pacific, the North-Central Region toward the Caribbean Region. The most marked deforestation was in the period 2000-2005 and 2005-2010. In the last five years, the tendency of loss of forest continued, but with lower incidence and a lower rate of loss, and a small change is observed, particularly in the Pacific Region.

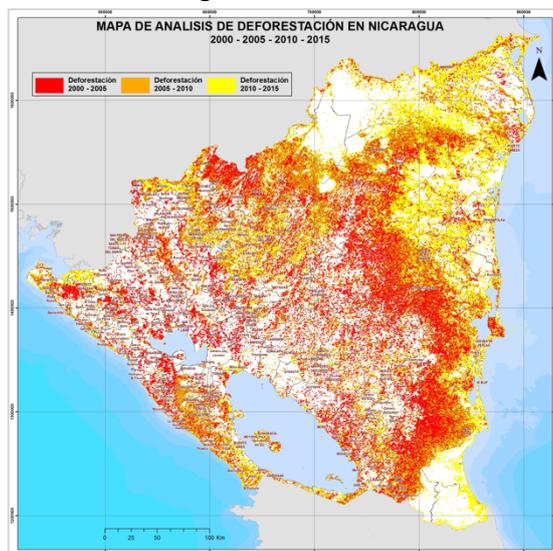


Figure 26 Distribution of deforestation and Hot Spots for deforestation in Nicaragua during 2000-2015.

3.3.2 Hot Spots for forest degradation on a national scale

Forest degradation is defined as the change of closed forests to open forests. Just as in deforestation, this continues with the incidence greater from West to East in the country, the

percentage of degradation of forests between periods has been reducing from 2000 to 2015, even though it continued with negative rates it should be attended to reverse the deterioration to the forest ecosystems. Currently, in the period 2005-2015, only 4 % of the total of areas was considered as forest degradation, although other sources signaled it could be as between 5 % and 8 %.

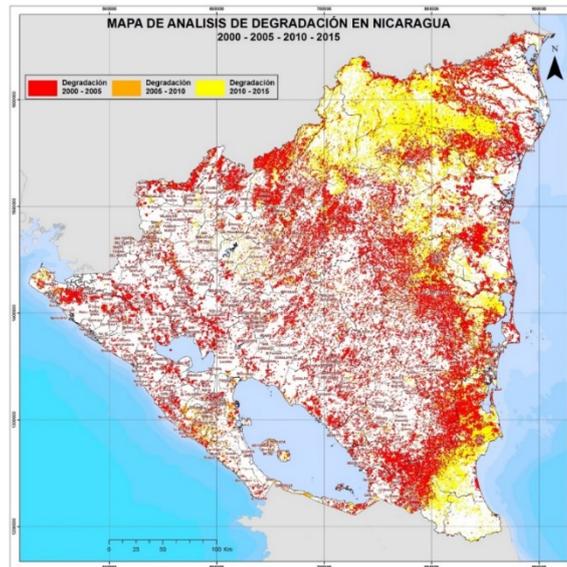


Figure 27 Distribution of forest degradation and Hot Spots in forest degradation in Nicaragua during 2000-2015.

3.3.3 Hot Spots of deforestation on a municipal scale

Upon evaluation of the changes from deforestation during 2000-2015 (changes in forested areas that are converted to areas of no forest), the greatest percentage change rates were found in municipalities of RACCN, RACCS in the Caribbean Coast. In comparison, the Pacific Region, the highest rates of deforestation were found in Carazo and Rivas; in the North-Central Region, the greatest rates of change were found in the department Nueva Segovia: Dipilto, Ocotal, Macuelizo, Santa María, Ciudad Antigua, and San Juan del Río Coco.

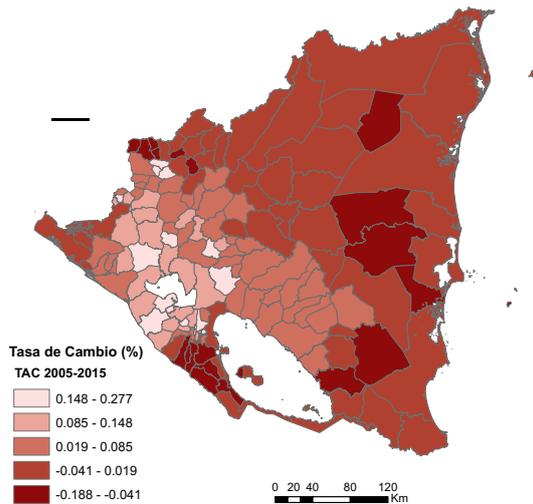


Figure 28 Distribution of the rates of change in forest in the municipalities during 2000-2015.

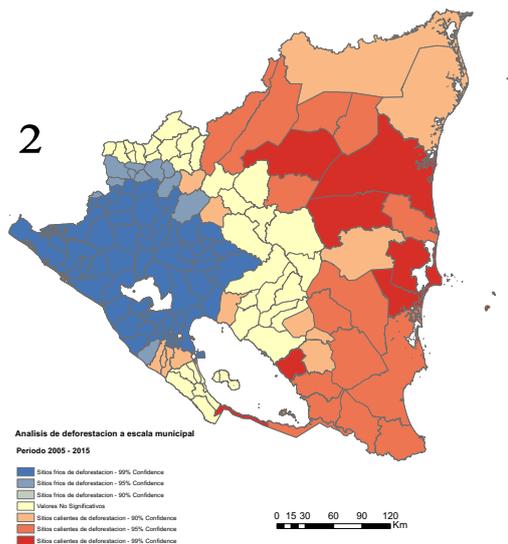


Figure 29 HotSpot analysis according to the rate of change on the municipal level during 2000-2015.

3.4 Rates of change in land use by region

During the periods 1983-2000 to 2000-2010, a tendency of deforestation with greater percentage values (negative values) was observed in the Caribbean Coast Regions. In contrast, during the period 2000-2015 or better, 2005-2015, the tendency of land-use change had been altered. In the North-Central and Pacific Regions, the percentage rates of change can be observed, with a tendency toward recovery of forests (positive values) and the rates of change (negative values) are maintained in the North and South Caribbean Coast Regions.

The 30 municipalities with greatest rates of loss (%) of forests are mentioned by region (from greater to lesser by region).

In the Pacific, they were: San Jorge, Rivas, Jinotepe, La Conquista, Moyogalpa, Santa Teresa, Belen, Tola, Diriamba, Altagracia, Granada, and San Juan del Sur.

In the North-Central, they were: Dipilto, Ocotol, Macuelizo, Ciudad Antigua, Santa Maria, El Jicaro, Mozonte, and Jalapa.

In RACCCN: Rosita, Prinzipolka, Siuna, and Bonanza.

In RACCS and Rio San Juan, they were: Corn Island, San Miguelito, La Cruz de Rio Grande, El Tortuguero, Nueva Guinea, and Kukra Hill.

Hot Spot analysis on a municipal scale.

*Variable=TAC2005-2015

*Values in %

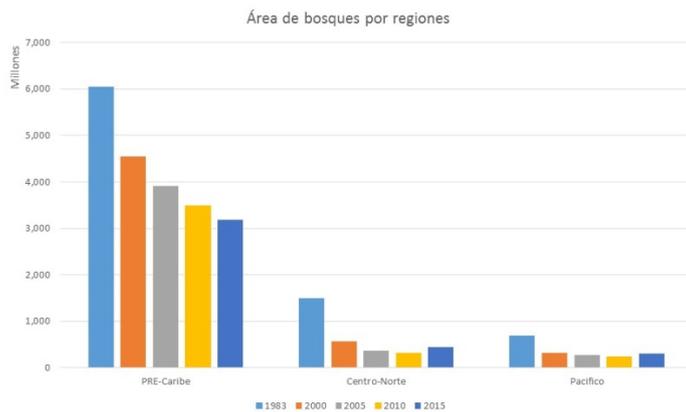
*Municipalities are statistically grouped according to the TAC deforestation values.

*Red color represents higher levels of forest loss.

* Blue colors represent lower rates of deforestation.

- Yellow color represents no grouping of significance (high or low).

Source: MARENA 2017.



The greater percentages of forests are found in the PRE-Caribe Region.

Figure 30 Areas of forests (millions of ha) by region during 1983-2015.

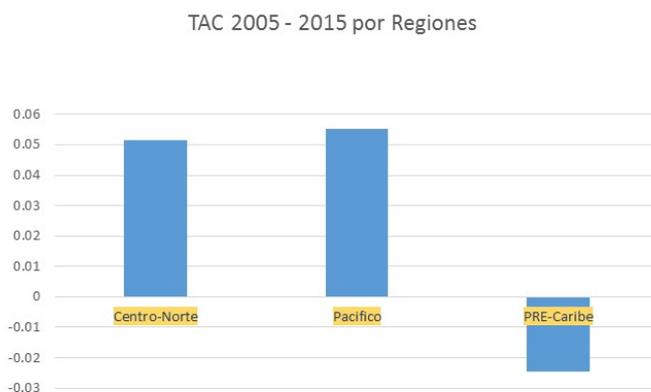


Figure 31 Rate of change (%) by region during 2000-2015.

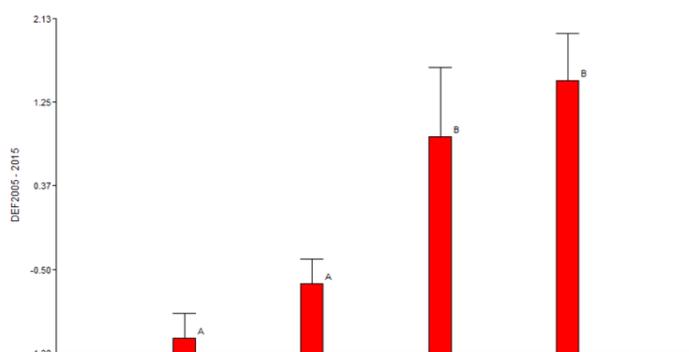


Figure 32 Result of the analysis of variance of the rates of change by region of the country.

The values of rates of change did not demonstrate significant differences in the values of the Caribbean Coast, and in the Pacific, Center and North.

*Equal letters indicate that there is no significant difference.

To evaluate the changes in land use for the period 2005-2015, the annual percentage rates of change were estimated. The results demonstrate that historically, the rates of change have been eminently negative, with an increasing rate of deforestation. Nonetheless, in the last period 2005-2015, small changes in the tendency of the rates of change are observed, presenting in some regions negative rates (deforestation) and in others positive rates (recovery). The negative

rates had range of -0.0001 to -0.188%, whereas the positive rates ranged from 0.002 to 0.277 %.

TAC average
2005-2015

Regions:
North-Central = -0.04
Pacific = -0.04
PRE-Caribe = -0.03

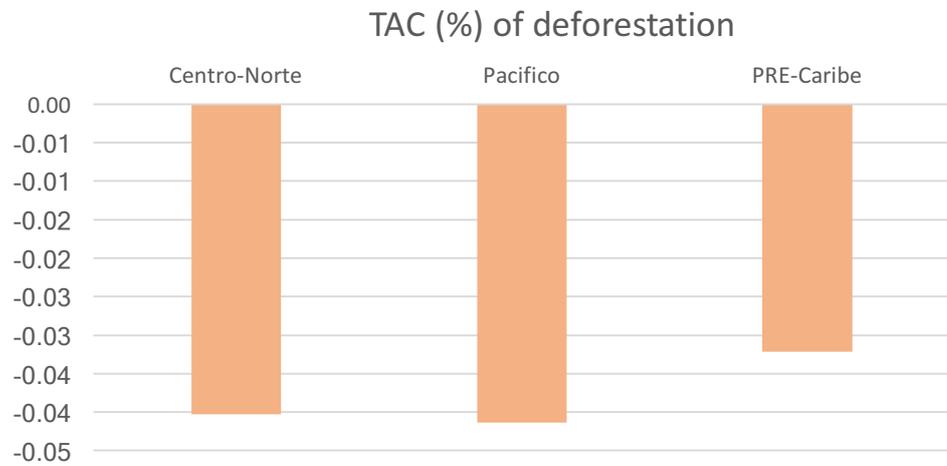


Figure 33 Rates of change (in %) averages for the municipalities that demonstrate deforestation (negative values) by region in the country.

TAC average
2005-2015

Regions:
Center-North = 0.008
Pacific = 0.10
PRE-Caribe = 0.02

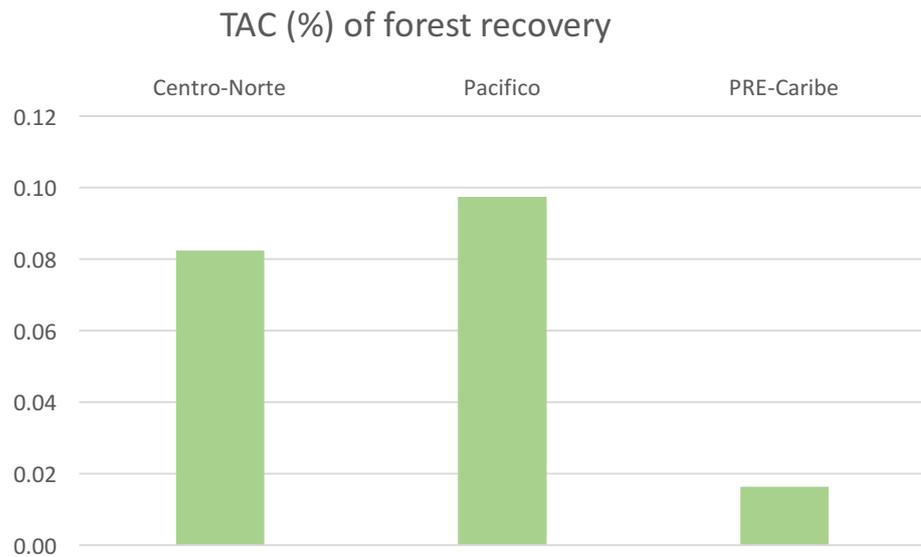
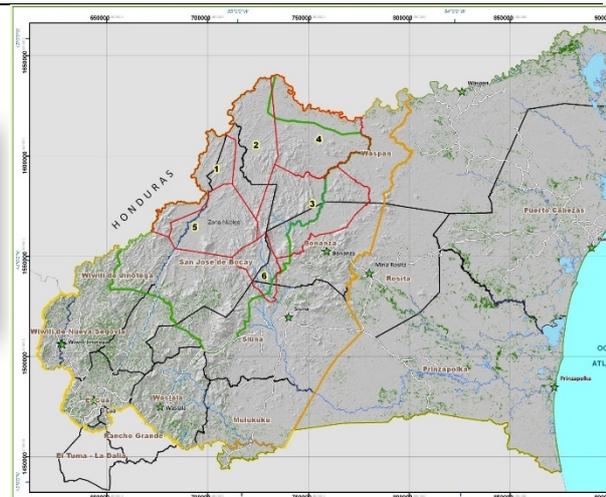


Figure 34 Rates of change (in %) averages for the municipalities that demonstrate recuperation of forests (positive values) by region in the country.

box 1 Forest gains within the six Indigenous Territories in BOSAWAS and RACCN

Forest gains within the six Indigenous Territories in BOSAWAS and RACCN

1. Territorio Indígena Miskitu Indian Tasbaika Kum
2. Territorio Indígena Kipla Sait Tasbaika
3. Territorio Indígena Mayangna Sauni As
4. Territorio Indígena Lilamni Tasbaika Kum
5. Territorio Indígena Mayangna Sauni Bu
6. Territorio Indígena Sikilta



Simbología

- ★ Cabeceras Municipales
- Ríos Principales
- ▭ Territorios Indígenas
- Red Vial
- Costa
- Zona de Estudio
- Cuerpos de Agua
- Zona Núcleo
- Zona de Amortiguamiento
- Límites Municipales
- Ganancia de Bosque

Localización General



Proyección: UTM Zona 16 Norte
Elipsoide y Datum: WGS 84

Escala 1:1,000,000



Fuente:
Cartografía Base: MAGFOR
Uso del Suelo: Imágenes Landsat
Modelo de Elevación del Terreno: SRTM - NASA

Elaborado por:
INTELSIG
Abril de 2008

- In this period, there was a forest recovery in 173,397 ha, representing 7.9 % of the total forest during the year 1999.
- This gain derives from 76.0 % secondary growth or bushy vegetation, 8.7 % in farming zones, and the 15.3 % remaining in the recovery of burned areas, savannas and wetlands.
- With respect to the BOSAWAS Biosphere Reserve, the forest gains correspond to 38.9 % in the buffer zone and the remaining 53.1 %, corresponds to forest gains outside the limits of the reserve.
- Recovery of forested areas during 1999-2005:

T_INDIGENA	Zona de Amortiguamiento	Zona Núcleo	Total (Has)
Territorio Indígena Kipla Sait Tasbaika		558	558
Territorio Indígena Lilamni Tasbaika Kum	1,365	539	1,904
Territorio Indígena Mayangna Sauni As	166	424	590
Territorio Indígena Mayangna Sauni Bu		605	605
Territorio Indígena Miskitu Indian Tasbaika Kum		957	957
Territorio Indígena Sikilta	310	246	557
Total general	1,842	3,329	5,171

Source: MASRENACE-GTZ 2008.

3.4 Deforestation and forest degradation in PRE-Caribe

Deforestation and forest degradation in Nicaragua has been concentrated in the most recent years in the PRE-Caribe Region, known as the Accounting zone. In the period from 2005 to 2015, the mean annual deforestation yearly was 72,500 ha, which is equivalent to a rate of deforestation of 1.8 %, which has reduced in comparison to the period 2000 – 2010 in which the deforestation was at 106,000 ha/year with an annual rate of deforestation of 2.33 % .

Historically, the behavior of forest losses in the Accounting zone has been considered in the following way. In the period 1983 – 2005, the deforestation increased in an accelerated manner, until during the five-year period 2000 – 2005, it reached the highest levels in the last 33 years. After 2005 and until 2015, the deforestation has gone down, as is illustrated in Figure 35.

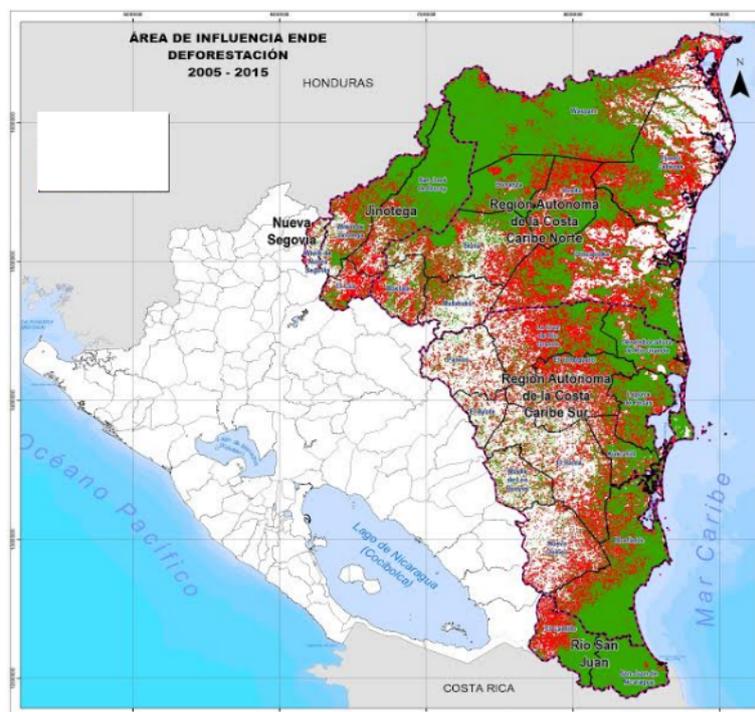


Figure 35 Deforestation 2005- 2015 in the PRE-Caribe zone (Accounting zone). Source: ENDE-REDD+.

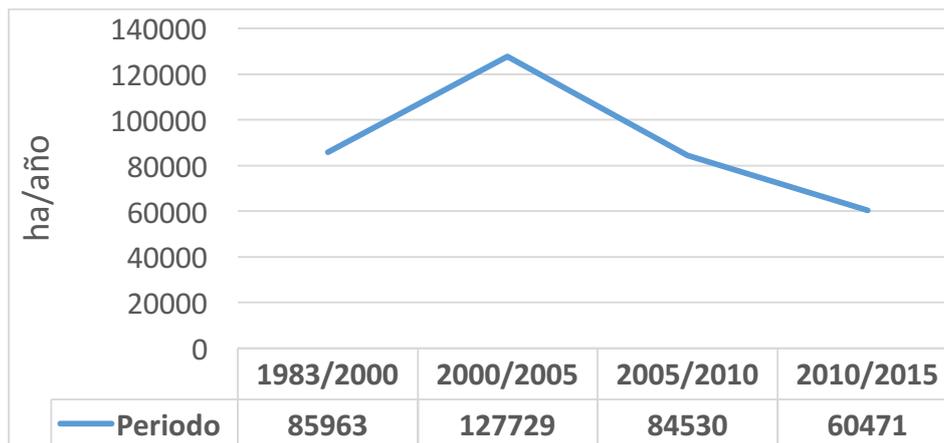


Figure 36 Historical behavior of deforestation in the Accounting zone, 1983 – 2015.

Up to the year 2005, deforestation was greater in RACCS than in RACCN. However, between 2005 and 2010, there were few differences in the forest loss in the two Regions. In the period 2010 – 2015, the deforestation in RACCN began to be slightly greater than in RACCS.

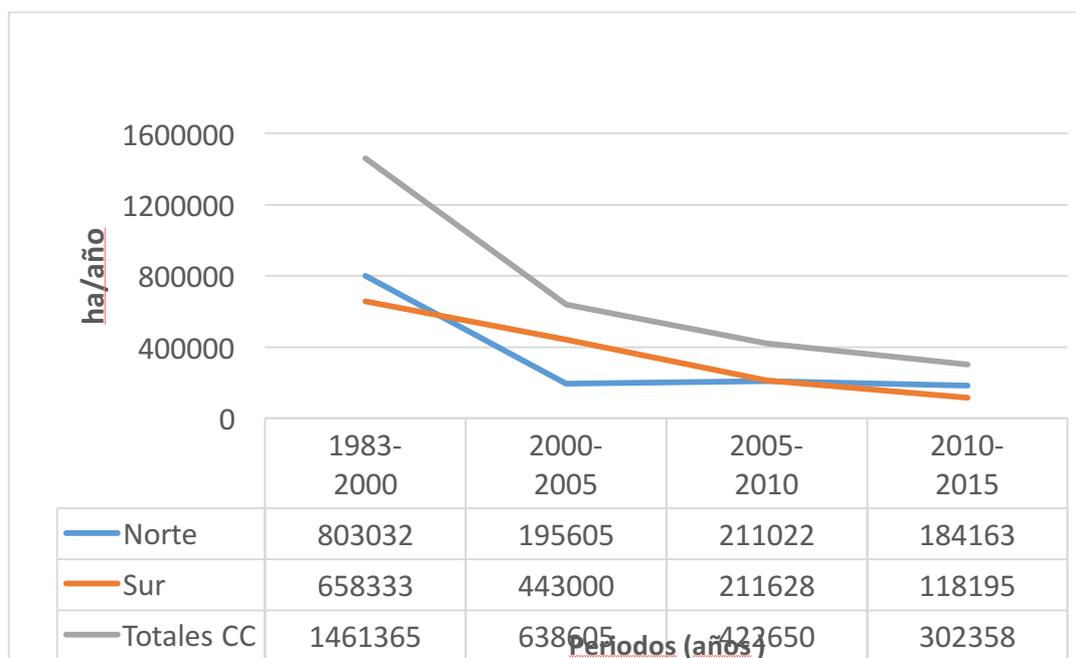


Figure 37 Deforestation by Autonomous Region, 1983 to 2015.

Regarding the relative annual rate of deforestation during the period 2010 – 2015, the two regions present similar behaviors. However, as is noted in Figure 40, in the period 2000 – 2005, the rate of loss of forests in RACCS was very high and later began to decrease, while the deforestation in RACCN maintained a slight increase in the later years. In RACCN is where there are currently more deforestation fronts.

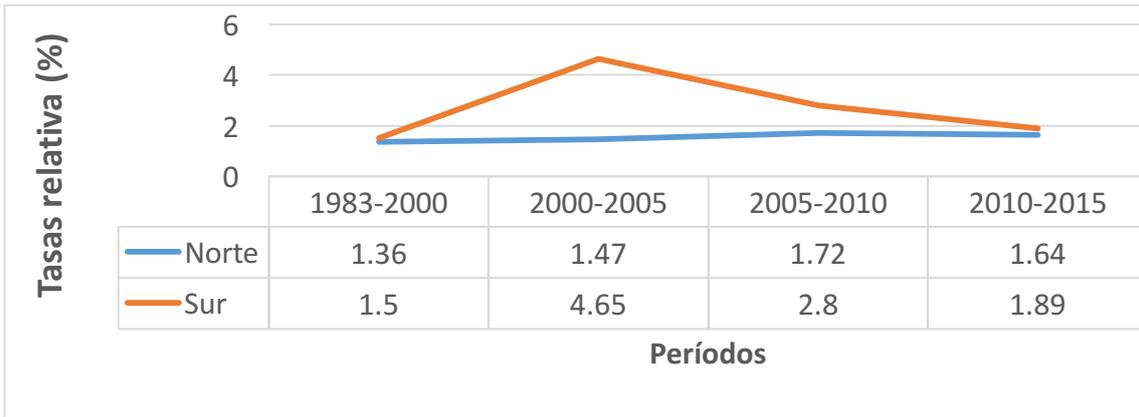


Figure 38 Historical, relative rates of deforestation (%), by region.

The regional technical teams have identified six deforestation fronts in the Accounting zone, in addition to the routes of entry for the deforestation agents, which are marked with yellow arrows in Figure 39. There exist 6 deforestation fronts, 4 in RACCN and 2 in RACCS. In RACCS as in RACCN, the new deforestation fronts are located in zones with newly opened access roads, and where the lands have low value. These conditions are attractive to *colonos* (invaders) who are able to become established and acquire land rights under different modalities that, in some cases, pertain to indigenous communities.

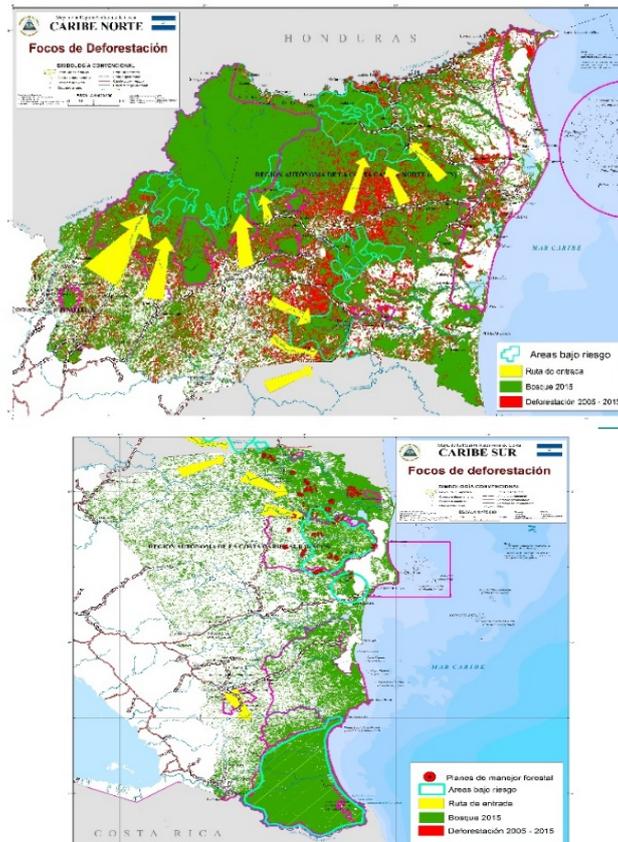


Figure 39 Deforestation fronts in RAACS and RAACN.

In the case of RACCS, an advance is noted in the deforestation in the Indio Maíz Biological Reserve. From the analysis of images 2005 – 2015, there is reported deforestation in the nuclear zone of the reserve of 4967 ha in the ten years, which is equivalent to 496 ha per year; in the buffer zone, the deforestation has occurred at 7144 ha per year (Figure 40).

Other deforestation focal points in RACCS are the sector of Wawashang, which is considered at high risk, and a deforestation front that is occurring in La Cruz de Rio Grande, toward the mouth of the river with pressure on the remaining forest of Karawala.

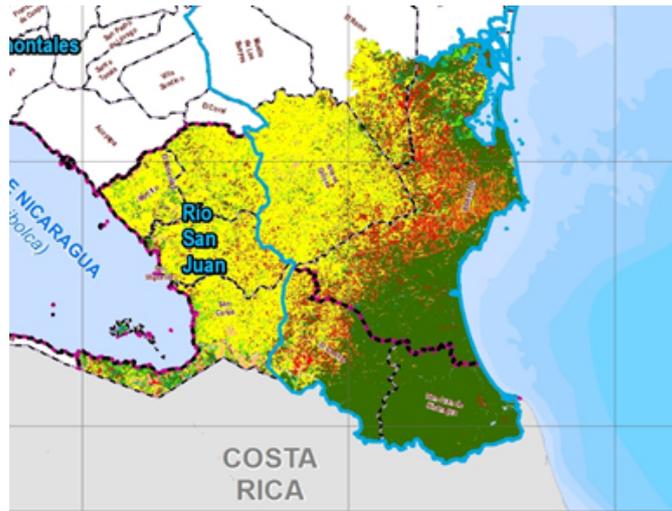
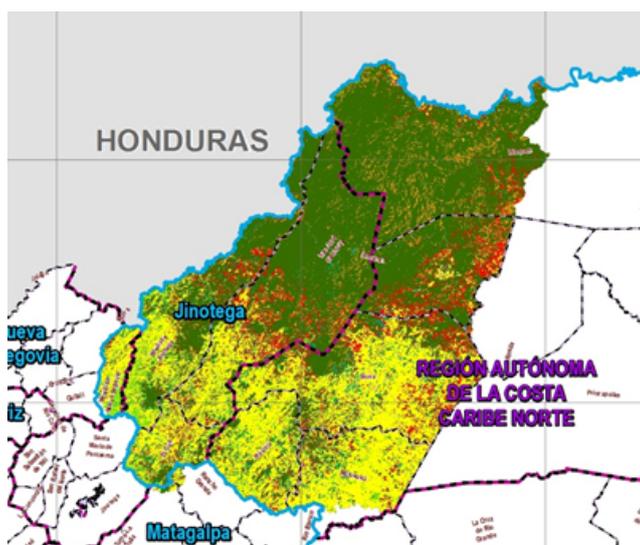


Figure 40 Land-use changes in the Indio Maíz Biological Reserve, 2005-2015.

In RACCN, the BOSAWAS Reserve and its buffer zone are the most threatened, as well as the sector of Waspam and of Prinzapolka. In the case of BOSAWAS, in the period 2005-2015, in the nuclear zone, 46,716 ha of original forest cover were lost (4,671.6 ha/year), and in the buffer zone, 119,902.59 ha (11,990 ha/year).



Source: Monitoring team ENDE REDD+

Figure 41 Deforestation and deforestation fronts in the BOSAWAS Biosphere Reserve.

Between the buffer zone and the nuclear zone of BOSAWAS, is concentrated 23 % of the annual deforestation in the Accounting zone; in the case of the Indio Maíz Biological Reserve, it is 10 %.

The majority of these deforestation fronts are pressuring indigenous territories and natural protected areas. Figure 42 and Table 12 indicate that the protected areas have served as a barrier to deforestation given that the loss of forests and the relative rate of deforestation are much lower in the protected areas than in lands outside the protected areas. Nonetheless, there is little difference in the loss of forests inside as compared to outside indigenous territories, even though the relative rates of deforestation in indigenous territories is half that outside, given that the majority of forests are found inside indigenous territories. The comparison of four curves in Figure 42 indicates that the greater change in forest cover occurred in the lands that are not indigenous, and outside the protected areas (FTI).

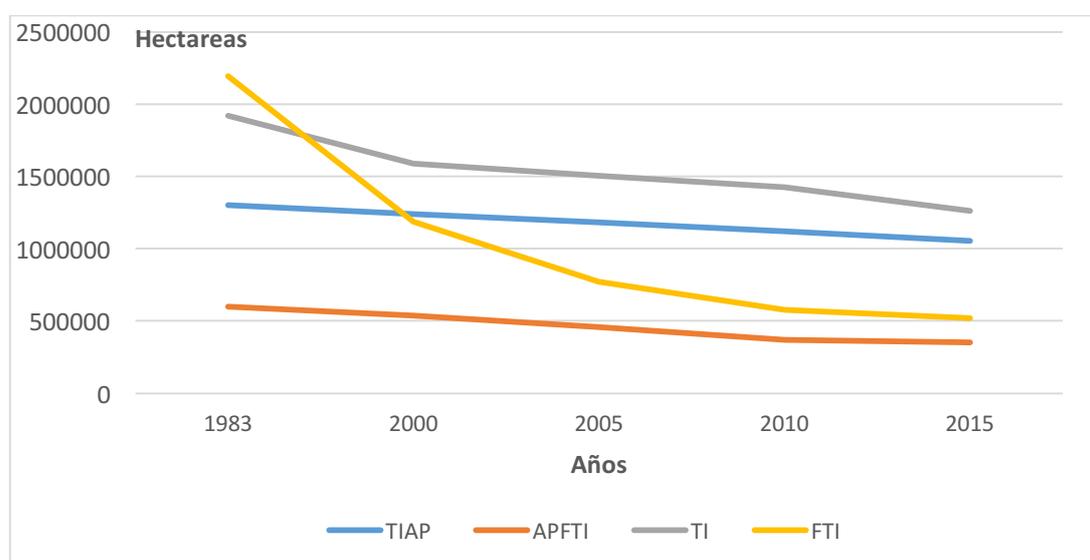


Figure 42 Forest cover by property type, years 1983 to 2015.

Table 12. Deforestation according to land tenure in the Accounting zone, 2005-2015.

Tipo de tenencia		Bosques remanentes 2005 (has)	Bosques remanentes 2015 (has)	Perdida de bosque (has)	Perdida anual (has)	Tasa Deforestación %
Dentro del Area protegida	En Territorio Indígena	1,183,525	1,056,235	127,290	12,729	1.07
	Fuera de Territorio Indígena	456,753	353,304	103,449	10,345	2.26
Fuera del Area Protegida	En Territorio Indígena	1,503,903	1,260,892	243,011	24,300	1.61
	Fuera de Territorio Indígena	769,694	518,435	251,259	25,126	3.26

3.4.1 Deforestation and land-use conflicts

Five indigenous territories have been identified with greater tension from land-use conflicts; these are: Awastigni, Sikilta, Tuahka, Mayanga Sauni y Tasba Pri (Nitlapan, 2014). Some characteristics in common among these territories are:

- ✓ They are located in RACCN.
- ✓ They are located on the agricultural frontier.
- ✓ Deforestation is occurring, but there is forest remaining.
- ✓ They are close to roads.
- ✓ In the case of Awastinghi, Tuahka y Tasba Pri, they are close to the Mining Triangle.

In Figure 43, four of these territories are illustrated, which demonstrated different levels of deforestation. To the left is Mayanga Sauni y Sikilta, where the deforestation is relatively low, compared to the territories of Awastinghi y Tuahka, to the right, where the loss of forests is considerable, but lower than in surrounding areas. These observations suggest that the land-use conflict is not strictly associated with deforestation.

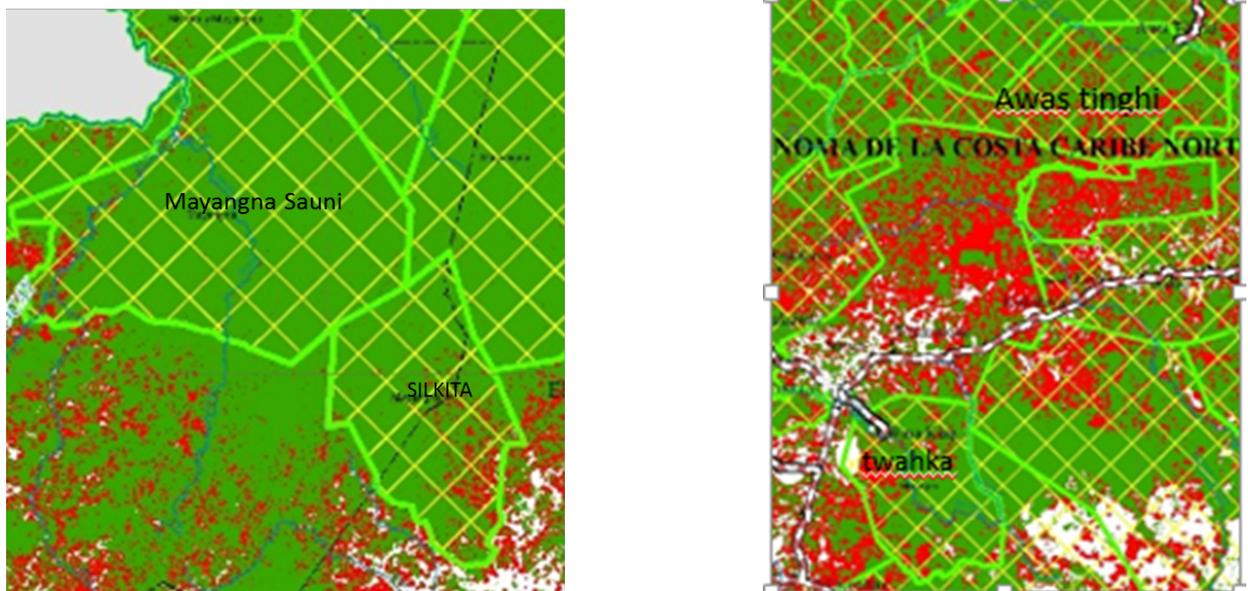


Figure 43 Deforestation in indigenous territories with greater incidence of land-use conflicts.

3.4.2 Deforestation and forest management plans

The ENDE-REDD+ Monitoring Team performed an analysis of the forest management plans that were delivered during the period 2000 – 2015. The categories for the studied plans were: General Forest Management Plan, SAF and Remediation Permits. In Figure 44, the placement of permits issues is observed and the review by region and its relation to deforestation, forest degradation, and remaining forest. In the PGMF in RACCN, the accumulated deforestation by 2015 was at 17% with respect to 2000, this means an annual rate of deforestation of 1.13 %; in RACCS in the same period, it was 12 %, with an annual rate of deforestation of 0.70 %. If the two

values are compared with the rates of deforestation in Figure 44, it can be observed that in the PGMF, the rates of deforestation are similar or lower than in the indigenous territories inside protected areas.

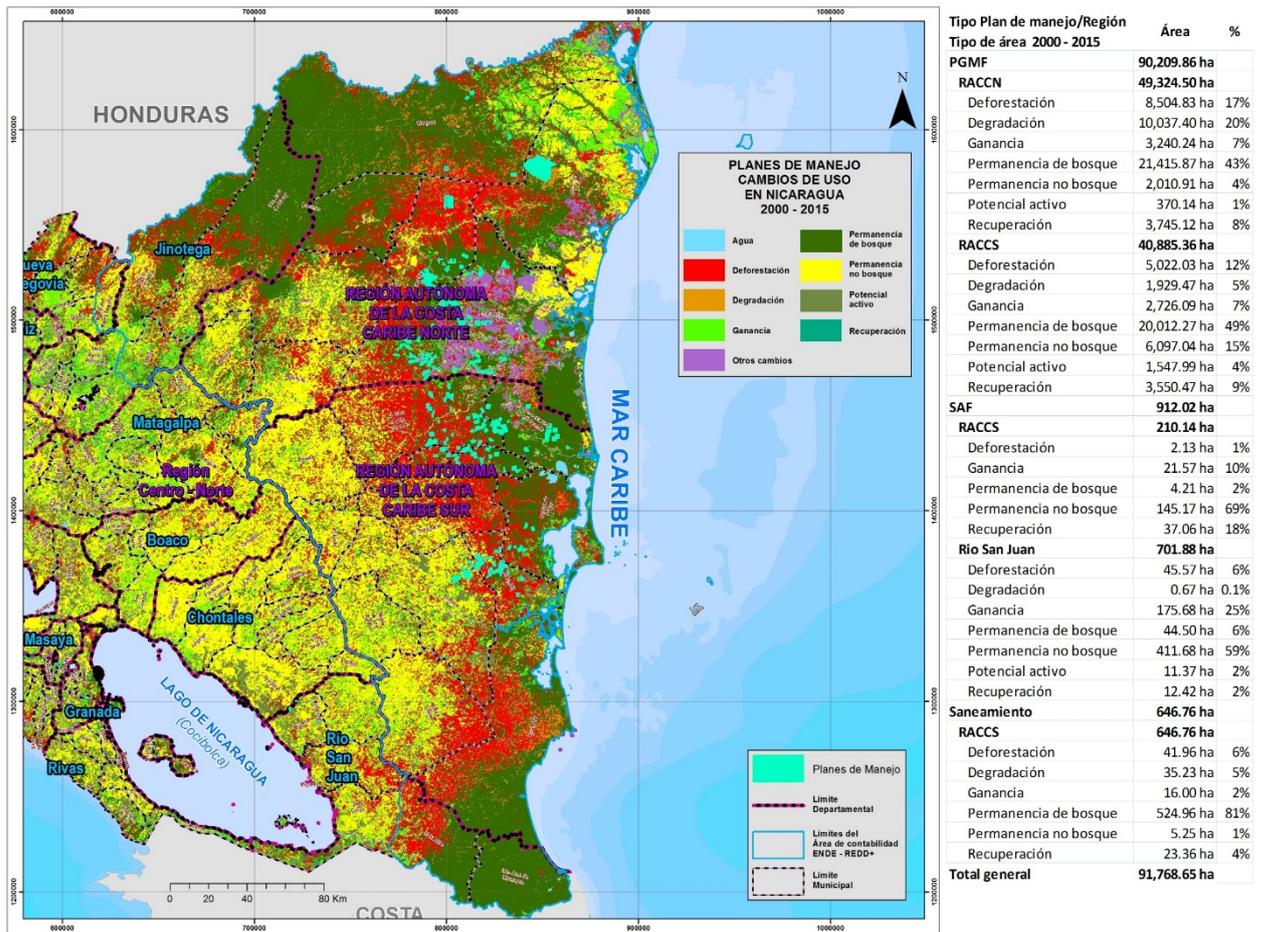


Figure 44 Land-use changes in the General Forest Management Plans, 2000-2015.

Regarding the degradation associated with this type of permit, the annual rate in the case of RACCS was 1.33 % and in RACCS, 0.33 %. Other types of permits such as the SAF or the remediations have been awarded in very small areas, nonetheless in the case of Remediation, the forest degradation and deforestation are very low in the sites where permits were awarded. With respect to this, there should be performed a deep analysis around these permits, to determine if the documents that authorize the departure of wood from these areas were used to legalize products from other forests. There does not exist information regarding the domestic permits, which have been awarded by the Indigenous Territorial Governments.

3.4.3 Deforestation in Protected Areas

The complex of protected areas in the country occupies an area of 1.7 million hectares, grouping 72 protected areas on a national level.

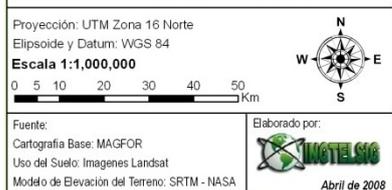
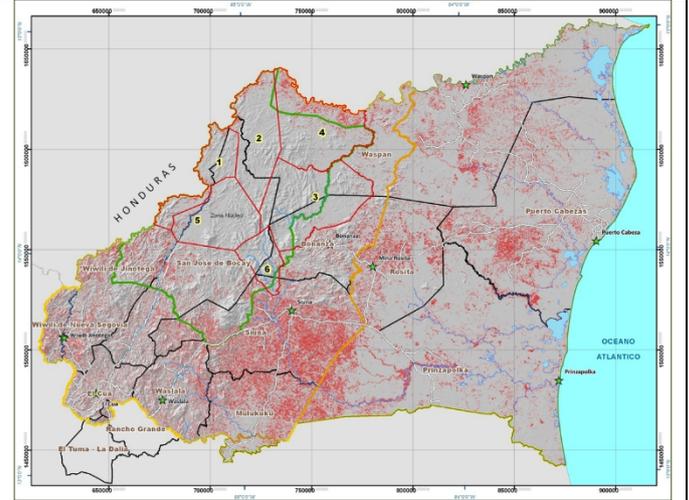
Table 9. Deforestation in protected areas for the period 2005 – 2015.

Protected Areas	PCN		North Caribbean		South Caribbean		National	
	Area (ha)	Deforested 2005-2015	Area (ha)	Deforested 2005-2015	Area (ha)	Deforested 2005-2015	Deforested 2005-2015	Area (ha)
		204,768	6,713	801,408	90,037	708,784	113,727	210,477
Indigenous Lands	21,321	562	591,158	41,876	504,887	74,339	116,777	1117,366
Palm forest		0	5,558	6,626	37,910	2,269	8,895	43,468
Open pine forest	2,427	1,579	9,886	3,148	89	41	4,768	12,402
Closed pine forest	1,766	-330	3,363	-1,231	40	6	-1,555	5,169
Open broadleaf forest	6,761	939	79,503	-37,784	105,590	-22,216	-59,062	191,854
Closed broadleaf forest	4,967	-2,879	445,524	67,686	323,941	104,499	169,305	774,432
Mangrove	2,204	158	42,227	4,210	2,605	36	4,405	47,036
Secondary growth	3,196	1,095	5,097	-779	34,712	-10,295	-9,979	43,005
Outside of Indigenous Lands	183,447	6,150	210,250	48,161	203,897	39,388	93,700	597,594
Palm forest	3,377	-1,341	0	0	12,211	2,864	1,523	15,588
Open pine forest	7,491	8,839		3		0	8,842	7,491
Closed pine forest	16,329	-8,680	63	-1		0	-8,682	16,392
Open broadleaf forest	63,885	3,047	48,465	3,244	38,130	6,716	13,007	150,480
Closed broadleaf forest	44,096	-23,372	136,505	51,576	117,806	38,990	67,194	298,407
Mangrove	22,519	6,358	73	57	50	0	6,415	22,642
Secondary growth	25,749	21,299	25,143	-6,717	35,700	-9,182	5,400	86,592

box 2. Deforestation in the BOSAWAS Biosphere Reserve and RACCN during 1989 – 2005.

Deforestation within six Indigenous Territories in BOSAWAS, RACCN

1. Territorio Indígena Miskitu Indian Tasbaika Kum
2. Territorio Indígena Kipla Sait Tasbaika
3. Territorio Indígena Mayangna Sauni As
4. Territorio Indígena Lilamni Tasbaika Kum
5. Territorio Indígena Mayangna Sauni Bu
6. Territorio Indígena Sikilta



- The BOSAWAS Biosphere Reserve has an area of 2,042,535.91 ha (15 % of the national territory).
- In the nuclear zone, are six Indigenous Territories (TI) (See names above).
- Of the 2,553,898 ha of forest that existed in the year 1999, 79.4 % is maintained unchanged, and 20.6 % changed to other land uses.
- Of the forest that was lost in this period, 72.1 % was converted to secondary growth or bushy vegetation, 15.8 % to farming areas, and 12.1 % remaining was affected by fires, flooding or wetlands.
- Regarding the BOSAWAS Biosphere Reserve, the land-use changes affecting the forest were 7.8 % within the nuclear zone, 49.6 % in the buffer zone, and 42.6 % corresponding to zones that are outside the protected area boundaries.
- La deforestación was distributed in the following manner: 224,304 ha outside of BOSAWAS, 224,304 ha deforested in the buffer zone, and 41,306 ha in the nuclear zone of the reserve.

Source: MASRENACE-GTZ 2008.

3.5 Principal impacts of deforestation and forest degradation

In this section, are presented the principal effects or impacts of the deforestation and forest degradation in Nicaragua. The first part is focused on the impacts in forest ecosystems according to each region of the country, of which the information was taken from analysis presented at FAO²⁶. In the second part of this section, are presented impacts on the Natural Resources, the productive systems and other sectors in the country. This part was extracted from the GEO 2003-2006 published by SINIA-MARENA in 2007.

Impacts on forest ecosystems

In the Pacific Region, the deciduous trees of savannas, deciduous bushy vegetation and trees, deciduous premontane forests and deciduous forests of lowland forests have been affected; all these due to accessibility and closeness to the larger population centers in the country. In prior decades, there was intense extraction of wood.

Currently, fuelwood is exploited, there is scarceness among species for timber wood, and greater influence from control and regulation exercised by the authorities in the area. In this group of ecosystems we can include Pacific mangroves, which has been affected by quite intensive extraction of several vegetable and animal products, among them: pillars, beams, fuelwood, bark from red mangrove, and stems of black mangrove to sustain banana bunches. Currently, the pressure is lower because of lower market pressure, regulation, and control.

In the Central Region (North and East), the seasonal evergreen forest of premontane pine has been and continues to be affected by the disordered extraction (defined areas of extraction and areas of genetic reserve and protection are not defined), although there are management plans, there is little control over the wood companies that have demonstrated greediness in the extraction of pine wood at the lowest possible cost, many times without respecting soil conservation, reforestation, or leaving the appropriate quality and quantity of seed trees. The areas, little by little, are being converted into natural pastures. Furthermore, the destruction of the pines by the pine bark beetle should be mentioned, affecting an area of 32,000 ha of the ecosystem predominant of the zone.

The elimination of the natural vegetation cover for the purpose of agriculture, with selective extraction of trees of wood value are: the mixed seasonal evergreen premontane forest, semideciduous forest, seasonal evergreen premontane forest, and the seasonal evergreen lower montane forest, in the majority of the cases, there is an advance of coffee plantations and in the last two ecosystems, with the total elimination of the vegetative covering owing to the new concept of sun coffee which is supposedly more productive. Also, the semi-deciduous floodplain gallery forest is affected, converting it to agriculture with irrigation and also ranching as an area for watering cattle.

In the Caribbean Region, the selective extraction of wood trees in combination with the advance of the agricultural frontier affects the better-drained forests because of the possibility of access, among them: well-drained seasonal evergreen forest, moderately drained evergreen forest in floodplains, and some areas of evergreen premontane forest.

The ecosystems that are best conserved are those that, because of their ecological conditions, are difficult to enter for extraction of forest products, among them: scarcely vegetated lava, swampy semi-

²⁶ <http://www.fao.org/docrep/007/j0602s/j0602s02.htm>

deciduous swampy forests of the Pacific Region; in the Caribbean and Rio San Juan: coastal swampy transition vegetation; seasonal evergreen forest dominated by palm, seasonal flooded alluvial evergreen forest, seasonal alluvial evergreen gallery forest, seasonal riparian evergreen forest, seasonal evergreen forest dominated by bamboo, flooded savanna with pine, swampy evergreen forest. In the swamp forest dominated by palm, the savannas with evergreen trees, and flooded savannas with trees and palms, there are small-scale fires to eliminate vegetation for plant rice.

In the freshwater have grassy perennial mosaics in organic deposits, it is known that the population extracts products such as platanillo leaf (*Heliconia* spp.), and caligüate (*Thalia geniculata*) to commercialize as tamales wrappers, alligator grass (*Eleocharis* spp. y *Typha*) to commercialize for several artisan products, nonetheless, the impacts on the ecosystem are not known.

On the other hand, the introduction of exotic germplasm is a common practice in Nicaragua, already having negative consequences on our own germplasm resources. There are several problems associated with the introduction of exotic species, such as hybridization with genetically related native species, competition at several levels with native species to the detriment of the latter, and transmission of disease. The hybridization with native species can provoke, in the long term, loss of capacity in the native species to adapt to local environmental conditions.

Additionally, the ENDE-REDD+ team evaluated the forest formations that present the greatest affectations due to farming practices, for this was conducted an overlap of variable or layers on the national level: head of cattle (CENAGRO 2011), forest formations (MARENA 2008), and land use maps (INETER 2015).

There were 15 forest formations with great levels of affectations found, of them some are highlighted: median or tall forests of sites permanently flooded with freshwater (Bordering the Great Lakes) (24.9%), Medium or high evergreen forests of fresh, humid zones (13.9%), Medium or high forests of sites flooded periodically or permanently with sweet water (11.1%), Pines: Caribbean or Coastal Pine (7.9%), and medium or high seasonal evergreen warm and semi-humid forest (7.8%) (Table 14).

Table 14. Forest formations that present greatest levels of disturbance from agricultural practices in Nicaragua.

No.	Forest Formations	% of the total area
1	Medium or high forests in permanently flooded sites with freshwater (Great Lake edge)	24.9
2	Medium or high seasonal evergreen forests in cool and humid zones	13.9
3	Medium or high forests in periodically or permanently flooded sites with freshwater	11.1
4	Pines: Caribbean or Coastal Pine.	7.9
5	Medium or high seasonal evergreen forests in moderately warm and semi-humid zones	7.8
6	Low or medium deciduous forests in hot and dry zones	7.0
7	Medium or high evergreen forests of cool and humid zones (Highland cloud forest)	6.4
8	High evergreen forests in cool and humid zones	4.9
9	Very high evergreen forests in moderately cool and very humid zones (Rainforest)	4.4
10	Medium or low semi-deciduous forests in warm and semi-humid zones	4.2

11	Medium or high evergreen forests of very cool and humid zones	2.4
12	Low forests of estuaries or marshes (Pacific Mangroves)	2.3
13	Medium or high evergreen forests in very cool and very humid zones (Highland cloud forests)	2.1
14	Low forests in periodically flooded sites with salt water (Salt marsh Gulf of Fonseca)	0.8
15	Very high evergreen forests in moderately warm and very humid zones (Rainforest)	0.02

Affectation on systems, sectors and other natural resources

In the III GEO, Nicaragua presented a general evaluation on the impacts that occur or are expected by not reversing the processes of deforestation and forest degradation in the country (MARENA 2007). In Figure 45, the cycle of these processes is sketched, and how other problems are unleashed that on a national scale and magnitude represent a dramatic vision of the present and future, if macro measures are not implemented to reverse this dilemma.

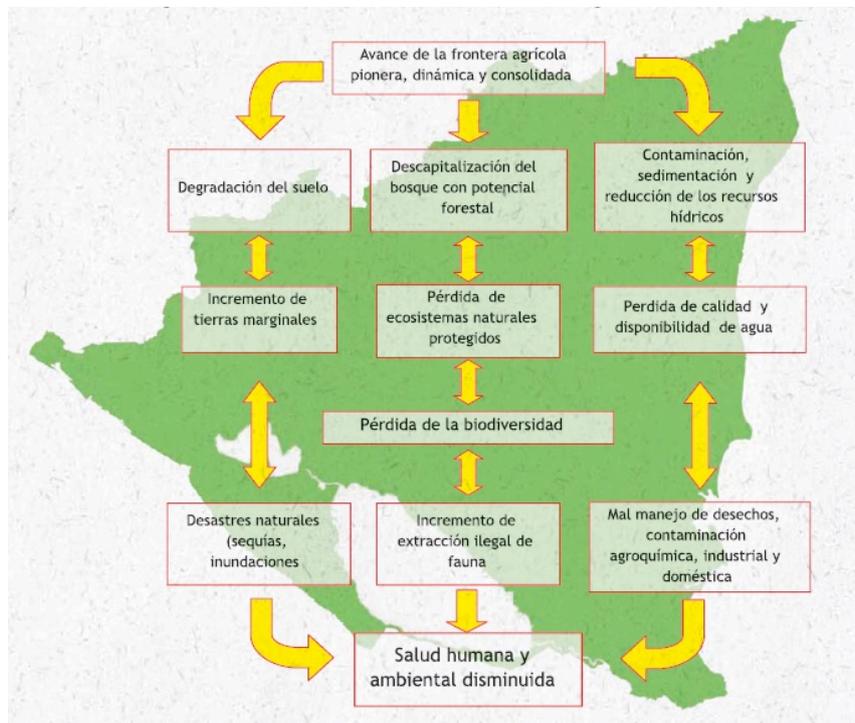


Figure 45 Effects of deforestation and forest degradation on a national level. Source: MARENA 2007

IV. Causes of deforestation and forest degradation

Deforestation and forest degradation are processes caused by multiple factors, which can be motors or unleashing factors. For this reason, various studies classify the DandD causes in direct, indirect, and fundamental causes²⁷.

The direct causes are direct actions that give rise to land-use change or the conversion of forests to other uses (i.e., deforestation and forest degradation), and can have multiple agents of change (i.e., ranchers, farmers, wood concession holders, third parties, etc.).

The indirect or underlying causes are complex interactions between fundamental processes of social, economic, political, cultural, and technological nature. These direct and underlying causes interact among themselves and establish synergies that advance the negative effects according to the regional and/or national context.

In contrast, the fundamental causes can be defined as macro or external aspects that obey other rules and can be developed in transversely to the direct or underlying causes. For example: the construction of infrastructure, poverty, demographic growth, migration, among others.

In Table 15, there is a review of the identified causal factors that have impact in the country, and that will be treated in detail in this section.

Table 15. Direct and underlying causes of deforestation and forest degradation in Nicaragua.

Direct causes ²⁸	Underlying causes ²⁹
<p>Deforestation³⁰</p> <ul style="list-style-type: none"> *Cattle (extensive and migratory) *Agriculture (subsistence agriculture as a historical cause and less so currently, and extensive commercial agriculture more like a current cause) *Phenomenon known also as the “advance of the agricultural frontier”. 	<p>Economic/Productive</p> <p>Institutional</p>
<p>Forest degradation³¹</p> <ul style="list-style-type: none"> *Fuelwood and charcoal consumption (commercial and subsistence) *Illegal wood cutting *Legal wood cutting (unsustainable) *Forest fires **Environmental emergencies (blights, disease, hurricanes) 	
<p>Fundamental Causes</p> <p>Construction of infrastructure, international markets, poverty, demographic expansion, migration.</p>	

²⁷ Geist and Lambin (2002), Kanel (2004).

²⁸ Derived from human activity or actions that have a direct impact on forest cover or loss of forest carbon.

²⁹ Complex interactions among fundamental processes of social, economic, political, cultural, or technological nature.

³⁰ Conversion by direct human activity, from forest lands, to non-forested lands.

³¹ Elimination and partial loss of the ecosystem function.

Table 16. Perception of incidence of the causes of deforestation by region of the country.

Zone of the country/ Direct causes	Cattle	Crops	Wood cutting
Caribbean	XXX	X	XXX
PCN	XX	XXX	XX

Table 10. Perception of incidence of the causes of forest degradation by region of the country.

Zone of the country/ Direct causes	Fuelwood	Forest fires	Wood cutting
Caribbean	X	X	XX
PCN	XXX	XX	X

4.1 Fundamental causes

4.1.1 Demographic growth

According to the V Census of populations and homes, the population of Nicaragua is 6,150,414 inhabitants. It has been growing gradually in the periods 2005 – 2010 and 2010 – 2013. This population growth has propelled an increase in the demand for goods and services to satisfy needs. For example, the demand for wood products goes up and consumption is higher at the time of replacement of the harvested resource.

In Figure 46, is shown the tendency of demographic growth in Nicaragua during the period 2000 – 2013 (INIDE, 2015).

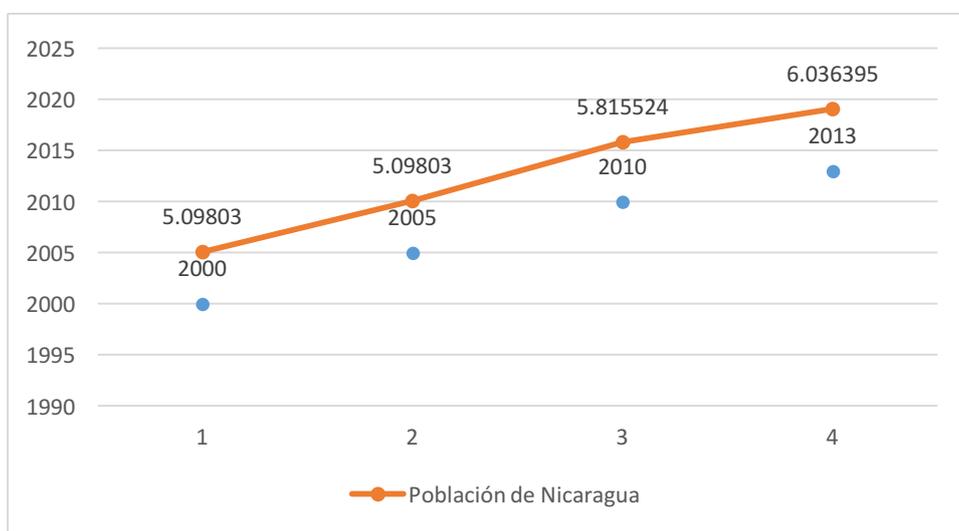


Figure 46 Demographic growth in Nicaragua during 2000-2013

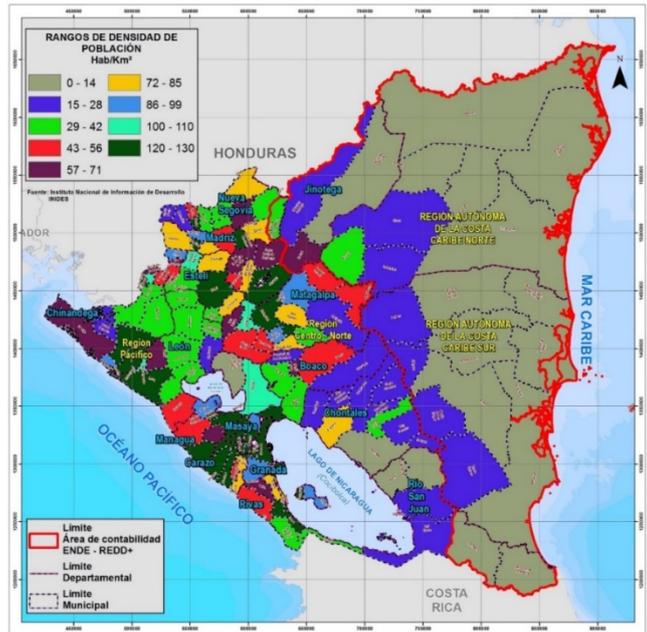


Figure 47 Population density ranges in Nicaragua.

4.1.2 Poverty

There has been an advance in the reduction of poverty since 1990. According to the Polls of Measurement of Standard of Living (EMNV), poverty went down 20.7 percentage points from 1993 to 2014 (from 50.3 % to 29.6 %). This indicates, nonetheless, that there are still almost a third of the Nicaraguans living in situations of poverty. Furthermore, a high percentage of the population is barely above the general poverty line and is very vulnerable to return to this situation. In the rural area, where 50 % of the population live below the general poverty line established by the Government (INIDE, 2016).

- The Pacific Region has an average % poverty.
- The Region Centro-North-Central Region has an average % poverty.
- The Caribbean Region has an average % poverty.

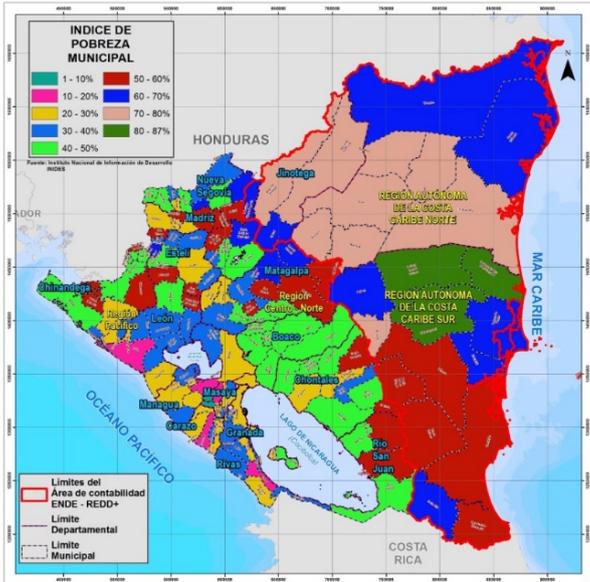


Figure 48 Municipal index of poverty (INIDE- EMV 2005).

The departments with highest indices of poverty on the municipal level are RAACN, RACCS, Jinotega, Rio San Juan and Matagalpa (Figure 49).

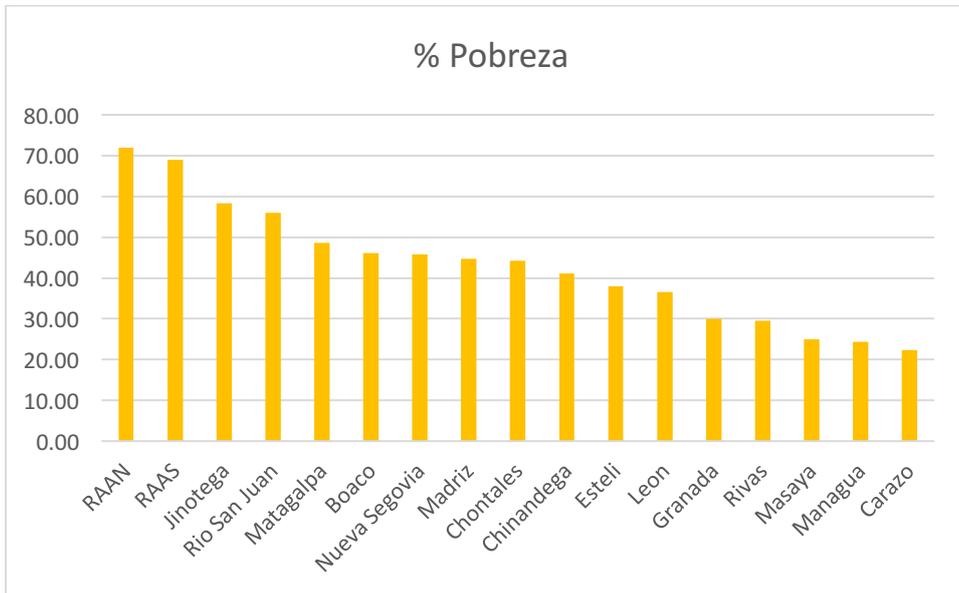


Figure 49 Municipal poverty index (INIDE- EMV 2005).



The forest sector (Silviculture) experiences a rebound with increase in investment in 2015.

Crecimiento promedio interanual (porcentaje), enero-septiembre 2015



Source: IMAE by economic activity. FUNIDES 2015

4.1.3 Migration

Nicaragua recognized different forms of property, classifying them as public, private, associative, cooperative, community, family, and mixed³², guaranteeing in addition, land tenure without discrimination with the objective to produce richness and at the same time a social function to benefit the inhabitants and the country.

Communal property: is representative of the indigenous groups and afro-descendent communities of the Caribbean Coast. The State of Nicaragua recognizes the complete rights of indigenous peoples and the afro-descendent communities over their property, use, administration of natural resources and management of the communal lands under different forms, rights consigned in the Political Constitution of Nicaragua³⁴. In the year two thousand three, the legislature approved Law No. 445, Law of the Regime of Communal Property of the Indigenous People and Ethnic Communities in the Autonomous Regions of the Atlantic Coast (now the Autonomous Regions of the Caribbean Coast) and of the Bocay, Coco, Indio and Maiz Rivers. Published in La Gaceta No. 16, 23 January 2003.

The Law No. 445 came to be through the inescapable commitment of the State of Nicaragua to respond to the demand for titles in the lands and Territories of the indigenous peoples and ethnic communities, rights awarded in the Political Constitution of Nicaragua in 1987, and in the Law No. 28, Statute of Autonomy of the Autonomous Regions of the Atlantic Coast, and international treaties.

³² Constitución Política de Nicaragua y sus reformas, Diario Oficial La Gaceta No.32, Managua Nicaragua 18 de febrero del año 2014.

The State, in the framework of Law No. 445, has finalized the process of conflict resolution among reclamation, demarcation, and titling of Territories. Currently, the indigenous peoples and afro-descendants are in a process of territorial planning, analysis and zoning of the areas, the communal lands are dealing with the dilemma of illegal settling by mestizo families, from the Pacific, North and Center of the country, that enter the territory to vie for lands that they consider idle. Indigenous Territories in the Autonomous Regions of the Caribbean Coast have initiated negotiation processes through a figure of peaceful co-existence and rental contracts under norms dictated by the highest authorities.

According to Robleto, G; Solorzano A; Lacayo, L. 2011, the topic of settlers should be understood in the framework of multiple, long-term, social, historical, and economic processes, in such a way that permits the concept of a different culture in the territory, and the development of urban social policies that guarantee the exercise of citizen rights.

The migratory pattern may be encouraged by differences in land prices, where producers with small parcels of land, located in areas with high prices, face incentives to sell and then purchase larger farms in areas where the land is still inexpensive (Polvorosa J. 2015).

Indigenous group and afro-descendant communities are pre-columbian inhabitants with ancestral possession in territories of the Caribbean Coast of Nicaragua, and due to different social processes, the process of advancing the agricultural frontier appears with the practice of agriculture and extensive livestock. History cites these social processes as relative to poverty that encourages emigration

The worldview of the indigenous group well attached to the conservation of their natural resources, since the forest is considered as part of a system of life. In an analysis performed by MARENA, in 2011, it is conceived that the deforestation in areas controlled by mestizos is higher than 2.15 ha/person/year, whereas in the indigenous communities oscillates around 0.2 ha/person/year. The rate of deforestation of the mestizos is ten times that of the indigenous, which is clearly evidenced in the geographic analyses performed by MARENA in 2011.

The productive logic of the Mestizos is similar to that of ranchers of the old agricultural frontier. Landless peasants from the Pacific, Center and North of the country who enter the territory to take advantage of the lands (under different community arrangements) that they consider to be idle, in the indigenous territories, then deforest to implement different productive systems, with time transform them to cattle pasture and finally abandon them and they are converted to secondary growth.

4.1.4 Infraestructure

The creation of infrastructure is necessary for development in the country, above all because the lag in development and the economy is high.

Since 2007, the Ministry of Transport and Infrastructure (MTI) (from 2008) has received the greatest amount of the public Budget with a sum of C\$5,068 million (25.3 %). Municipal transfers were in the first place in the Public Investment Budget 2015, were in second place with C\$4,856 million (24.2 %), and in third place was the National Enterprise for Electrical Transmission (ENATREL) with C\$1,828 million (9.1 %). Only these three institutions encompass 59 per cent of the PIP (FUNIDES 2016).

It deserves to be highlighted that in 2016, the Public Investment Program (PIP) presented the greatest increases in the Budget of the Autonomous Regions of the North and South Caribbean Coast. The assigned

PIP was doubled in 2016 with respect to 2015. Likewise, the multi-departmental PIP also doubled in 2016. This focus of one of the projects that is contemplated is the improvement of the Rio Blanco-Mulukuku highway, located between the departments Matagalpa and RACCN (FUNIDES 2016).

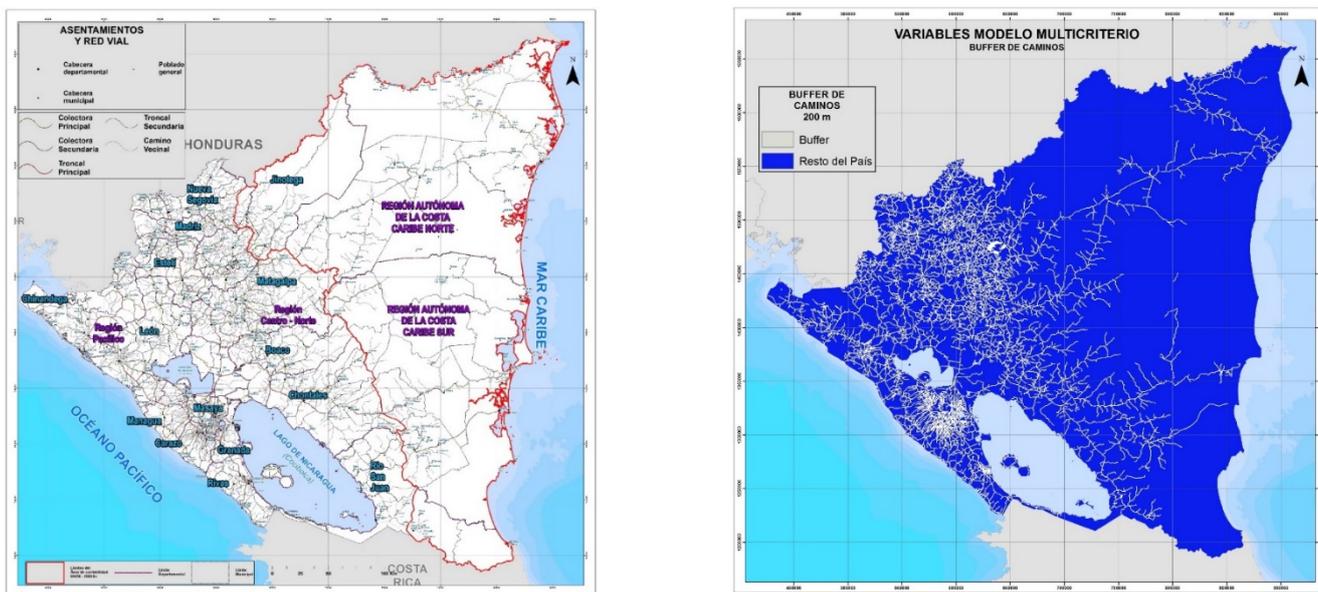


Figure 50 Network of primary and secondary roads existing in the country.

4.1.5 Favorable market conditions for farm products

The favorable market conditions for farm products and the expansion of the farming sector also stimulate the migrations and resultant deforestation. The agricultural sector has expanded due to the free trade agreements with the Central American countries and USA. In 2015, of the five greatest value principal exportation products, four were from the agricultural sector: meat (US\$ 454.3 million), coffee (US\$ 392.3 million), dairy (US\$ 218.2 million) y sugar (US\$ 153.0 million), which, together with gold (US\$ 317.9 million) constitute 63 % of the total exported value in the country (BNC 2015).

Within the agricultural sector, in recent years, the domestic market for dairy and the exportation of meat and dairy have increased. Between 2000 and 2009, the ranching sector grew at 5 % yearly rate, and between 2006 and 2015, the value of ranching exportations increased 176 % (Technoserve 2017). In 2015, 3 of the 10 principal exportation products were associated with ranching (Figure 51) and had a combined value of approximately US\$700 million, where the dairy sector had a value of US\$203 million in exportation and the meat sector contributed another US\$415 million. Currently, the ranching sector represents almost 10 % of the PBI and contributes 25 % of the exports.

In this context, it is important to note that Nicaragua is the greatest producer of meat and dairy in Central America. The herd of approximately 5.2 million head of cattle is found on 4.2 million ha and is managed by around 140,000 producers for meat and dairy, of which 85 % are small and medium producers; the sector employs 600,000 persons altogether (BCN, 2015). According to the National Agricultural Census in 2011, RACCN and RACCS hold 38% of the bovine cattle herd. Of the national herd, 49 % are in small and medium production scales, up to 70 ha, whereas 51 % of the national herd pertains to farms of 70 to 350 ha, and 35 % are in farms of between 70 and 140 ha (CENAGRO 2011).

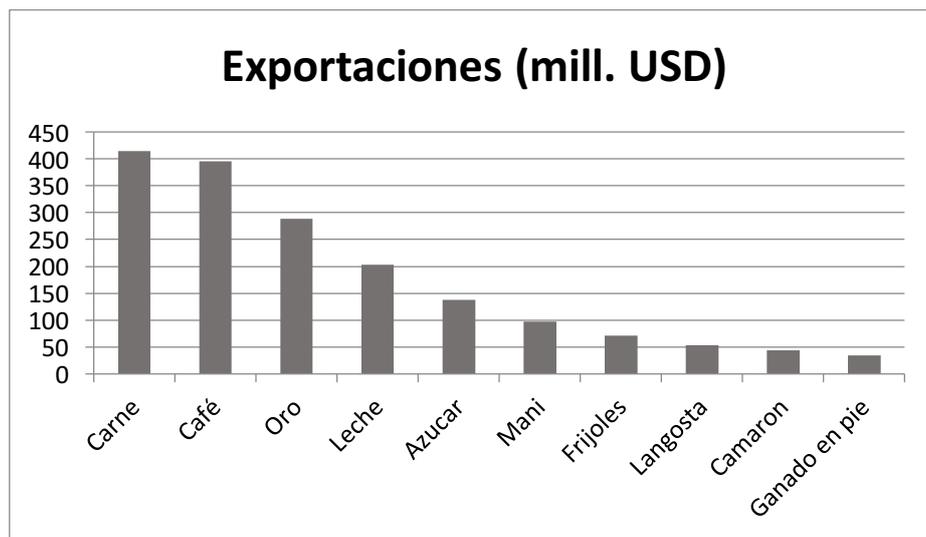


Figure 51 Principal categories of exportation in the country, according to their contribution to exports (CENAGRO 2011).

Source: <http://www.ico.org/documents/cy2015-16/Presentations/national-coffee-policies-nicaragua-march-2016.pdf>

López (2012) indicates that the increasing demand for food products from the national and regional markets has given incentive to land-use changes for the planting of products related to the active agro-exportation market, pushing further the agricultural frontier.

4.2 Direct causes of deforestation

4.2.1 Cattle

Cattle farming is considered the principal cause of deforestation according to the evaluations of historic (Arnold 2011) and recent (MARENA 2007, 2010) land use, because it is an extensive activity which has expanded rapidly, provoking the advance of the agricultural frontier from west to east in the national territory.

The cattle sector provides 10 % of the PIB, nationally (BCN 2016), for which the contribution to the current economy is undeniable; cheese and milk represent almost 27 % of the basic demand of the Nicaraguan household. Furthermore, in rural areas, cattle are part of the Nicaraguan culture and represent status; in social perception, to be a 'cattleman' is greater than to be a 'crop farmer', and for the peasant, cattle more than just a source of income, represents a savings account for the family emergencies.

Cattle farming can be characterized as an extensive activity with low productive yield. The conversion of forests to cattle farms is attached to business interests and to rural, poor family subsistence. For example, during the dry season, poor people in wetter climates (i.e., Caribbean Coast) offer areas for pasturing cattle in the form of land rent (lands that earlier held forests), with the objective to feed cattle during the

dry season, the cattle usually coming from other parts of the country (INAFOR, 2004). For which, in the Caribbean Regions, there is a buffering or compensating of the scarceness of pasture in the dry areas of the country.

In recent years, the exportation of pasteurized dairy products has taken on a greater importance in Nicaragua, given the greater demand for dairy products and the development of the dairy chain nationally (cheese and milk). This interest has arisen as a result of the free trade agreements signed between other countries and the countries of Central America and the USA. At the same time, in Nicaragua, the milk cattle constitute an important source of income for a large part of the rural population (Polvorosa J. 2015).

Nicaragua has had a large growth in the production, but the industrialization of milk is still limited. It is estimated that approximately 200,000 cattle-farming families and a herd of 4.2 million head of cattle are found; some 80 % are considered small or medium productive units. The animal density is approximately 0.84 ha, per head of cattle. In spite of the country having greater possibility of growth in production, there continues a lag in technology and in access to better markets in comparison to those of the Central American region.

During 2000 – 2009, the agricultural sector grew at an annual average of 3.6 %, a little more than the average for Central America (3.2 %). Part of this growth is explained by the efforts of the animal husbandry sector, which grew at an annual rate of 5 %. Bovine cattle generated approximately 5 % of the PIB and represented 27 % of the value of exports of domestic merchandise. In the last six years, the exportations of beef have grown significantly, growing from 107.6 in the year 2006, to 230.4 million lb in 2011, with 114 % increase. In the same manner, it increased 188 % in terms of monetary units.

According to CENAGRO 2011, the management of cattle on the departmental level demonstrates that the departments with greater numbers of head of cattle were, from highest to lowest: RACCS, RACCN, Matagalpa, Río San Juan, and Jinotega (Figures 52 and 53), with these data, the departments behind that have been historically eminently cattle-related, Chontales and Boaco. Furthermore, these values reinforce the hypothesis that the migration of cattle toward the sites that are more humid and with greater availability of surface water (process called “Chontalization”), added to other factors, reduces the costs of production in cattle, but increases the pressure on forested areas.

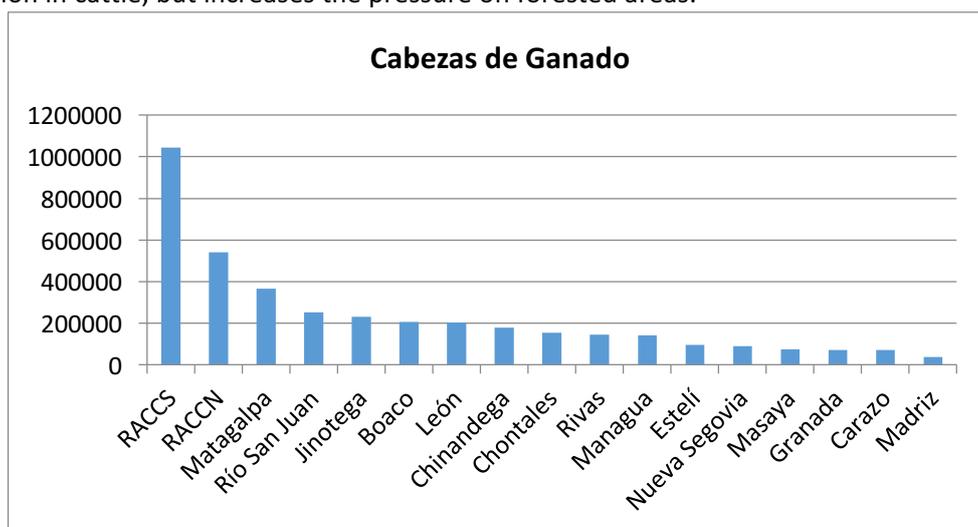
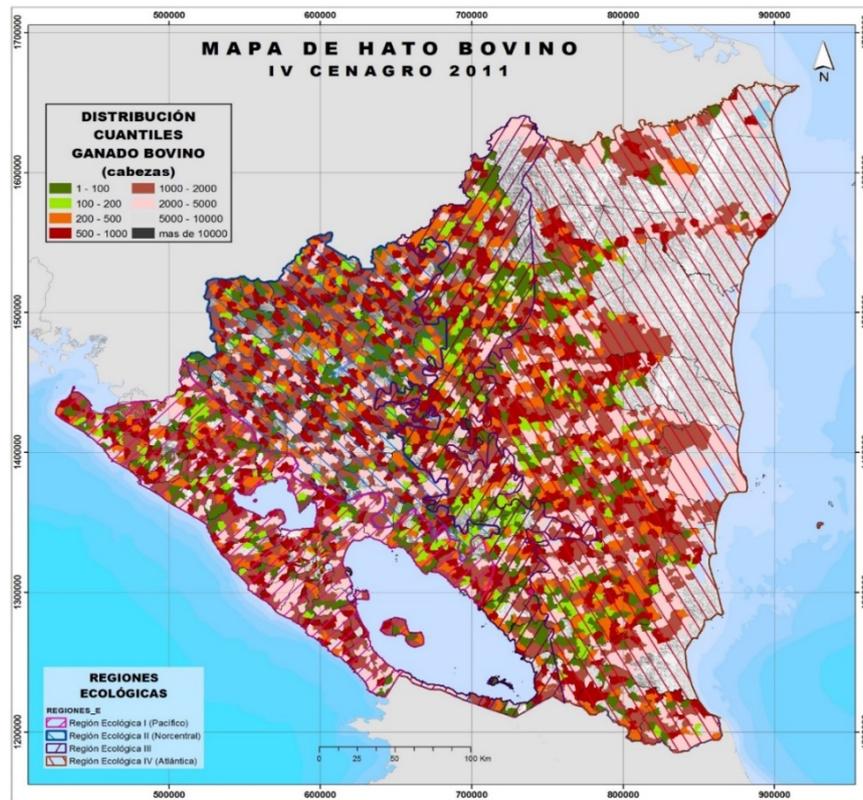
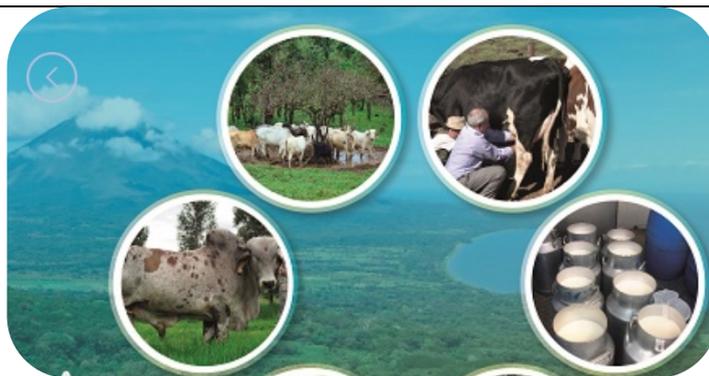


Figure 52 Distribution of the number of heads in the departments, census of CENAGRO 2011.



box 3. Dairy chain in Nicaragua.

The Dairy Chain in Nicaragua is distributed principally in the Central-North and Caribbean Regions.



- The Nicaraguan Chamber for the Dairy Sector, CANISLAC, was created in 2001.
- It is an institution that represents the economic interests of the dairy sector.
- It is composed of individual producers, small, medium and large scale; also collectors, processors, and/or marketing of milk and derivatives; small, medium and large businesses; guilds of producers; and agro-business service providers.

Source: CANISLAC

Within RAACN, the municipalities that have the greatest numbers of head of cattle are: Prinzapolka, Waslala, Waspam, and Puerto Cabezas (CENAGRO 2011).

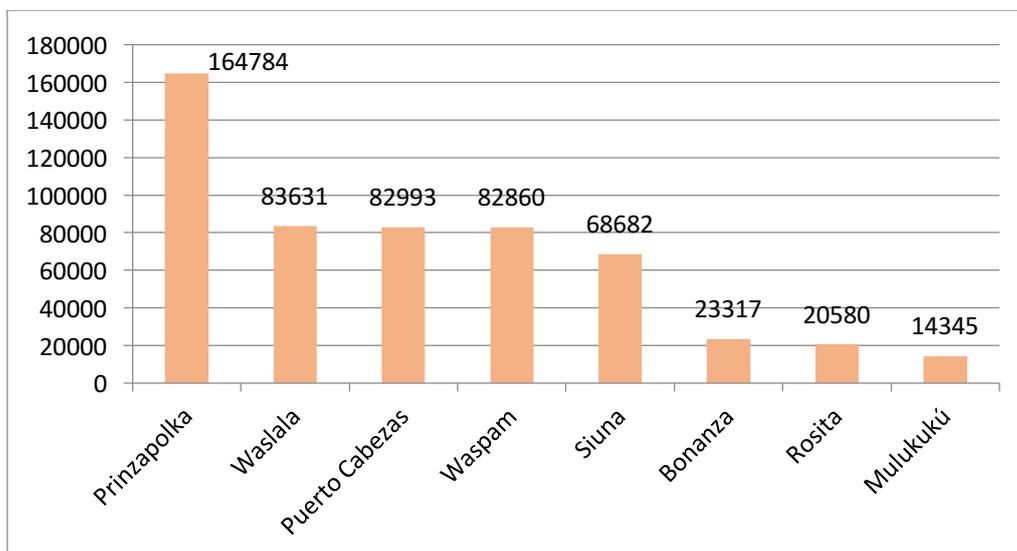


Figure 53 Number of head of cattle in the municipalities of RACCN according to CENAGRO 2011.

In RACCS, the municipalities with greatest numbers of head of cattle are: Tortuguero, Bluefields, El Rama and La Cruz de Rio Grande (Figure 55). In contrast, in the Department Rio San Juan, the municipalities with the greatest numbers of head of cattle are: Rio San Juan de Nicaragua, El Castillo and San Carlos (CENAGRO 2011).

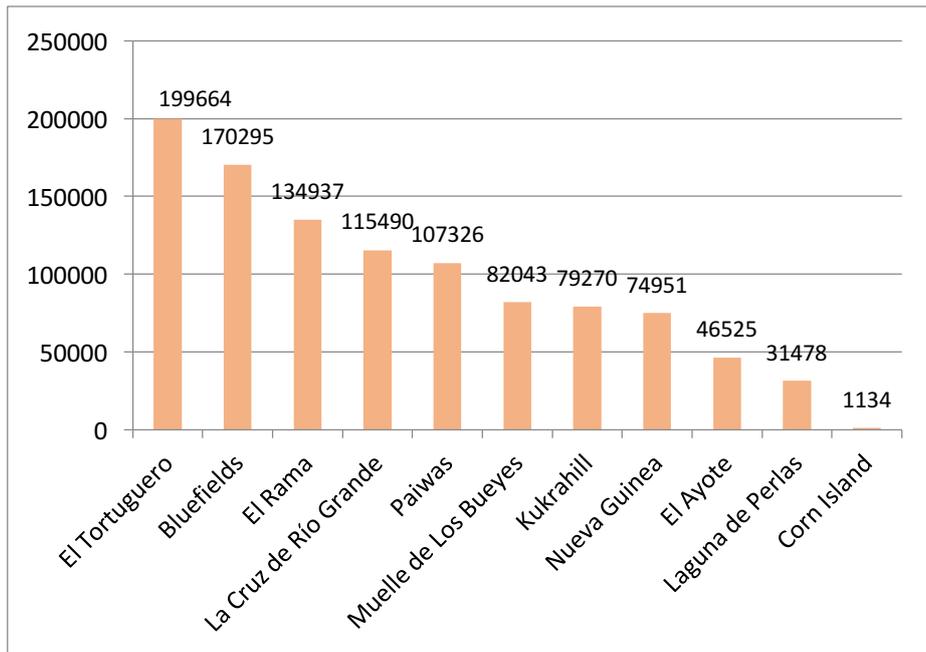


Figure 54 Number of head of cattle in the municipalities of RACCS according to CENAGRO 2011.

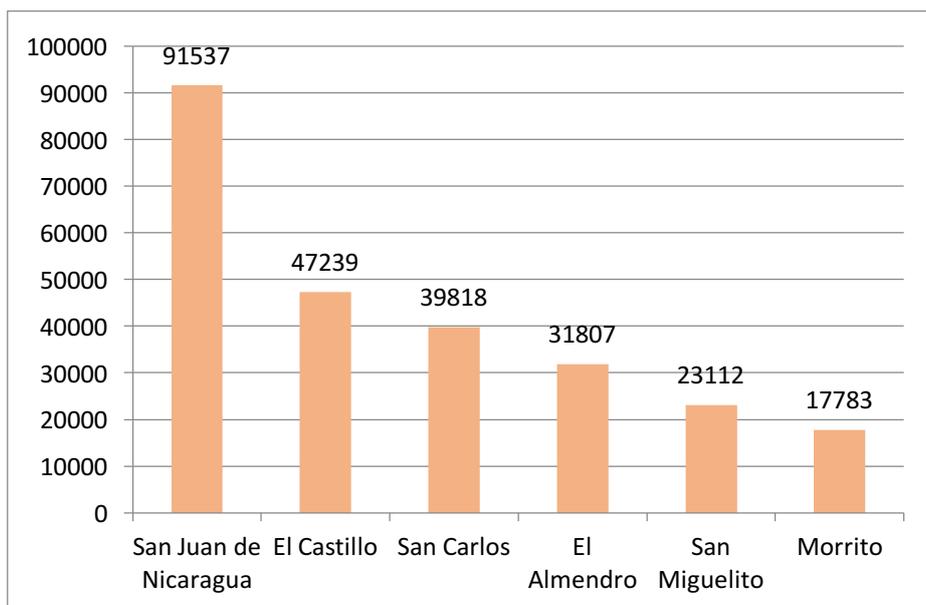


Figure 55 Number of head of cattle in the municipalities of Río San Juan according to CENAGRO 2011.

Furthermore, in the Department of Matagalpa, numbers of head of cattle are greatest in Matiguas, Muy Muy, and Ciudad Darío.

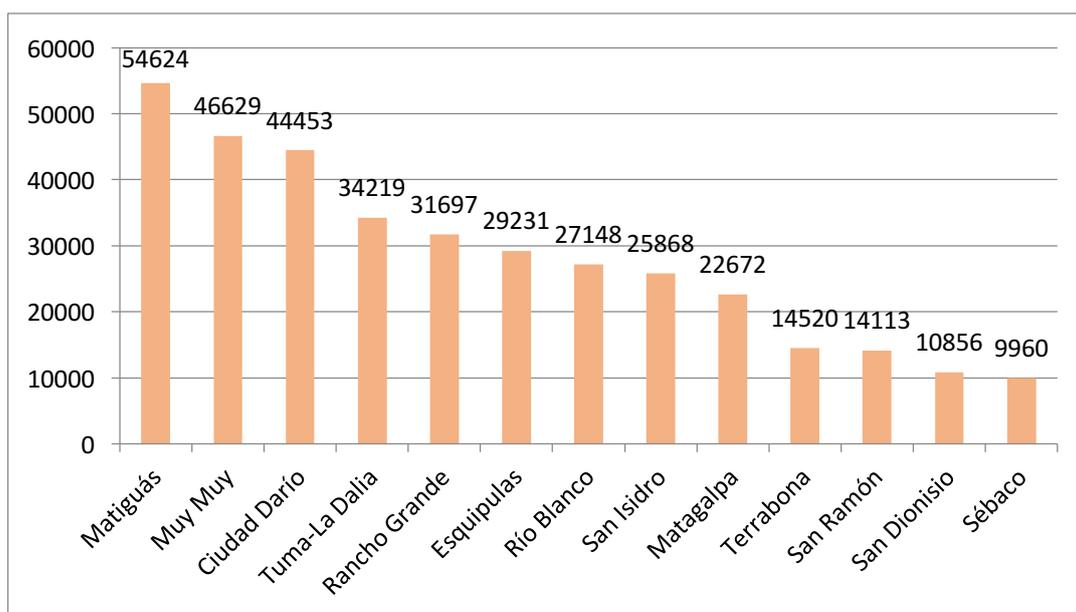


Figure 56 Number of head of cattle in the municipalities of Matagalpa, according to CENAGRO 2011

Currently, it is possible to find the presence of cattle in the municipalities that historically maintained remnants of reserves of natural forests and/or are found in several protected areas or buffer zones. In CENAGRO 2011, the magnitude and distribution of the cattle sector on a national level is evident, having developed in its majority within the Farming Businesses (private farms). Nonetheless, this study sustains that the sites that before 2015 were covered by natural forests now are pastures, for which reason it is considered that the cattle sector is the principal cause of deforestation in the country.

4.2.2 Agriculture

The areas with crops increased from 660,820 thousand in 1983, to 742,000 in 2015. It is estimated that, in the period 2005 to 2015, farming has had an increase in areas of 10176 ha per year. This data includes both annuals and perennials in the country.

The larger part of the areas planted with basic grains are found in the soils of mountainsides, with limitations of depth, little retention of moisture, and poor fertility. Furthermore, planting is done dry, with little and poorly distributed rains. The dry season farming is found, in its majority, in soils constantly facing degradation due to poor utilization of the natural resources and little value that is given to the ecosystem services by nature (INTA, 2014).

Basic grains production on a national level (corn, bean, rice, sorghum) increased productivity in 3,772,800 *quintales* (hundredweight) (24 % in comparison to 2001). Sorghum was the only crop that reported a reduction of -36.6 %, in spite of having demonstrated an increase in the planted area (BCN, 2011).

The transformation of raw materials plays a determinant role in the value chain for agricultural products, for which there are few national-level initiatives. The State of Nicaragua is aware of this, taking steps in this direction with the promotion and support of some MYPIMES that share a clear vision of the country, pointing toward the future incentive being situated in the cluster that can be formed with different land-based products that can reduce the advance of the agricultural frontier, given that more resources will be dedicated to the transformation process than to raw materials and this will satisfy more of the basic necessities of the society (jobs, consumption, prices, quality).

Area of export crops. The crops for agro-exportation (coffee, banana/plantain, sugar, peanut, sesame, soy, cotton), present in 2011 an area of approximately 288,075.2 ha, with an increase of the areas under cultivation of 13.14 % (in relation to 2001). Other agro-exportation crops (cacao, citrus, coco, mango, pineapple, avocado, African palm, pitahaya, papaya, and others), also show an increase in areas planted to 18,405.59 ha in comparison to 2001.

Table 11. Area of agro-exportation crops, 2001 – 2011.

National Agricultural Census	Total area cultivated (ha)	Crops (ha)						
		Coffee	Banana/Plantain	Sugar	Peanut	Sesame	Soy	Cotton
III CENAGRO 2001	254,610	129,911	63,491	61,207				
IV CENAGRO 2011	288,075	126,153	54,075	63,092	32,845	9,813	1,851	242
<i>Variation in area</i>	33,464	-3,757	-9,416	1,885	32,845	9,813	1,851	242
<i>% Variation</i>	576,150	-3	-15	3				

Source: CENAGRO 2001/CENAGRO 2011
 Note: In the III CENAGRO, cultivated areas of peanut, sesame, soy and cotton were not reported, for which the increase in area cultivated could be due to these crops not being considered as important economic activities.

In 2011, there were 183,782 ha of agricultural activities (EAs) reported³³, occupying 6,011,926 ha, of which 2,693,523 ha (44.8 %) were dedicated to crop production and 3,248,496 ha (54 %), destined for animal husbandry; and the remaining 699,066 ha (1.2 %) were occupied by several installations and in support of agricultural production (CENAGRO, 2011).

The IV CENAGRO registered that land use in agriculture in 2011 was 5,942,020 ha, which represented an increase of 34 % in relation to 2001 (803,278 ha more). The increase in land use was 25 % in crop production, and only 9 % for animal husbandry. According to the biodiversity report, 2016.

Table 12. Area in agriculture registered in the agricultural censuses of 2001 and 2011.

National Agricultural Census	Area (ha)	Farming area (ha)	
		Crop	Animal
III CENAGRO 2001	5,138,742	2,154,132	2,984,609
IV CENAGRO 2011	5,942,020	2,693,523	3,248,496
<i>Variation in area</i>	803,278	539,391	263,886
<i>% Variation</i>	11,080,762	25	9
<i>% Variation (farming)</i>		34	

Source: CENAGRO 2001, 2011

In the Pacific, Central, and North Region (PCN), annual crops presented a reduction of more than 100,000 ha, in 1983 it was estimated that more than 500,000 ha was cultivated, and in 2015, more than 350,000 ha; for perennial crops, there was a tendency toward growth during the entire period. In contrast, for the Caribbean Region, the annual and perennial crops presented a tendency of growth (Figure 58).

³³EA's – Agricultural Activities by area.

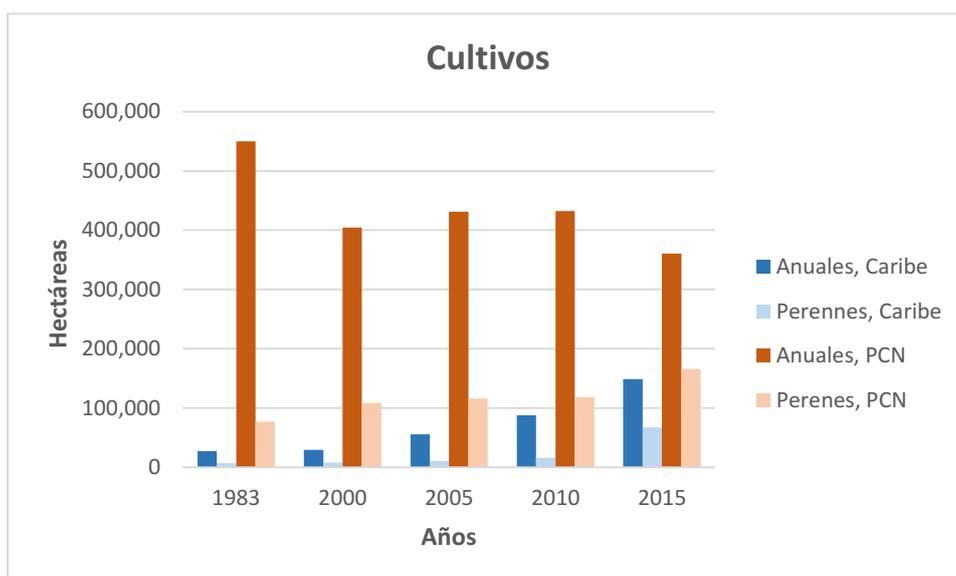


Figure 57 Dynamic of the areas with crops (in ha), from 1983 to 2015.

Table 13. Land use (ha) by annual and perennial crops from the year 1983 to 2015.

Type of crop	1983	2000	2005	2010	2015
Annual crops	26,954	29,537	55,695	87,625	148,866
Perennial crops	6,899	7,896	10,526	16,039	67,368
Total	33,853	37,433	66,221	103,664	216,234



Figure 58 Distribution of the areas with crops (Mz), according to the ecological regions of the country (CENAGRO 2011).

To conclude, this section is important to highlight that Nicaragua, historically, has sustained its economy in the primary sector, principally in crops and animal husbandry. In 2011, the exportations of beef and coffee were the categories that provided the greatest value.

box 4. Analysis of the historic causes of deforestation on national and regional bases.

Historic causes of deforestation (Data from Land-use map 2008. INAFOR 2009)

The analysis of historic causes concluded that the principal historic cause of deforestation in Nicaragua was cattle farming with a contribution of 53.2 %, followed by crop farming with 39.5 % of the land-use changes. Agro-forestry provided 7.2 % of these changes.

The results by region were:

- 1) In the Pacific Region, the principal cause was crop farming with 55.9 %, afterward cattle with 34.4 %, and agro-forestry with 9.8 %.
- 2) Las Segovias, Jinotega, and Matagalpa, the principal cause was cattle (45.5 %), followed by crops (39.5 %) and then agro-forestry (15.1 %).
- 3) In Boaco, Chontales, Río San Juan and in the Caribbean Region (RAACN, RAACS), cattle was leading (74 %), followed by crops (21.2 %) and then agro-forestry (4.8 %).
- 4) In the Caribbean, cattle provided 56.2 % and crops, 41.3 %.

Source: ARNOLD, 2010

4.3. Direct causes to forest degradation

4.3.1 Fuelwood and Charcoal Consumption

In Nicaragua, fuelwood is the principal use of the forest, representing 10 to 15 times the consumption assigned to the forestry industry. In 1983, the annual consumption of wood for fuel rose to 3.7 million m³ (2.6 million tons), or the consumption per inhabitant at 0.85 tons per year.

Historically, fuelwood and vegetable carbon, as in other biomass-derived products, have always played an important role in the satisfaction of basic energy needs, such as for cooking for Nicaraguans. In 1990, according to PAFNIC, fuelwood represented 55 % of the net, final consumption of energy; charcoal at 1 % and petroleum derivatives, 27 %. According to this study, the consumption of fuelwood was estimated at between 1,500,000 and 1,800,000 metric tons (TM). In residential and commercial zones, 89 % was consumed, and 5 % in the industrial sector, and the remaining 6 % in the production of charcoal. Thus it was also indicated that 1.8 million persons utilized fuelwood as the principal combustible. The consumption of fuelwood per year and its importance to the National Energetic Balance are expressed in the following table:

Table 14. Consumption of fuelwood in homes, yearly, in Nicaragua.

Consumption of fuelwood yearly in relation to BEN		
Year	Thousands of Equivalent Tons of Petroleum (TEP)	Relation to the final energetic total consumption (BEN)
1997	1,028.7	54.0%
2001	1,150.3	54.6%
2006	935.7	47.8%
2008 (preliminary)	946.2	47.1%

Source: MARENA et al. 2011.

In spite of the importance of fuelwood in the Nicaraguan economy, the energy policy in the country has not considered it as a renewable, alternative source of energy. The energy policy has been based on diversifying sources, But above all in a reduction of the consumption of hydrocarbons.

According to the methodology introduced by ENL, as of 2006, the national energy balances estimate fuelwood consumption based on an average consumption of 1.81 kg / inhab / day, contrary to the 2.51 kg / hab / day used For the calculation of the previous balance sheets. It is also observed that the annual growth rate of fuelwood consumption in the period 1997-2005 was 3.93% and in the period 2006 - 2008 this rate decreased to 0.56% due to the changes introduced

Finally, in the latest available national energy balance (2008, preliminary), the total consumption of fuelwood in that year was 946.2 thousand TEP and represented 47.1 % of the final total energy consumption. The earlier tendency of consumption has implications of the socio-economic and environmental type. The environmental impacts generated principally during the extraction of fuelwood have provoked, in extensive zones in the country, deforestation and forest degradation among primary forests, reduced the wildlife, and the quality and quantity the water bodies such as rivers, streams, springs, lakes of the national territory due to the agricultural uses that the land use has provoked.

Fuelwood and charcoal come practically totally from natural forests. About 60 % of the fuelwood obtained comes from tree branches, trees outside of forests, secondary growth, bushes, and dry wood recovered from fallen trees, whereas it is considered that 9 % comes from the cutting and pruning of trees (MEM,

2007). It is worth mentioning that this economic activity generates employment to some 250,000 personas that live permanently dedicated to the extraction activities and of these, 75 % are small and medium, rural, producers; being the principal source of energy in homes, in the small, medium, and recently in large industries. Nevertheless, in this process, it has been identified that many actors in the forest sector do not execute their activities in accordance with the legal and technical framework of management of forests; for this reason, they do not assure a sustainable production and conservation of the resource.

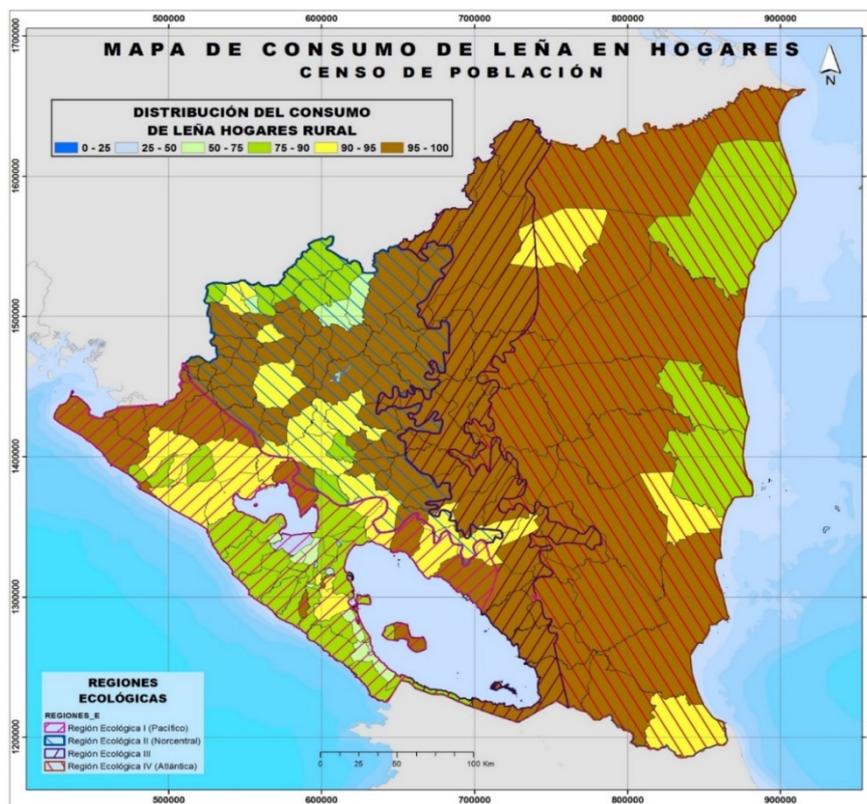


Figure 59 Distribution of the consumption of fuelwood in homes (%) according to ecological region of the country (CENAGRO 2011).

Figure 61 shows that the consumption of fuelwood is very similar and above 60 % of the homes in all the departments of the country. The national average consumption of fuelwood is 90.26 %.

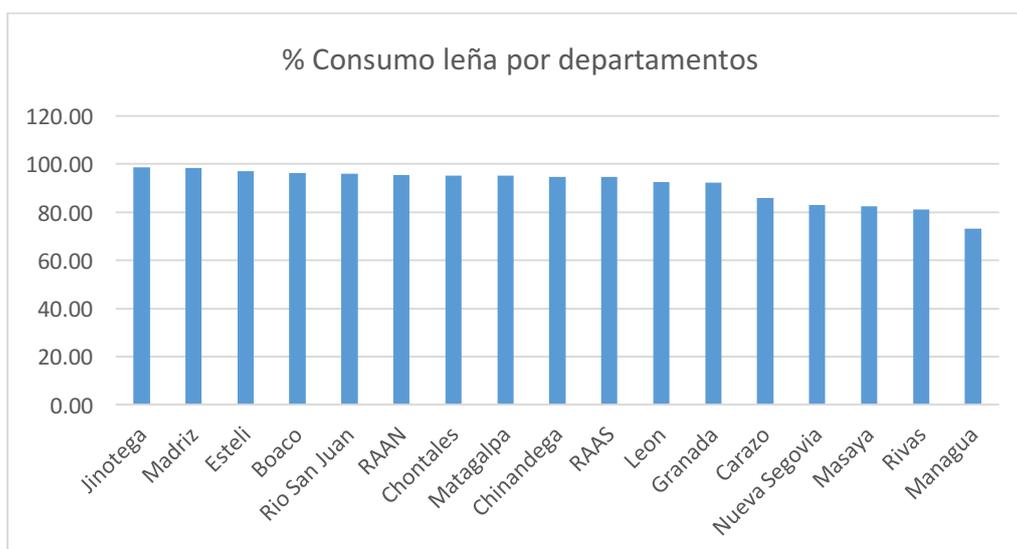


Figure 60 Percentage of consumption of fuelwood in homes by department according to CENAGRO 2011.

4.3.2 Illegal cutting

The illegal cutting of forests continues to be one of the important causes of deforestation and forest degradation. Some people affirm that illegal cutting could be as much as legally cut wood volumes, reported and under the authorized harvesting. Studies executed in 2000 and 2003 indicate that the extracted volume of illegally cut wood is equivalent to 60 % of the volumes authorized and registered by INAFOR, and studies executed by the World Bank and cited by the same indicate that the illegal wood cutting oscillates around 30,000 – 35,000 m³ in broadleaf and between 110,000 and 135,000 m³ in conifer wood.

This study estimated that the fiscal losses as a result of the illegal cutting cost the government of Nicaragua between US\$4 and US\$8 million per year, in terms of actual net value (VAN), these losses being estimated at between US\$30 and 60 million. With the deterioration of the forests, the environmental goods and services required by the various ecosystems are also reduced (MARENA 2013).

4.3.3 Legal Cutting

In the forest sector, there is missing appropriate techniques for the harvesting, for cutting as well as for the transformation steps of the product, so that it is exported with little value added (FUNICA, 2012).

The forest industry in Nicaragua has not been developed in accordance with the necessities of the country, and it faces a series of limitations that impede it from being exercised in an efficient manner; the following are highlighted: low technology in machinery and equipment; low level of modernization in designs; deficiencies in the wood drying process; low quality of final product; low levels of organization, of technical knowledge, and of business management; little access to financing appropriate to the conditions of the forestry activities.

The forestry industry is concentrated practically in the first transformation: the industry of sawmills, and uses only 50 % of the national installed capacity. The industry of second transformation is totally in the

hands of PYMES (3,000), located in the majority in the urban sector. There exist only three industries of the third transformation (Plywood in Tipitapa, PRADA in RACCN and NIVESA in RACCS). All these businesses work well below their installed capacity and face problems of supply of raw material, just as the PYME of second transformation, as a consequence of the forestry prohibition.

The technical assistance services and training have been surrendered to the owners of forests under different modes and focuses through different development projects executed from the public institutions, the private sector and NGOs. In spite of the fact that, in many cases, the provision of services has been executed efficiently, it has not been possible to establish a sustainable demand of services for their continuity, because once the programs and projects finalize, the technical assistance also ends. The principal programs and projects that have been implemented in the past 15 years are the Socio-Environmental Forestry Program (POSAF), the Silviculture Support Fund (FONDOSILVA), the Forestry Project of Nicaragua (PROFOR-MAGFOR-BM). Other projects and institutions that have provided technical assistance are: FAT and FAITAN (FUNICA), INTA, and IDR. Only a few institutions have developed programs of technical or higher education, and/or research, in the forestry sector (INTECFOR, UNA, UNAN-León, Center for Genetic Improvement and the Forest Seed Bank/INAFOR), having little availability of technical information and research to facilitate development and to provide technological validation in the sector.

FONADEFO is an institution created in 2003, with the objective of financing forestry development under Law 462 and its opening in 2005, the intervention of the Forest Development Fund has presented limitations for the financing of the sector.

Forest incentives include those provided by programs and projects such as the Regional Forestry Program (PROCAFOR), the project "Institutional strengthening for the management of natural regeneration in areas of forests affected by the pest of the pine bark beetle in Nueva Segovia And Estelí", and the POSAF. This situation of low accessibility to adequate financing and incentives has been one of the problems most mentioned by the participants in the majority of the departmental workshops of analysis of the problematic forest.

The actors (indigenous communities, producers, owners of forests) located in different links in the forestry chain present low levels of organization. Even though there have been successful organizing experiences (Segovia and RACCN), very few have achieved consolidation and sustained organization.

In Figure 62, the placement of the awarded permits can be seen, and the overview by region and their relation to deforestation, forest degradation, and remaining forest. The categories of the studies plans were: General Forestry Management Plan, SAF, and Remediation Permits.

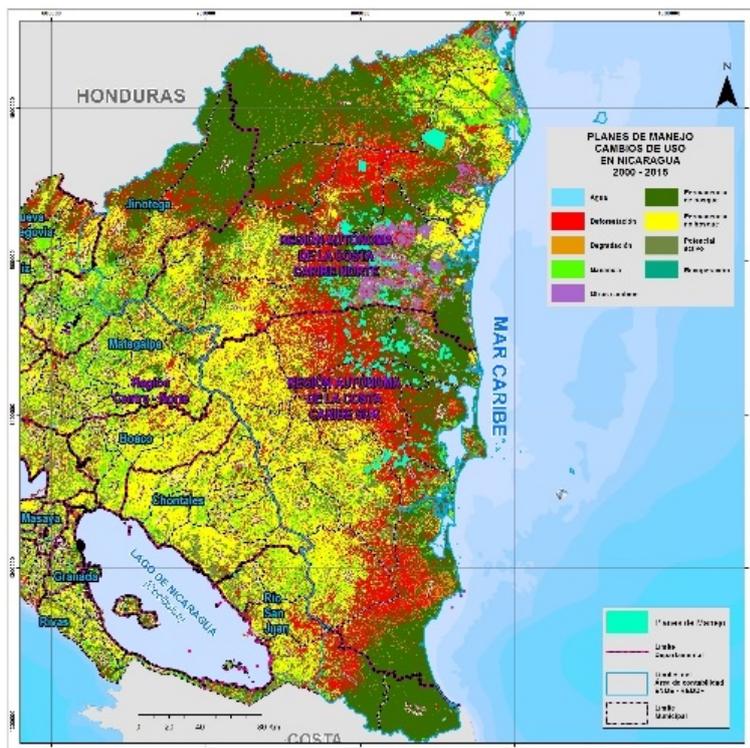


Figure 61 Locations of the General Management Plans assigned to the Caribbean Coast, and the relation found to deforestation and forest degradation.

General Management Plans in relation to deforestation

In RACCN, the accumulated deforestation by 2015 was 17 % with respect to 2000, this means an annual rate of deforestation of 1.13 %.

In RACCS it was 12 %, with an annual rate of deforestation of 0.70 %.

4.3.4 Forest fires

Forest fires constitute one of the principal threats to forests that have increased with the threat of climate change, giving rise to great, severe negative impacts to the ecosystems with greatest affectations in different municipalities in the departments of León, Chinandega, Nueva Segovia, Madriz and in the Autonomous Regions of the Caribbean Coast.

The cumulative impacts provoke alterations in the protected areas, leading to the deterioration of the same, which leaves in evidence the detriment of the quality of the various forms of life in the environment. The principal impacts lie in species of broadleaf and pine forests and their different successional states (Regeneration, Young, Mature).

The main cause of the constant recurrence and aggressiveness of forest and agricultural fires lies in burning as a traditional and estimated low cost, land use change; Transforming conservation areas into areas of agricultural production, unplanned burns that start in areas of agricultural use and end in forests, among other causes we include honey producers, hunters, social mobilization of groups of people that anthropizing sites for conservation and Improving human settlements are generating new risks.

Fire is the principal utilized for the justification of land-use change, broadening the areas cultivated and pastures, for which it is intimately related to the advance of the agricultural frontier, affecting annually, great extensions of forests (degrading the structure and floristic composition). The forest fires represent economic losses, in short, medium, and long-term, in, among other effects: a) grave affectations to the

base of environmental factors, principally biodiversity and alterations to the functionality of the forest ecosystems; b) increase the concentration of the carbon dioxide emissions and the loss of carbon sinks, which increase the greenhouse effect; c) the infrastructure and human lives are affected; d) productive activities are deficient as a result of the loss of fertility of the soils; and e) increasing rural poverty.

Forest fires constitute one of the important causes of the deterioration and degradation of the forests. The fires are generated by natural and cultural causes. These can be provoked by electrical storms, spontaneous combustion of vegetable material exposed to the sun during the dry season, or by the producers in their farming and ranching activities, generally to clean parcels in the months of February, March, and April for the first planting season. Fire is also used by producers that conduct migratory planting, for which each year they move to new lands to plant. They advance into the forest with technique of tree felling, cutting the low vegetation, and burning.

Comparative data of the last periods related to fires within protected areas, show that fires are a recurring phenomenon that repeats its intensity every certain period of time. Figure 63 shows the number of fires and the affected areas (in ha), as observed in 2008 the fires reached their peak with 9022 fires, then there was a 50% fire reduction in the following three years, and Subsequently there was a rise to the subsequent fourth year



Figure 62 Number of fires and the area affected by fires from 2008 to 2014 in Nicaragua. Source: INAFOR.

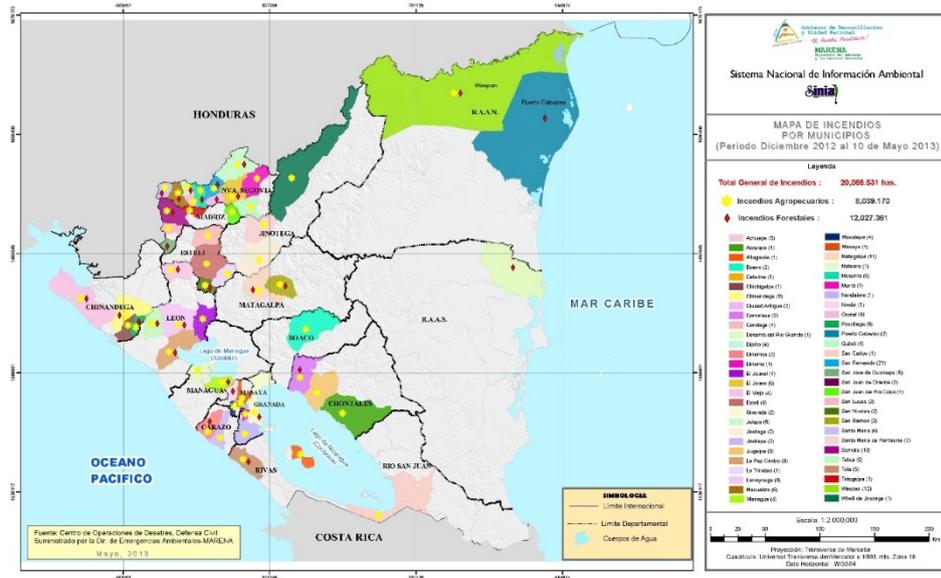


Figure 63 Number of fires (farm and forest) by municipality during 2012 to 2013 in Nicaragua. Source: SINIA.

4.4 Environmental Emergencies

Environmental emergencies are recognized as causes of loss and degradation of forests and other natural ecosystems in the country. As their origin is not anthropogenic, they are not included as causes DandD to evaluate REDD+. Nonetheless, after an event such as blights and hurricanes, the lack of institutional control in the affected areas provokes a greater dynamic in the forest use, changing to other uses. For this reason, the lack of institutional control is considered an underlying cause. Following, the two principal environmental emergencies that affect the country will be mentioned briefly.

4.4.1 Blights and disease

This is one of the threats that have achieved a major return in the conifer forests, particularly in those located in Las Segovias, Jinotega and Yucul, with the appearance of pine bark beetles (*Ips sp.*, *Dendroctonus frontalis*). It has been noted that the affectation is greater where there is absence of management, forests weakened by fire, with deficit of precipitation, and when subject to high temperatures.

On the other hand, other adverse climate events such as droughts and intense rains have affected pine forests in the Central Zone of Nicaragua, combined with the natural conditions of these forest ecosystems, they have been seen affected by blights such as the pine bark beetle (*Dendroctonus frontalis*), in an area of 32,873.46 ha, there is a volume of almost 4 million m³ (INAFOR 2009), according to the environmental emergency declared in 2000. Affecting the economy of the sector, its reflection is evident in the rural poverty and increasing the economic, social, and environmental vulnerability.

The forest blights are another important cause of the current deterioration of the forests in the country, especially in the pines of the north of Nicaragua that are affected by the pine bark beetle (*Dendroctonus frontalis*), with greater affectations in the municipalities of Chinandega, Estelí, Jinotega, Madriz, Matagalpa and Nueva Segovia.

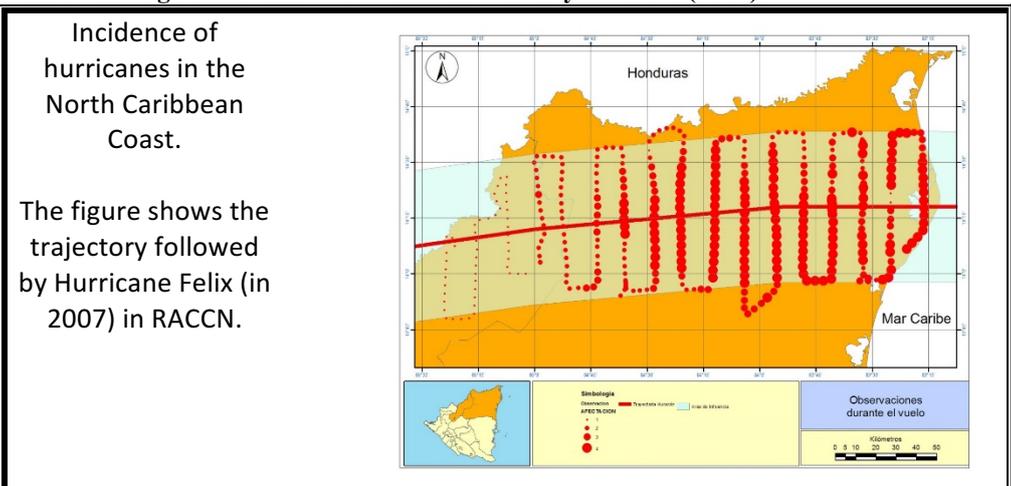
4.4.2 Hurricanes

They constitute one of the less frequent threats in relation to others, but when one occurs, it produces greater negative impacts to forest ecosystems. For example, Hurricane Felix left losses on the order of 599 million dollars to the country with the affectations limited to RACCN. Nonetheless, in the 80s, part of the deforestation was caused by Hurricane Joan in 1988, which affected half million hectares, principally inn RACCS.

Hurricanes cause enormous losses for example Hurricane Felix in RACCN in 2007, provoked economic losses on the order of half the PIB for that year in the country; the subsector most affected was agricultural exportation. Later, Hurricane Felix that affected a large part of the forest cover in the Autonomous Regions of the Caribbean Coast. The principal problem generated with the pass of these hurricanes is the degradation of forest ecosystems, the affected forests have also been denominated by ecologists as hurricane-affected forests.

The natural resources in general and the forest resources in particular, have been strongly affected by natural phenomena, principally by hurricanes. Those of greatest importance have been Hurricane Joan, that strongly affected RACCS, causing damage to about one-half million hectares; Hurricane Mitch that affected the Pacific Zone, and recently Hurricane Felix, that caused damage to more than a million hectares (one-half million in the category highly affected), in RACCN.

box 5. Estimate of damage of Huracán Félix en BOSAWAS y RACCN (2007).



• The BOSAWAS Biosphere Reserve has an area of 2,042,535.91 ha (15 % of the national territory).

Leyenda	COBERTURA 05	AREA AFECTADA			
		ALTA	MEDIA	BAJA	Total
1	Bosque Latifoliado Denso	394,391	269,756	108,005	772,152
2	Bosque Latifoliado Abierto	58,711	56,144	24,098	138,953
3	Bosque de Pino Denso	4,325	1,637	3,278	9,239
4	Bosque de Pino Abierto	18,144	7,931	16,464	42,539
5	Bosque Mixto				
6	Bosque de Mangle	10,733		3	10,736
Sub Total Bosque		486,304	335,468	151,848	973,619

ESTIMACION DE DAÑOS A LA COBERTURA FORESTAL

■ ALTO
■ MEDIO
■ BAJO

Source: MASRENACE-GTZ 2008.

4.5 Indirect or Underlying Causes

There exist several aspects that were mentioned as underlying or indirect causes during the events executed in the regions of the country. In Table 21, a review of the results of the participative process

performed for the construction of the ER-PIN document was developed; in these events, the actors consulted identified direct and underlying causes in addition to those previously reported.

Table 15. Principal driving factors and underlying causes mentioned by the actors during the consultation events in Nicaragua.

Dynamic Factors of DyD	Underlying Causes
<ul style="list-style-type: none"> a. Weakness in coordination mechanisms, monitoring and interinstitutional evaluation. b. Weak coordination between GTI and state institutions. c. Presence of third parties in indigenous communities. d. Lack of control of commercial permits linked to the informal market. e. Low level of enforcement of environmental and forest laws. f. Low local institutional presence (INAFOR, MARENA, INTA, MAGFOR). g. Budgetary constraints. 	<ul style="list-style-type: none"> a. Limited institutional practice in environmental fields. b. Little institutional presence in far-off rural areas. c. Lack of institutional policy to address the problem. d. Local inability to respond to the problem. e. Search for fertile soils for agriculture (basic grains). Economic interest in precious wood trees. f. Weak institutional capacity to cover and control the informal timber market in the country. g. Limited budget resource to meet basic needs. h. A large number of bureaucratic administrative procedures for applying for forest use permits.
<ul style="list-style-type: none"> a. Few mechanisms to control won b. Bureaucratic and complicated procedures c. Low presence of financial institutions d. Tariff measures to sell wood (INAFOR). e. Local institutional presence (police, army, PGR, Prosecutor's Office). f. Weakness in coordination mechanisms, monitoring and interinstitutional evaluation. 	<ul style="list-style-type: none"> a. Weak institutional presence in areas with greater intensity in the development of this activity. b. Inadequate application of procedures and voids that induce personal interpretations. c. Financing for agricultural and livestock activities increasing forest degradation. d. The forest does not represent any type of interest for the financial sector. e. Payment of taxes related to the condition of the farm. f. The better the tariff rate. g. Policies to exempt agricultural activities encourage their growth. h. Budget inability to meet the basic needs of local offices. i. Poor institutional priority to environmental problems
<ul style="list-style-type: none"> a. Recognition of the social value of the forest limited to Worldview of indigenous peoples. b. Market does not quantify or value services Environmental impacts. c. Ignorance of laws, procedures, regulations, norms, etc., in the rural area. 	<ul style="list-style-type: none"> a. Productive technological management backward, unprofitable, and contrary to the environment. b. Medium used by large producers to expand their areas in operation. c. Mercantilist approach to goods and services prevails. d. Lack of capacity for the generation of new business alternatives. e. High dependence on outsourcing as unskilled labor. f. Little disclosure of laws, rules, legal procedures in communities away from urban centers. g. Low level of schooling in communities. h. Poor dissemination in indigenous languages
<ul style="list-style-type: none"> a. Higher opportunity cost than the forest. b. Few incentives for alternative markets for agroforestry products. c. Market does not quantify and value environmental services. d. Lack of financial mechanisms to reduce deforestation 	<ul style="list-style-type: none"> a. Financial institutions interested more in the profitability of their operations than in socio-economic development. b. Little private and institutional capacity for the development of alternative markets. c. There is no availability of economic resources earmarked for services from ecosystems. d. Institutional weakness of the State for the management of economic resources in support of the environment.
<ul style="list-style-type: none"> a. Influence of the value chain. 	<ul style="list-style-type: none"> a. Monopolized commercial cladding, focused on the

	<p>commercialization of wood in roll or to a first level of processing.</p> <p>b. Weak local capacity to develop diversity in viable economic alternatives to forest products. Low bargaining power of owners who own trees.</p> <p>c. Poor access roads.</p> <p>d. . Difficulty of access to markets for agricultural products.</p>
<p>a. Lack of control of commercial permits linked to the informal market.</p> <p>b. Level of application of environmental and forest laws</p> <p>c. Weakness of indigenous peoples to manage their Territories.</p> <p>d. Speculation of the earth.</p> <p>e. Illegal land tenure.</p> <p>f. Little use of property records.</p>	<p>a- Institutional inability to provide coverage and control of the informal market at the national level.</p> <p>b. Institutional inability to implement laws in areas with the greatest impact on forests.</p> <p>c. Institutional difficulties to accompany the indigenous and Afro-descendant peoples in the administration of their territories.</p> <p>d. Weaknesses in the use and registral sanitation of properties.</p>

4.5.1 Underlying economic/productive causes

The underlying causes can be grouped into economic / productive, and institutional. Among the underlying economic / productive causes there are, on the one hand, the characteristics of forests: the availability of forest land and the low value of forest lands and forest goods and services. The low value of forest lands is due to the under-valuation of goods and services produced by forests that does not allow forest production to compete with alternative uses of land. Forest assets are of low value because production chains such as timber are inefficient, with low yields and without much added value, and environmental services have no demand in the domestic market and international markets are tightly contracted

On the other side, there is a series of economic/productive causes related to agricultural production: the little capitalization and access to credit and the low technological capacities of the producers result in a low investment in production. Furthermore, there are local and international markets that are not demanding in quality or production method. These factors work together to cause a low agricultural productivity, which combines with the economic forest characteristics to give incentives to extensive production systems.

In a context where the forest lands and workers are available and cheap, the capitalization of producers is low, the producers choose to substitute the forest land use for inputs, deforesting them – once the productivity of the parcels drops, they are abandoned and new forest areas are converted into crops and pastures. This relation among the farm processes and deforestation in the agricultural frontier is demonstrated in Figure 65.

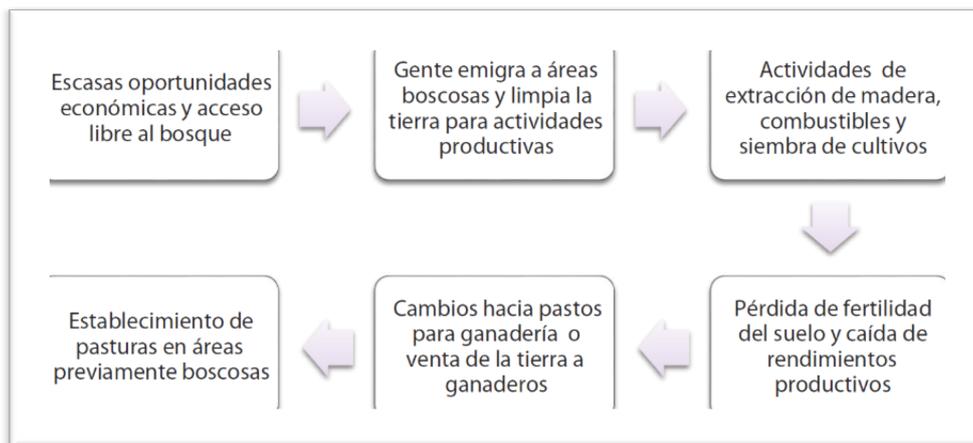


Figure 64 Process of deforestation in the agricultural frontier, Nicaragua.

Source: Polvosa and Bastiaensen, (2016)

The change of forests to pastures and crops forms part of a strategy of extensive production, characterized by the availability of lands and workers at low Price that translate into low production costs. For example, López (2012) mentions that “In Nicaragua the system of feeding is free, extensive pasture and in the buffer zones of the agricultural frontier, the pasture has a low price, in relation to the rest of the country. While the rent of a head/month of pasture in the North costs between 150 and 200 cordobas, in the Atlantic, extensive forms of rental permit rents at between 10 and 20 cordobas per head/month.” These low-cost systems require little capital and produce relatively stable income, but the profitability for the majority of the farmers is low. In the case of ranching, this tendency is reinforced by the cattle culture and the social status that is conferred.

At the same time, the extensive land use forms an element of other strategies of capitalization, where farmers without the means to invest in cattle rent their lands, directly or through arrangements of shared production, to larger and more capitalized ranchers; or, where they speculate on the land, taking advantage of “improvements” represented by deforested and planted lands with grasses to sell at better prices to producers better capitalized from the Central or Pacific Regions, which permits the continuation of the cycle in new areas of the agricultural frontier (Lezama, 2007). According to Bermúdez et al. (2015), the large ranchers are converted into leaders to establish relations of clientelist cooperation with the smaller producers, from whom they have bought land and later, buy animals for growing out. These ranchers, as the animals grow, yield some for the shared production. Furthermore, they lend transportation services, buy grain, sell consumer goods and provide small credits. Thus, it can be considered that the large-scale ranchers are drivers of the deforestation, in the sense that they provide incentives for the deforestation with the objective to establish lands for rent or sale.

This situation also reduces the incentive of productive intensification. Polvorosa and Bastiaensen (2016), citing White et al. (2001), and other actors emphasize that “when the land prices are low the producers choose to expand production through the incorporation of more land, but in the measure that land is more expensive, and the producers cannot easily purchase more, they will elect to increase productions through technologies tied to intensification. This has brought to conclude that scarceness of tropical forests is a

necessary pre-condition for the producers to adopt intensive production practices (Kaimowitz & Angelsen, 2007; White et al., 2001). Under this context, the loss of tropical forest in Central America can be explained, principally, by the growing agro-exportation dynamic that has made cattle (and in other crops) a more profitable activity. At the same time, the barriers that exclude some producers from these activities (small and/or poor, principally) push them to value the possibility of migration toward the agricultural frontier, especially when there exist high differences in the price of land that make this option attractive. Given that there still exist in Central America unprotected forests with free access, the efforts to promote productive changes are blocked and fail to stop the advance of the agricultural frontier in the measure that the productive system based on the purchase and aggregation of more land for production persists (Tomich et al. 1998)."

In a similar manner, the SPPN (2016) indicate that *"abundance and low price of lands, joined to low cost of labor, never has motivated farmers to improve their productive levels through technological improvements, mechanization of irrigation, for which the demand for farm products was supplied through the expansion of the agricultural frontier, through the access to cheap lands devastated by thousands of poor, landless peasants"*.

Other factors that contribute to the lack of investment and low productivity are the following:

Limited access to credit. According to the SPPN 2016): "The percentage of the portfolio that national, private banks dedicate to crop agriculture is scarcely 9 %, approximately US\$ 316 million. Generally, these credits go directly to the big agricultural businesses that can present the corresponding guarantees and have a good level of organization in their farms. The case of ranching is more afflicting, given that the percentage of the portfolio is only 2 %, equivalent to only US\$72 million approximately, with the same characteristic as the crop credit".

In the case of the forestry sector, there has not existed financial credit. Additionally, the small and medium producers face restrictions to get credit in the better markets, particularly if they are located at more than two hours of distance from one of the principal roads or highways.

Among the perceived limitations on the part of the Commercial Bank and the Micro-financing Institutions to increase credit access, the following can be stated:

- i. The complexity of the value chains which weakens their integration and the alliances among the financial institutions and the representative businesses to make credit viable to the producers.
- ii. Limited resources for long-term credit or financial products that area adjusted to the productive conditions.
- iii. Limited or absent Technical Assistance, having as a result poor technological adoption and for this, poor productivity and high risk.
- iv. Lack of managerial and financial information on the part of the producers, which makes difficult to analyze the viability of their operations.
- v. Perception of high risk, owing to a weak commitment to a culture of payment.
- vi. Land tenure, where possession and not dominion exists.
- vii. Weak judicial security for the fulfillment of contracts.
- viii. Little understanding by credit officials about the dynamics of the sector.

- ix. Problems with anchoring on the part of Produzcamos or the Intermediary Non-banking Financial Institutions.
- x. High costs of transaction for credit to atomized and dispersed farmers.

Little knowledge and technological capacities. Technical assistance, technology transfer, and farming extension are tools to orient the producer and his/her family and strengthen knowledge, abilities, and talents in diverse productive, administrative, and human relations areas, as a means to improve their standard of living. Nonetheless, these have had little coverage and have been little effective. According to the IV CENAGRO, of the total number of existing farms only 17.4 % of the producers received some service of technical assistance and/or training; 2.5 % of them only received technical assistance and principally of a thematic character. Of that, 17.4 % of the farms that received some service of technical assistance, there has to be considered that a good proportion of that type of service was supplied by technicians from the businesses supplying agricultural supplies (fertilizers, seed, pesticides, etc.), industrial plants, universities, cooperation projects, from the cattlemen's organizations, NGO, etc.

Additionally, the poor associative culture, the application of empirical knowledge of farm management and managerial styles that pass on from generation to generation, which do not permit innovations, believing that tradition can keep them alive in a market more demanding at each turn, contribute to low productivity in the farms.

For these and other reasons stated above, in many cases the production systems have not been changed in 60 years. In the cattle sector, it is notable that, in spite of a great number of projects focused on the improvement of the cattle sector during the most recent decades, the indicators are still low, with few improvements (IICA, 2014). Furthermore, many programs of cattle reconversion, focused on increasing productivity and profitability of the sector, have had unintended consequences of expanding ranching at the expense of the forests (Kaimowitz & Angelsen, 2008).

Local and international markets, with little requirement of quality and production methods. The relative lack of capital and access credit impedes investment in infrastructure necessary to comply with the norms of quality for the best markets and to invest in improved grasses or foraging crops to improve the productivity. In the absence of bank credit, the large-scale ranchers, buyers and agricultural suppliers, and wood sector businesses have filled this void, with high costs of intermediation added to the products and without requirements regarding the productive system. The local and regional farm products market has been ruled by a search for low prices, without giving importance to the sources of the product, its legality, or its quality. Furthermore, the regional markets, principally in El Salvador and Honduras, likewise lack requirements for quality in farm products that are produced in the agricultural frontier (López, 2012).

4.5.2 Underlying institutional causes

In recent years, Nicaragua's institutions have made significant progress. A robust policy and legal framework has been formulated in relation to rights to land and natural resources, environmental protection, and sustainable development. It has established the autonomy of the regions of the Caribbean and has integrated them to the rest of the country, and has managed to title all the indigenous territories of the Caribbean Coast. In economic terms, the formation of alliances and the promotion of private sector investments, together with the achievement of the good credit rating of the national financial system, have created sustained growth that has reduced poverty and extreme poverty.

To continue this positive evolution, the country needs to integrate and harmonize more fully the productive and environmental aspects on an institutional level. Good growth in the farming sector has been based on the use of unsustainable productive practices that have caused deforestation and forest degradation, invasion of protected areas, and the consequent loss and degradation of ecosystems, soils, water, and biodiversity. These processes increase the vulnerability of the country toward climate change³⁴ and the welfare of current and future generations are reduced.

The ability to control the occupation of forested lands not used or affected by natural disasters, and to conserve these protected areas, are affected by a series of factors associated with the abilities of the institutions to unify and harmonize efforts, monitor, control, and police land use.

The weak application consistent with the criteria of success, that integrate the economic, social, and environmental considerations, as mentioned in the PNDH, among the sectors and within the purview of the government, results in the waste of opportunities to integrate these considerations in the application of policies and programs, and take away effectively from the efforts to achieve good government.

4.6 Agents of deforestation and forest degradation

In this section, are presented the results obtained from the IV Report on the Farm Census executed in 2011.

Of the agricultural exploitation by land surface (EAs), approximately 95.9 % (5,763,801.23 ha) are private properties exploited by the owners, 1.3 % (78,324.44 ha) are rented from other producers, 2.4 % (146,839.72 ha) are worked under a regimen of awarded land tenure or lent, and 0.4 % are worked by producers under some other regimen of land tenure; this suggests a classification of producers in three groups, small, medium and large (CENAGRO, 2011).

Small producers: Farmers that possess or manage agricultural production between 0.35 ha to 35 ha of land, these represent 25.10 % of the farm producers of the country and together, manage 2,130,897 ha of land in agriculture.

Medium producers: Farmers that possess or manage in between 35 and 70 ha of land, these represent 17.98 % of the farmers of the country, and together manage 1, 526,190.57 *manzanas* of farming land.

Large producers: Farmers that possess or manage between 70 and 350 ha of land, representing 56.92 % of the farmers in the country, and together they manage 3,382,059.562 ha of farming land.

³⁴According to the Global Climate Risk Index by Germanwatch, for the year 2016, Nicaragua is the fourth most-vulnerable country facing Climate Change in the past 20 years.

² Law No. 28, Article 15.

Table 16. Principal agents of land use and land-use changes in Nicaragua.

Principal causes	Agents	Region of the country where the incidence occurs
Advance of the agricultural frontier	Crop farmers, extensive ranchers	Caribbean Center
Forest fires ad farm fires	Farmers that use fire in land preparation without adequate control, illegal hunting	Pacific (León Chinandega, Carazo, Masaya, Rivas) North (Estelí, Nueva Segovia, Madriz) RACCN and RACCS.
Forest cutting, extraction and illegal traffic of forest products	Loggers, Forest owners, Landless peasants, business people	Caribbean Norte Pacific
Environmental emergencies or disasters from natural phenomena	Hurricanes, landslides, floods, droughts ³⁵	Pacific, North, Caribbean
Insecurity in land tenure	Landless peasants, peasants, displaced people	Caribbean, Pacific and North
Promotion of mining activity	Mining companies	North-Central and Caribbean

4.7 Multidimensional analysis of the causes of DandD

4.7.1 Quantitative and spatial analysis of the causes of DandD

In this section are described the results of the exploratory regression analysis and the Random forest model applied to the national database.

The factors associated with the municipal rates of change are shown in the figures

³⁵ Environmental emergencies are not identified or related with a human cause for which they are not discussed in that section.

4.7.1.1 Factors associated with the causes of DandD (PENDING)

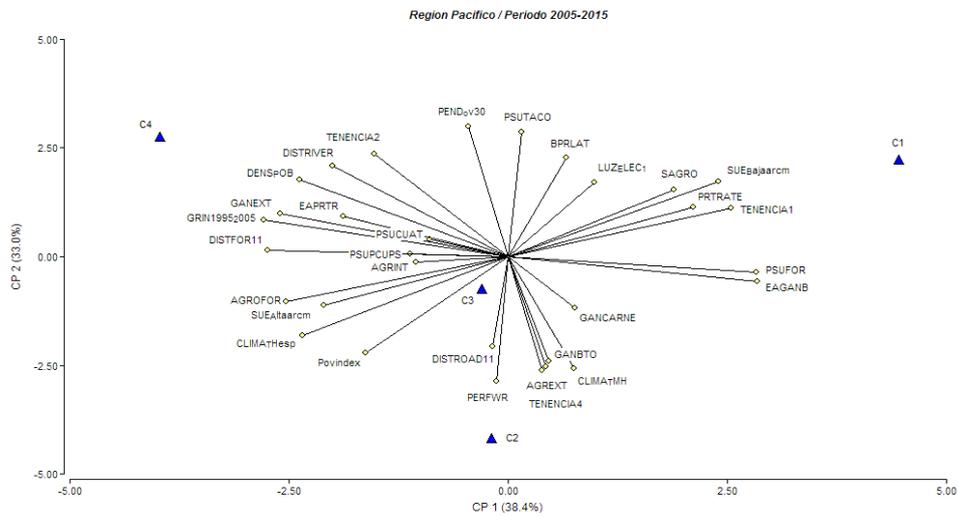


Figure 65 Results of the Principal Component Analysis of the variables associated with each range of TAC (%) in the Pacific Region for the period 2005 – 2015.

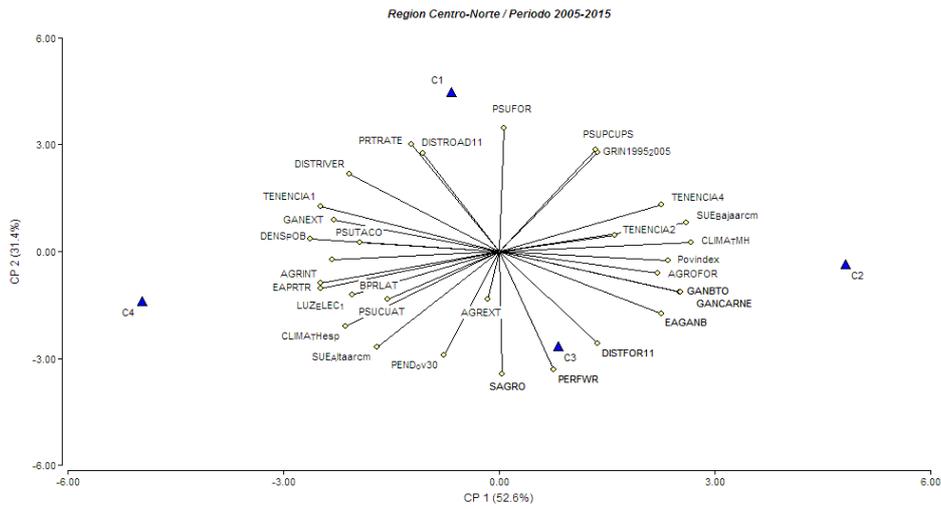


Figure 66 Results of the Principal Component Analysis of the variables associated with each range of TAC (%) in the North-Central Region in the period 2005 – 2015.

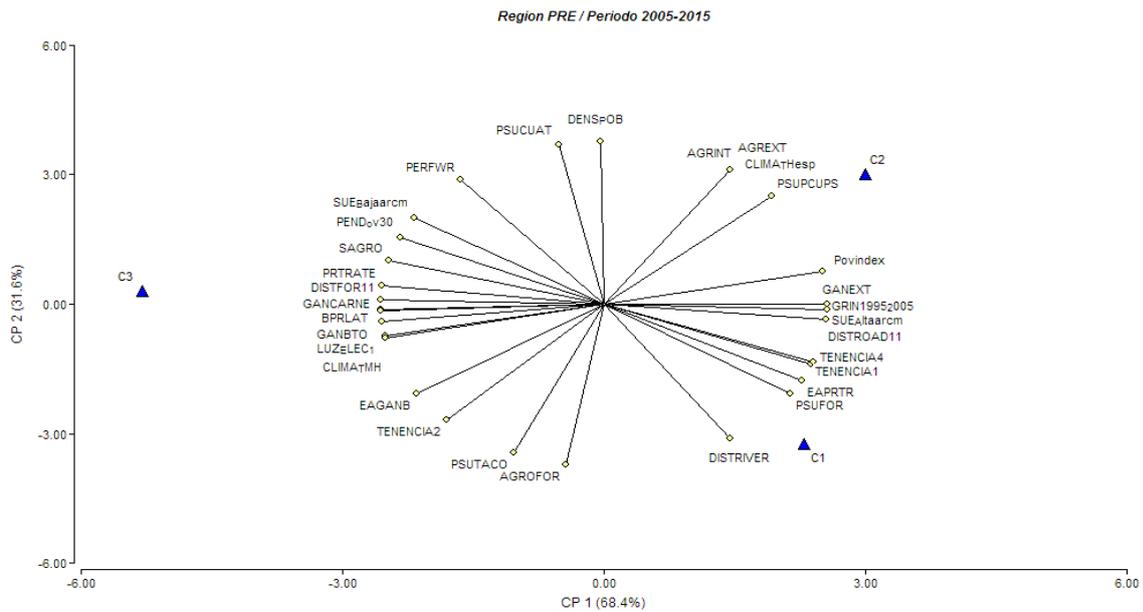


Figure 67 Results of the Principal Component Analysis of the variables associated with each range of TAC (%) in the PRE-Caribe Region in the period 2005 – 2015.

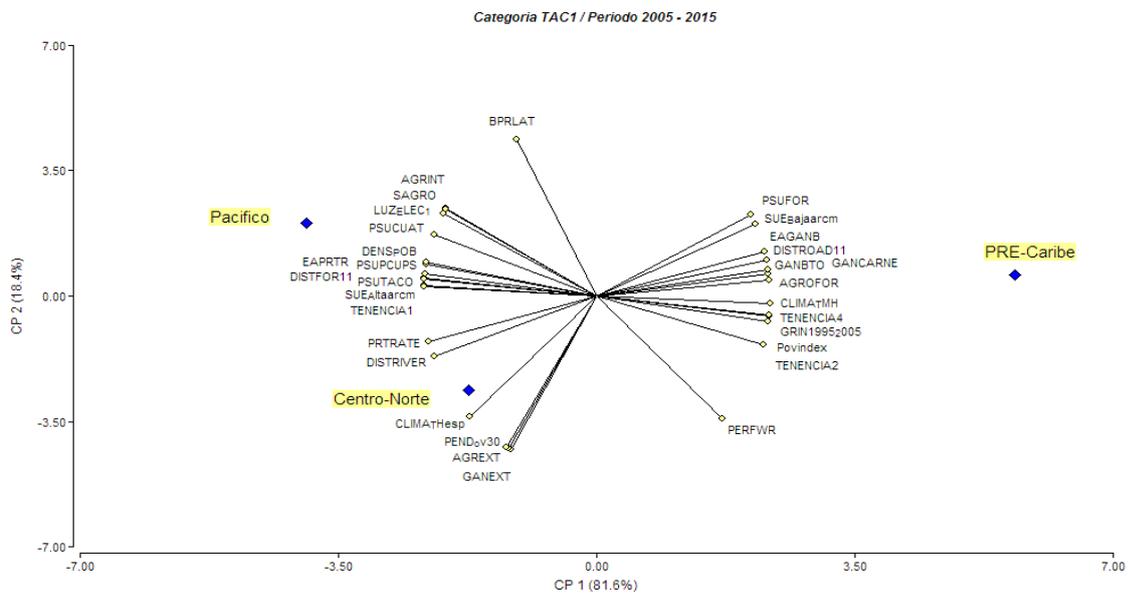


Figure 68 Results of the Principal Component Analysis of the variables associated with each region of the country for the TAC of deforestation (%) in the period 2005 – 2015.

4.7.1.2 Spatial exploratory regression

To explore the relationships between variables and deforestation (municipal rates of change of deforestation, $n = 154$), socio-economic, demographic, productive, technical, biophysical, and other categories of variables were considered.

The negative values indicated a negative correlation: roads, population density, distance to protected areas, distance to markets, percentage of forests in the farm, among others.

The positive values indicated a positive correlation: poverty, areas with potential for conservation and production, consumption of rural fuelwood, economically active population, among others.

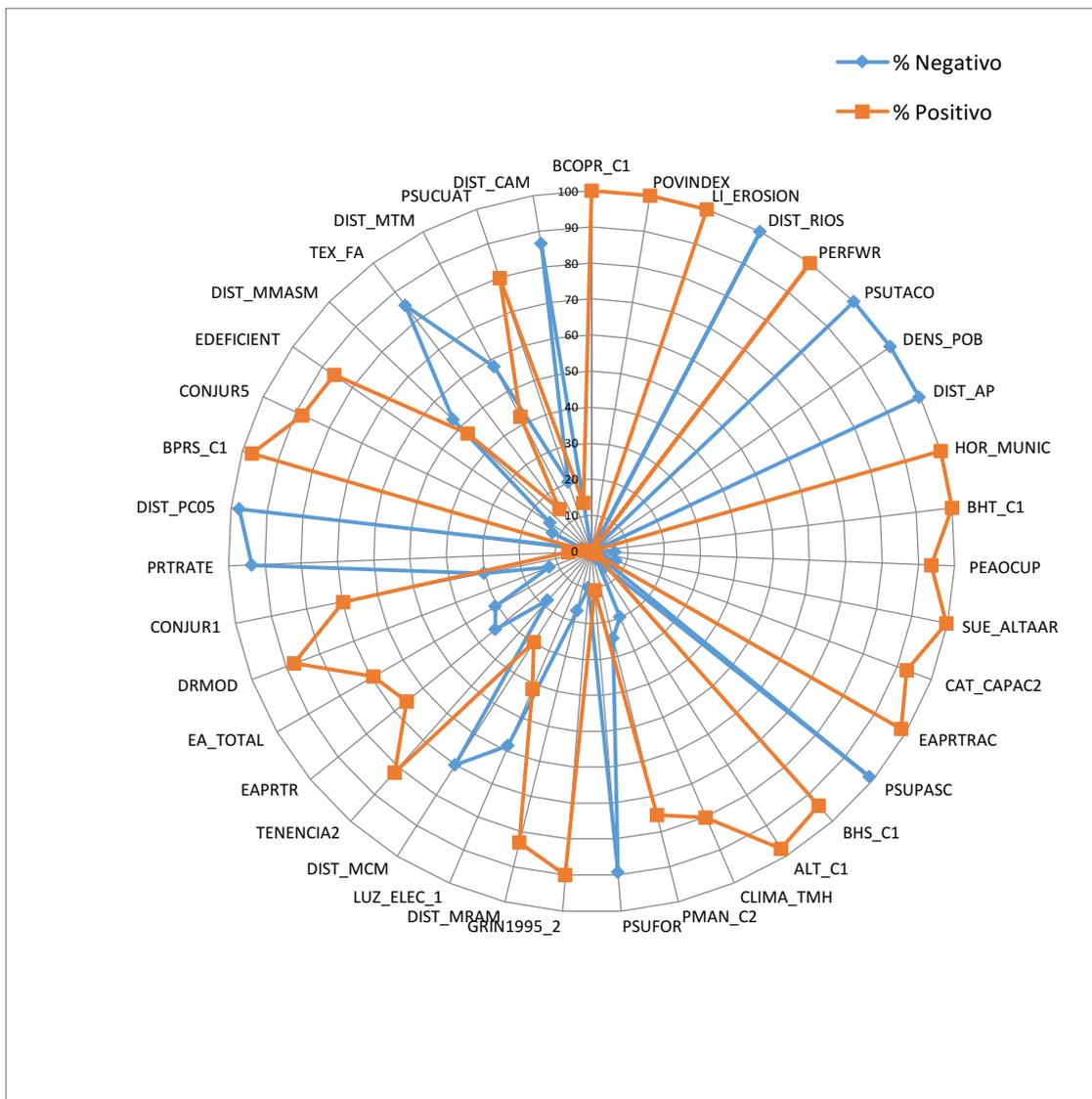


Figure 69 Relation among multifactors and the rate of deforestation 2005-2015 on a national level.

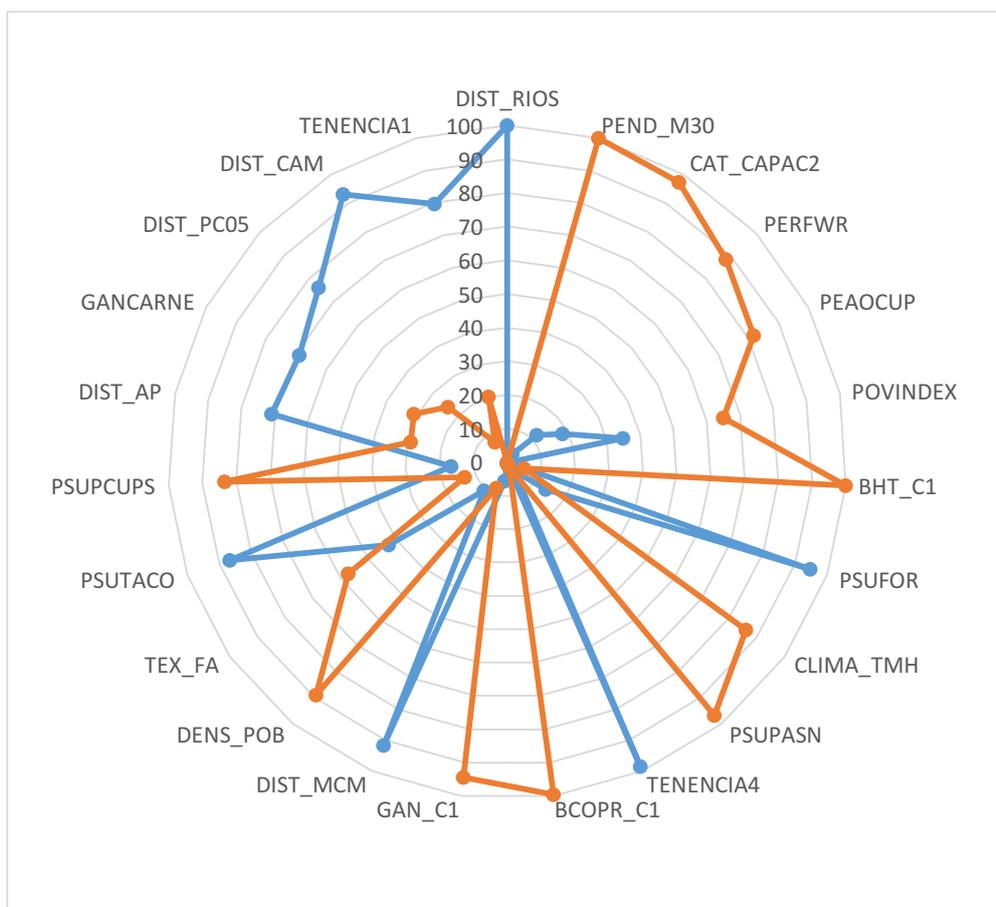


Figure 70 Relation between multifactors and the rate of deforestation 2005-2015 in the PRE-Caribe Region.

4.7.1.3 Random forest

The analysis using Random forest permitted the identification of a small set of variables with better chances of predicting the future deforestation. In Figure 72, the areas that may be potential deforested are observed, employing a correlation among the variables. The grey area was excluded because of high estimated values.

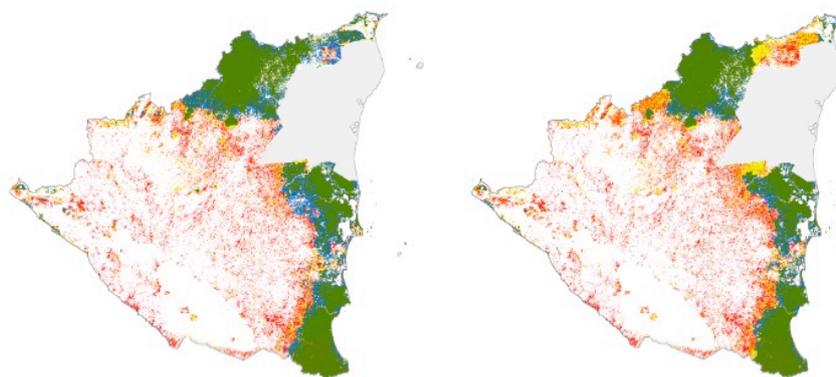


Figure 71 Prediction of deforestation according to the selected predictive variables.

V. Policy, legal and institutional frameworks

5.1 Public and institutional policy

Nicaragua has advanced significantly in its public policy directed toward the use, protection, conservation, and restoration of Mother Earth, making a call to different levels of the society for shared responsibility. The PNDH proposes environmental sustainability and forest development to be of vital importance for the recovery of all the ecosystems. Highlighting the principal achievements in the management of 12,455 ha of natural regeneration; the National Reforestation Crusade left 82,000 ha of forest and soils protected in 1,536 rural communities, strengthening the capacities of the ethnic communities of the Caribbean Coast and the dry zone of the country, to adapt to Climate Change.

In that sense, the PNDH, in the period 2012-2016, outlines the objective of the policy to continue increasing and protecting forest areas through reforestation in all its forms, implementing the different forest systems and natural regeneration, to Conserving protected areas, increasing biological corridors, reducing deforested areas, restoring degraded soils, restoring forests in buffer zones and recovering forests and key ecosystems for water conservation in quality and quantity, soils And biodiversity, and strengthen natural livelihoods in the fight against poverty, as well as increase our ability to adapt to climate change through the protection of restored and empowered genetic areas.

The forest sector is of great productive interest in the country, since the year 2012 to the date there are applying a large number of programs directed at the promotion and momentum of the development of sustainable systems of production in permanent alliance with the farming sector, for which agreements have been reached that aim at a solution of the problem of deforestation.

The forest sector incentives for conservation as for development of the industry have been determinant in the use and management of forest resources.

Nicaragua counts on a complete legal framework for the management and use of the forest, but with weak application and institutional absence that limits the efficacy in the regulation of the forest resources in the country. The sectorial powers of the different institutions of the State such as MEM, MARENA, MAGFOR, MIFIC e INAFOR, among others, are determined in Law No. 290; Law of Organization, Procedures, and y Powers of the Executive Authority, its reform (Law No. 612), and its regulatory framework.

In this context and with the intension to conserve the forest, the State of Nicaragua has developed a series of modern legal instruments (policies, laws, regulation, norms), for their administration, control, and ordering. The legal instruments of greatest importance created in the period 1990 – 2007 are: Forest Development Policy, Law (462) of Sustainable Conservation, Promotion, and Development of the Forest Sector and its Regulation, the administrative dispositions for the sustainable management of the tropical broadleaf and conifer forests and forestry plantations of 2004, the Decree 32 – 2006 of Economic Emergency I the RACCN, RACCS, and the Departments of Rio San Juan and Nueva Segovia, for the illegal cutting, transport, management, processing, storage, possession, exportation, and commercialization of forest resources, the Law (585) of forest prohibition, the National Forest Development Policy (2007), Law (559), Law (217), and Decree 01 – 2007 created by SINAP.

The National Policy for the Sustainable Development of the Nicaraguan Forestry Sector (Decree No. 69-2008, Approved on November 4, 2008), establishes in its article No. 14, item 10 that: The forest

replenishment process will be developed under an approach (Firewood and coal) to ensure a balance between the supply of the forest resource and its demand, for which specific policies will be established. However, in spite of the great social, economic and environmental importance generated by the magnitude of the wood and coal activity, the efforts of the institutional actors have been very limited to promote the sustainable development of the production and replenishment of the firewood resource , Add value to the product (drying, quality, etc.), provide mechanisms for an expeditious commercialization and conversion of biomass-based energy transforming systems through efficient technology

Nicaragua recognizes different forms of property, classifying them as public, private, associative, cooperative, community, communal, familiar, and mixed³⁶, guaranteeing furthermore, land tenure without any discrimination with the objective to produce profit and at the same time, comply with social functions in benefit of its inhabitants and the country.

Communal property: it is representative of the indigenous peoples and afro-descendant communities of the Caribbean Coast. The State of Nicaragua recognizes for the indigenous peoples and afro-descendant communities the complete rights to property, use, administration of natural resources, and management of their communal lands under different forms, rights awarded in the Political Constitution of Nicaragua³⁷. In the year 2003 the Legislature approved Law No. 445, the Law of Regimen of Communal Property for Indigenous Peoples and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua (now known as the Autonomous Regions of the Caribbean Coast) and of the Bocay, Coco, Indio and Maiz Rivers. Published in La Gaceta, No. 16, 23 January 2003.

Law No. 445 became effective through the unavoidable commitment of the State of Nicaragua to respond to the demands for titling lands and Territories of the indigenous peoples and ethnic communities, rights consigned in the Political Constitution of Nicaragua in 1987, and in Law No. 28, Statute of Autonomy of the Autonomous Regions of the Atlantic Coast, and international treaties.

The State within the framework of Law 445, has culminated the process of titling communal and territorial property. At present, the indigenous territories in the Autonomous Regions of the Caribbean Coast have begun negotiations with third parties through the figure of peaceful coexistence and lease contracts under the regulations issued by the highest authorities.

5.2 Current forest regulations

The Political Constitution of Nicaragua, in Article 102, establishes that “the natural resources are national patrimony. The preservation of the environment and the conservation, development, and rational use of the natural resources correspond to the State; it can execute contracts for rational use of these resources, when the national interest requires, under transparent and public processes, nonetheless the Political Constitution awards complete rights to the harvesting, enjoyment, use, and pleasure of waters and forests in the communal lands³⁸ transmitting dominion on the resources under the titling of the original communities in the Autonomous Regions of the Caribbean Coast.

³⁶ Political Constitution of Nicaragua and its reforms, Official Daily La Gaceta No.32, Managua Nicaragua 18 February 2014.

³⁷ Political Constitution of Nicaragua, articles 5, 79, and 180.

³⁸ Political Constitution of Nicaragua Article 89 The communities of the Caribbean Coast are an indissoluble part of the Nicaraguan people and as such, enjoy the same rights and have the same obligations. The communities of the Caribbean Coast have the right to preserve and develop their cultural identities in national unity; endow themselves of their own forms of social organization and administration of local affairs in agreement with their traditions. *The State recognizes the communal forms of land tenure of the communities of the Caribbean Coast equally, it recognizes the enjoyment, use, and pleasure of the waters and forests of the communal territories.*

The forestry sector is regulated by Law No. 462, the Law of Conservation, Promotion and Sustainable Development of the Forestry Sector³⁹, whose objective is to establish a legal regimen for the conservation, promotion, and sustainable development of the forestry sector, taking as a fundamental base, the forestry management of natural forest, the promotion of plantations, the protection, conservation, and restoration of forest areas. The Law No. 462, in Article 2, determines that the proprietor of the land is to whom corresponds dominion over the forestry area⁴⁰ existing over it and its derived benefits, being responsible for its management, clearly the Law determines to whom pertains the forest and makes a relationship of obligations with the owner before the state.

The Law No. 462 and its regulation, in its application, is concordant with other laws, such as: Law No. 28, Statute of Autonomy of the Regions of the Caribbean Coast, Law No. 40 of Municipalities, Law No. 217, the General Law of the Environment and Natural Resources, and Law No. 445, Law of the Regimen of Communal Property of the Indigenous Peoples and Ethnic Communities of the Autonomous Regions of the Caribbean Coast of Nicaragua and of the Bocay, Coco, Indio, and Maiz Rivers. The forestry sector must take into account the characteristics of the country in relation to the special regulations in protected areas; regimen of autonomy in the Regions of the Caribbean Coast, regimen of communal property and local autonomy.

In relation to what was expressed earlier on forestry, the Law contemplates a National System of Forestry Administration, composed of public institutions and the private sector involved in the forestry activity. In regard to authority in the public sector, it is defined in a large number of laws, among them, those cited in the previous paragraph and the Law No. 290, the Law of Organization, Authorities and Procedures of the Executive Power and its reforms.

Current Forestry Incentive

Nicaragua has established a series of incentives for the benefit of natural persons and legally recognized entities that conduct activities of investment, protection, management, and restoration of the forest sector, whether in natural forests or plantations.

The law creates a large number of provisions with regard to the implementation of incentives, directed toward: Protection and conservation of forested areas, owners of forests that opt for the preservation and management of the forest, with the object capture of carbon, promotion of the management of natural forest, augmentation of forest cover, protection and conservation of forests, promotion of research, strengthen the forestry sector, among others.

Another important aspect of Law No. 462 harmonizes with other laws, regarding taxes, the distribution of benefits related to the amount collected by the State as taxes for forestry harvesting, fines, rights of renewal and auctions for confiscated materials, which will be distributed in the Autonomous Regions of the Caribbean Coast equitably for all the different forms of government from the regional, local and communal, according to the Law No. 445, Law of the Regimen of Communal Property of the Indigenous Peoples and Ethnic Communities of the Autonomous Regions of the Atlantic Coast of Nicaragua and the Bocay, Coco, Indio, and Maiz Rivers, which establishes:

39 Law No. 462. Approved 26 June 2003. Published in La Gaceta Diario Oficial No. 168, 4 September 2003.

⁴⁰ Article 4, definition of **Vuelo Forestal**: All the trees, bushes, woody plants, and other species of plants that are above the surface of the soil. , Regulation of the Law No. 462, Law of conservation, promotion, and sustainable development of the forestry sector, Decree No 73-2003. Published in La Gaceta No. 208, 3 November 2003.

1. 25 % for the indigenous community or communities where the resource to be harvested is found.
2. 25 % for the municipality where the indigenous community is found.
3. 25 % for the corresponding Regional Council and the Regional Government.
4. 25 % for the National Treasury.

Law No. 462 and Law No. 822, Law of Tributary Agreement; the latter has extended the fiscal benefits for forestry activities through 31 December 2023, including the following incentives:

Legal Basis	Incentives
<p>Law No. 462, Law of Conservation, Promotion, and Sustainable Development of the Forest Sector, published in La Gaceta No. 168 04 September 2003 General Regulations Decree 73-2003 published in La Gaceta No. 208 03 November 2003.</p>	<p>Article No. 38: Special fiscal incentives are established:</p> <ol style="list-style-type: none"> 1. Exoneration of fifty per cent (50 %) of the Municipal Tax on sales and fifty per cent (50 %) on the utilities derived from the harvesting, in registered plantations during the first 10 years of effect of this law. 2. Exoneration on Real Estate Tax in the properties that establish forestry plantations and areas where forest management is conducted with a Forest Management Plan, during the first ten years of effect of the law. 3. Businesses of any type that invest in forestry plantations can reduce by 50 % the amount invested in payment of taxes (IR). 4. Exoneration of payment of the Interaction Tax for Secondary businesses. <p>Transformation and third transformation that import machinery, equipment and accessories that improve the technological level for processing wood, not including sawmills.</p> <ol style="list-style-type: none"> 5. All the institutions of the State must prioritize in their contracts, the acquisition of wood products with forestry certificates from INAFOR, with recognition of up to 5 % difference of price offer in the bidding process. 6. All natural and legal entities (persons and businesses) can reduce as much as 100 % of the payment of tax (IR) when destined to the promotion of reforestation or the creation of plantations. To receive this benefit, the contributor must present the forestry initiative to INAFOR before making claim.

The country has a Manual of incentives⁴¹ for the development of sustainable forestry investments that establish the administrative procedure to gain access to the benefit.

5.4 National programs and plans that helps to reduce the causes of DandD

⁴¹<http://www.magfor.gob.ni/descargas/legislacion/MANUAL%20DE%20ACCESO%20A%20LOS%20INCENTIVOS.pdf>

The Government of Nicaragua has defined as one of its priority axes the conservation of forest of the country and the recuperation of degraded areas. Nicaragua is implementing the following plans, programs, and projects that aid to reverse, mitigate, or reduce the impacts of the causes of deforestation and forest degradation.

The National Plan for Human Development (PNDH), the General Territorial Planning Policy, the General Framework of Land Policy, the National Policy for Sustainable Development of the Forest Sector, The National Strategy for Climate Change, The Agro-ecological Strategy, the Strategy for Fuelwood and Charcoal, Strategy for Development of the Caribbean Coast and upper Wangki and Bocay, Plan for Production, Consumption, and Commerce 2016-2017, National Forestry Program, National Reforestation Plan, National Plan for the Prevention and Control of Forest Fires, and the Reconversion Plan for Bovine Cattle.

National Plan for Human Development⁴²: is a proactive plan that seeks to transform the country, in a national context of macroeconomic stability and social cohesion, in spite of the menace of Climate Change. The Plan Strategy is constructed with a base in 12 themes that combine the continuity of policies that have transformed the country starting in 2007, with the incorporation of new priorities whose goal is to attend the pressing needs of productive and social transformation of the country.

National Forestry Plan⁴³: this plan is focused on strategic lines of the national policy for sustainable development of the forestry sector, and in criteria recommended in different international initiatives on the forests; its objective is to improve the quality of life for the population with emphasis on small and medium farm and forestry producers, indigenous peoples and ethnic communities, supported in conservation of the environment and sustainable production, national food security and sovereignty, under a focus of territorial planning.

National Reforestation Plan⁴⁴: this plan aims to sensitize the population through reforestation crusades, and reverse the process of deforestation and reforest to add to the forests; environmental services and carbon stocks in the country.

⁴² <http://www.pndh.gob.ni/documentos/pndhactualizado/pndh.pdf>

⁴³ https://www.google.com.ni/?gws_rd=cr&ei=aJx1V4HgFYi9eL6kugP#q=programa+forestal+nacional+de+nicaragua

⁴⁴ https://www.google.com.ni/?gws_rd=cr&ei=aJx1V4HgFYi9eL6kugP#q=plan+nacional+de+reforestacion+en+nicaragua

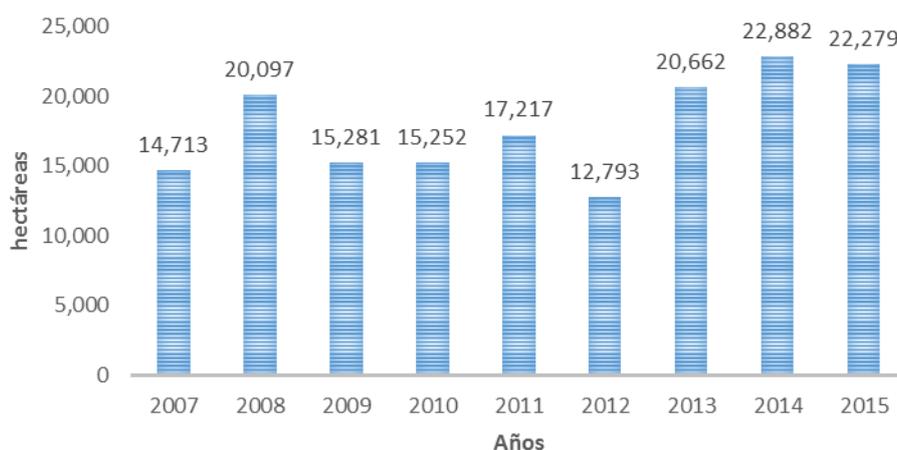


Figure 72 Reforestation in hectares per year (2007-2015).

These activities promoted by the GRUN are developed from the Ministry for the environment and natural resources and the national forestry institute. The Annual Citizen Participation in Reforestation Activities reaches an average of 398,389 citizens, both men and women, of which 210,799 are male and 187,590 are female (Table 24) (from INAFOR 2015). From the years 2007 until 2015, reforestation was performed on a national level on 161,178 ha.

Table 17. Citizen participation in reforestation activities 2010-2015.

	2010	2011	2012	2013	2014	2015	Average yearly
Men	265,012	116,800	215,000	174,154	240,078	253,748	210,799
Women	211,971	83,200	185,000	230,853	215,142	199,373	187,590
Total	476,983	200,000	400,000	405,007	455,220	453,121	398,389

Source: INAFOR 2016.

National Plan for the Prevention and Control of Forest Fires⁴⁵: these are yearly-renewed instruments that bring together strategic inter-institutional efforts, coordinated in a commission that includes representation of: CD-SINAPRED, INAFOR, MARENA, Civil Defense, MINED, Fire fighters, PGR, PN.

Currently, in the country plans for prevention and control of forest fires are developed and prepared, coordinated with these inter-institutional structures that make up CD/SINAPRED, whose objectives are:

- Develop public awareness and use social communication activities directed at the prevention of forest and agricultural fires.
- Strengthen the organization and the response capacity of the municipal and local committees for the prevention and control of forest fires.
- Strengthen the brigades for the prevention and control of forest fires.
- Establish forest observation posts (POF) and organize forest exploration patrol (PEF).

⁴⁵https://www.google.com.ni/?gws_rd=cr&ei=ajx1V4HgFYi9eL6kugP#q=plan+de+prevenir+de+incendios+en+nicaragua

- Together with the local committees, define the zones at risk, zones of security, evacuation routes.

National Fuelwood and Charcoal Strategy: This strategy is founded on sustainable production through the gradual establishment of energetic forest plantations; agro-forestry and silvi-pastoral systems for the promotion of the rational and efficient use of fuelwood and charcoal.

National Environmental and Climate Change Strategy: This instrument is based on the strengthening of environmental education for life; defense and environmental protection of natural resources; conservation, recovery, capture, and harvesting of water; mitigation, adaptation, and management of risks facing climate change; sustainable management of the earth.

CAVAMA: Improvement in the value chain for cut wood, facing key weaknesses in the value added of wood at multiple levels that involve both the private and public sectors.

NICADAPTA: Support Project for the adaptation to the production of coffee and cacao for small-scale farmers in apt agro-climatic zones, implemented with the objected to improve sustainably the conditions of life of rural families.

CRISOL: Christian, socialist, and solidary program, based on a credit plan that provides resources to peasants with greater ease of payment and without usury; functions as a program of purchasing futures in the crops of small farmers.

Other instruments: In the year 2000, with the objective to stop the depletion of mahogany, Nicaragua and Guatemala proposed the inclusion of mahogany in Appendix II of CITES as a species at risk of extinction.

In 2003, the Law for Conservation, Promotion, and Sustainable Development of the Forestry Sector (462) was approved, with the objective to “establish the legal regimen for the conservation, promotion, and development of the forestry sector, taking into account as a fundamental basis of forestry management, the natural forest, the promotion of plantations, protection, conservation, and restoration of forest areas.

In May 2006, the Decree No. 32-2006 is emitted, which dictates economic emergency in RACCN, RACCS, and in the departments Rio San Juan and Nueva Segovia, for the illegal cutting, transport, management, processing, storage, possession, exportation, and commercialization of forest resources for a period of 180 days.

The Forestry Prohibition Law (585) prohibits the harvesting of six forestry species (Mahogany, Royal Cedar, Pochote, Mangle, Pine, y Ceiba) for a period of 10 years outside of protected areas, and indefinitely for all the species in the protected areas.

VI. How to face the causes of deforestation and forest degradation

6.1 Core problems, challenges, missing elements to address the causes DandD

This section provides an overview of the participative workshops held where the topic of the causes of deforestation and forest degradation (Causes), the supposed origins (Core Problems) and some Action Proposals (Challenges and missing elements) for each identified cause that was considered a motor of

deforestation and degradation of forests⁴⁶. The dialogue spaces that were promoted during the process of readiness preparation permitted knowledge from the territories of the feeling of the actors regarding aspects that they considered bottle-necks in the management and governance of the forests, natural resources, and in general, land use.

Table 18. Description of causes of DandD, origin of the causes (core problems), and proposed strategic actions to mitigate the identified causes⁴⁷.

Environmental Forestry Governance			
Direct Causes	Causas Underlying	Origin of causes (Problems)	Strategic actions to address the identified causes (Challenges and emtys)
Weakness in mechanisms for coordination, monitoring and inter-institutional evaluation	Limited institutional practice in environmental fields. Little institutional presence in far-off rural areas. Institutional weakness to address the problem.	Institutional Weakness	Study organization and strategic planning, Expansion of technical and technological capacity, strengthening of the analytical capacities of members of the production and level 1 cabinet
Presence of third parties in indigenous communities.	Search for fertile soils for agriculture (Basic Grains) Economic interest in precious wood trees Lack of definition of indigenous areas	Weak territorial governance, Use of Inappropriate technology	Extension of institutional territorial coverage, Research, innovation and technology development, Knowledge management, Stop the advance of the agricultural frontier
Low local institutional presence (INAFOR, MARENA, INTA, MAGFOR, Police, Army, PGR, Prosecutor's Office).	Limited budget resource to meet basic needs.	Weak Institutions	Strengthening institutional capacity for the management of economic resources
	Poor institutional priority to environmental problems.	Weak Institutions	Harmonization of the regulatory and political framework

⁴⁶ Systematization of the regional and national consultation workshops.

⁴⁷ Source: Results of work groups during workshops of the ER-PIN in the Caribbean Coast.

Socio Cultural Ambit			
Direct Causes	Causas Underlying	Origin of causes (Problems)	Strategic actions to address the identified causes (Challenges and emtys)
Search for income opportunities for poor rural families	Lack of capacity to generate new business alternatives Productive technology management behind, unprofitable, and contrary to the environment Medium used by large producers to expand their areas in operation	Technological deficiency	Research, innovation and development of technologies, Knowledge management, creating and strengthening structures with a business approach
Temporary Societies and Uncontrolled Engineering	Loss or inability of productive areas to generate sufficient animal feed Low-cost business opportunity for low-income producers Low-level producer organization for business purposes	Technology deficiency, weak business capacity	Research, innovation and development of technologies, Knowledge management, creating and strengthening structures with a business approach
Under recognition of the social and economic value of the forest (only the indigenous and Afro-descendant peoples)	Mercantilist approach to goods and services prevails	Weak business capacity	Knowledge management Apply incentives to reduce significant differences in opportunity costs
Under the knowledge of laws, procedures, regulations, norms.	Little disclosure of laws, rules, legal procedures in communities away from urban centers. Low level of schooling in communities Poor dissemination in indigenous languages	Weakness in local capacities	Dialogue and Environmental Awareness

Financial Ambit			
Direct Causes	Causes Underlying	Origen of Causes	Strategic actions proposed by identified causes
Limited presence of financial institutions	Financing for agricultural and livestock activities increasing forest degradation	Financing without environmental vision	Harmonization of the regulatory and political framework
Little Influence of the value chain			Research, opening of new markets
Market does not quantify and value environmental services	Technical and institutional incapacity to generate requirements or comply with procedures to accuse those resources Unidentified tradable volumes such as to interest markets in these services	Technological weakness, weakness in the value chain	Knowledge management
Tariff measures approach not consistent with national priority to reduce D & D	Tax payments related to the condition of the farm, to better condition the tariff rate Exemption policies for agricultural activities encourage the growth of these	Weak application of regulatory and political framework	Harmonization of the regulatory and political framework
Lack of control of commercial permits linked to the informal market	Institutional Incapacity to provide coverage and control the informal market at the national level	Weak institutional, weak territorial governance	Expansion of institutional territorial coverage, Institutional strengthening of forest governance structures
Few incentives for alternative markets for agroforestry products	Financial institutions interested more in the profitability of their operations than in the socio-economic development Little private and institutional capacity for the development of alternative markets	Financial weakness, Weakness in the value chain	Desarrollo de mecanismos de incentivos financieros
Budgetary constraints of key institutions	Environment is not considered a priority in the national budget. Poor budget management from bureaucratic administrative procedures	Financial Weakness, Institutional Weakness	Strengthening institutional capacity for the management of economic resources
Lack of economic alternatives (formal employment) for landless peasants	Weak capacity for the generation of profitable and sustainable economic activities in all economic sectors of the country	Weak capacity for business generation, Weakness in value	Knowledge management, Research, opening and market development, Promotion and development of new eating habits, Create and strengthen

	High dependence on outsourcing as unskilled labor	chains and market access	organizational structures with a business approach
Lack of financial mechanisms to reduce deforestation	Institutional weakness of the state for the management of economic resources in support of the environment Institutional inability to visualize new economic alternatives that finance environmental activities	Financial Weakness	Implementation of the forest bond, Development of financial incentive mechanisms
Low land value in agricultural border areas	Poor access roads Difficulty of access to markets for agricultural products	Weak access to markets, technological weakness	Create and strengthen organizational structures with a business approach

Legal Ambit			
Direct Causes	Underlying Causes	Origin of the causes (Problems)	Strategic actions to address the identified causes (Challenges and emtys)
Level of Application of environmental and forest laws	Institutional incapacity for the implementation of these in areas with greater involvement in forests	Institutional Weakness	Expansion of institutional coverage, Institutional strengthening of forest governance structures
Weakness in livestock records	Deficiency in regulation and ordering of activity in state institutions	Institutional Weakness, Weak Governance	
Few mechanisms to control livestock	Deficiency in policies and law that regulate and effectively order this activity Weak institutional presence in areas with greater intensity in the development of this activity	Institutional Weakness, Weak Governance	Harmonization of the regulatory and political framework
Bureaucratic and complicated paperwork to sell wood	Inadequate application of procedures and voids that induce	Institutional Weakness, Weak Governance	Simplification of procedures

6.2 Holistic approach for the mitigation of the DandD causes

Reversing the processes of deforestation and forest degradation is an enormous task because of the magnitude and speed with which these processes advance. Therefore, in order to mitigate both processes, it is imperative to maintain a holistic approach.

The capacities of the Central Government, regional, territorial and communal authorities should be articulated in order to establish a solid basis in national policy regarding natural forests for the present and future of the country.

The Government of Nicaragua has defined the conservation of the country's forests and the recovery of degraded areas as one of its priorities. To this end, the country has a framework of policies, strategies and plans, such as: The National Human Development Plan (PNDH), the General Territorial Planning Policy, the General Land Policy Framework, Sustainable Development of the Forestry Sector, the National Climate Change Strategy, the Agroecological Strategy, the Development Strategy of the Caribbean Coast and Alto Wangki and Bocay, the 2016-2017 Production, Consumption and Trade Plan, the National Forestry Program, National Plan for Reforestation, the National Plan for Prevention and Control of Forest Fires, and the Program for the Conversion of Livestock.

In Table 24, are described the identified causes and how the country currently manages or reduces the causes, of deforestation and forest degradation in the country, as in the public institutions involved to reduce these causes.

Table 19. Relation between the DandD causes, the agents of change, the region of incidence, and the institutions involved in the management of natural resources that help to reduce these causes.

Principal causes	Agents	Region of the country where the incidence occurs	How the country currently reduces the causes of DandD in the country	Institutions involved to reduce the causes
Ranching and crops (Advance of the agricultural frontier)	Crop farmers, extensive cattlemen	Caribbean Center	National Food Program National Agro-industry Program National Reforestation Campaign National Forest Program (PFN)	MAGFOR, INAFOR, MARENA, Businesses, Schools, Universities, NGO
Forest and farm fires	Farmers that use practices including fire and uncontrolled fires Illegal hunting	Pacific (León Chinandega, Carazo, Masaya, Rivas)	-Systematic monitoring of the Hot Spots (NOAA satellite), - Joint development among MARENA, INAFOR, CIVIL DEFENSE of the army, an integrated, annual plan for the prevention of and attention to forest fires.	MARENA-SINIA INAFOR Civil Defense SE-SINAPRED

Principal causes	Agents	Region of the country where the incidence occurs	How the country currently reduces the causes of DandD in the country	Institutions involved to reduce the causes
		North (Estelí, Nueva Segovia, Madriz) RACCN and RACCS.	- Identification by MARENA, INAFOR, CIVIL DEFENSE of the army of 5 regions as critical sites facing forest and agricultural fires. – Standardized, consolidated report of fire occurrence nationally - Projects to finance the organization, systematic training, and constant equipping of local fire-fighting brigades.	Local Volunteer and Military Brigades
Cutting forests, illegal extraction and traffic of forest products	Wood industry, forest owners, settlers, business people	Caribbean North Pacific	Forest Projects Facility: Improvements in the implementation of the forestry law, greater promotion of the sustainable management of forests through Community Forestry	INAFOR FAO Community forest businesses
Environmental emergencies or disasters from natural phenomena	Hurricanes, landslides, floods, drought	Pacific, Caribbean	Projects; Environmental risk management in 70 municipalities in the country. Disaster risk management related to Climate Change	Presidency, MAGFOR, INETER MARENA-DGEA INAFOR, SE-SINAPRED, Civil Defense, Red Cross
Insecurity in land tenure	Settlers, peasants, displaced people.	Caribbean, Pacific North	-Title awards for more than 65,000 rural and urban titles in the Pacific, Central and North of the country. -Title awards for the indigenous communities: 15 Territories with titles, made up of 214 Indigenous and Afro-descendant communities. Territorial extension titled 22,478.996 km ² , approximately 103,790 beneficiaries.	Presidency INIDE CONADETI GRACCN GRACCS URACCAN
Promotion of mining activities	Mining businesses,	Central, Caribbean	Greater control over the environmental impact of the mining activities, application of	MEM MARENA

Principal causes	Agents	Region of the country where the incidence occurs	How the country currently reduces the causes of DandD in the country	Institutions involved to reduce the causes
			environmental laws and environmental impact studies (EIA)	

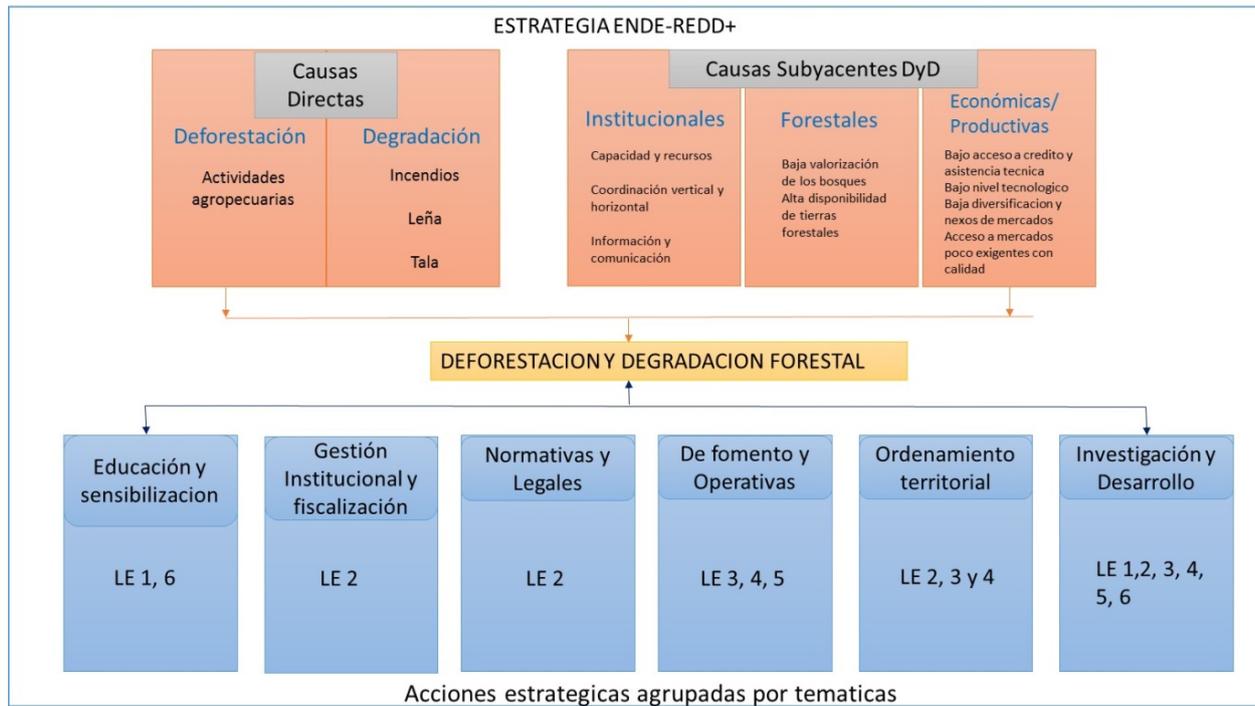


Figure 73 Relation between the DandD causes and the strategic lines and actions necessary to mitigate them.

6.3 The way to continue under the ENDE-REDD+ framework

Within the Readiness process, the design of the National Strategy for the ENDE-REDD+ Program has been started, which will be the basis for outlining the mission, strategic actions and measures that will be applied in the country during the coming 30 years, at least in the Forestry, Farming, and Environmental Sectors.

In Figure 75, there is a brief review of the proposal for the initial version of the ENDE-REDD+ Strategy, where the large components and the work focus are described.



Figure 74 Components and focuses inherent to the ENDE-REDD+ Program Strategy.

It merits mention that the studies signal that, given the extensive, traditional management of the production systems, intensification policies directed to the sector have the potential to reduce the rate of deforestation in the country (Polvorosa J. 2015).

The ENDE-REDD+ strategy to assure that success is based on four pillars: institutional, ethnic, awareness, and production and conservation. Furthermore, it is hoped that, during the design of this strategy, the concrete measures and actions necessary to apply in the territories is set; at the moment, more than 30 actions within six strategic lines have been systematized (Figure 76).

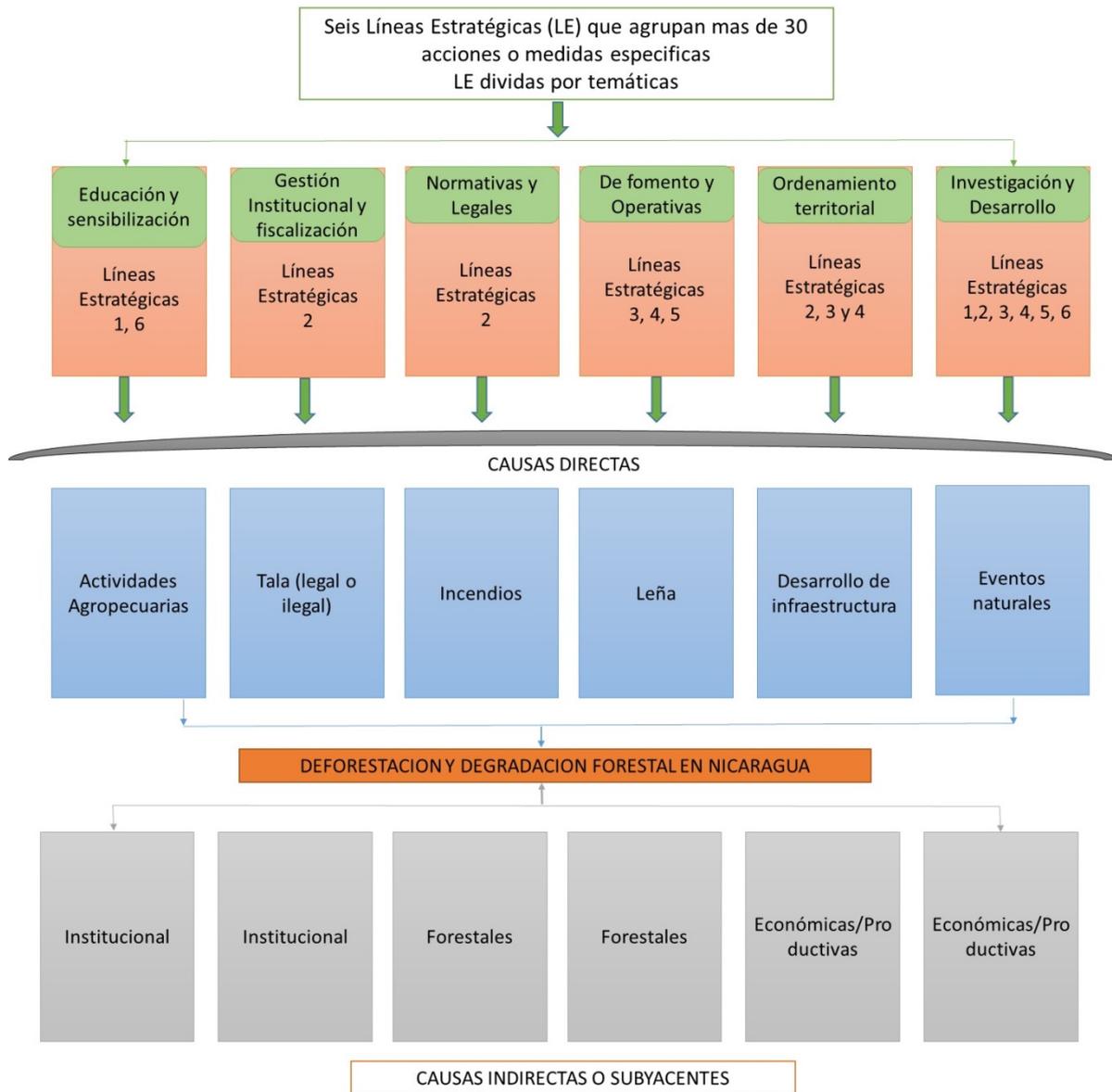


Figure 75 Conceptual framework of the Strategic Lines classified in six action areas, and their relation to the DandD causes.

Table 24. Defined strategic lines (SL) and their contribution toward REDD+ actions.

No.	Strategic Lines (SL)	REDD+ Actions				
		Reducing emissions from deforestation	Reducing emissions from degradation	Enhancement of carbon stocks	Conserving carbon reservoirs	Sustainable management of forests
1	Strengthen awareness, education, communication and promotion of values and information linked to the protection of mother Earth, taking territorial identity as well as the worldview of indigenous and Afro-descendant peoples into account.	X	X	X	X	X
2	Strengthen national, regional and local coordination as well as government's ability to use the land and natural resources, taking forestry, environmental, agricultural and energy-related laws and policies into account.	XXX	XXX	XX	XX	XX
3	Promote the protection, conservation and restoration of landscapes and biological corridors by means of afforestation, reforestation and natural regeneration in the Caribbean Coast as well as the Pacific and Northern regions.	XX	XXX	XX	XX	X
4	Increase low-emission, sustainable agroforestry production as well as farmer's income and employment.	XX	X	XX	XX	XX
5	Promote investments in and strengthening of forestry and agricultural value chains with a sustainable-market, low-emission approach that takes sustainability and reduced deforestation into account.	XXX	XX	X	X	X
6	Strengthen climate change adaptation initiatives in the indigenous and Afro-descendant peoples' territories in the Caribbean Coast and the Pacific/Central-Northern regions.	XX	XX	X	X	X
Totals		13	12	9	9	8

6.4 Multi-criteria analysis

The results derived from the multi-criteria analysis⁴⁸ allow us to explore several options and identify what areas in the country are in greater need for ENDE-REDD+ activities/measures. The parameters in each

⁴⁸ Spatial multi-criteria model, where the social, demographic, biophysical and environmental variables were applied as well as land use, ecosystems and productive activities. Methodology specified in: MARENA 2017.

spatial model were assessed in order to identify the sites with high, medium and low priority. Six thematic models were evaluated: economic, social, biophysical, soil cover, environmental and a model merging all the other models.

It is important to highlight that this can be deemed an exploratory study used to identify priority intervention sites at the sub-national level. Since these models are at the national level, obtained results display a broad or much generalized appraisal of priority sites according to each assessed category (i.e. high, medium and low priority). However, the multi-criteria analysis is a starting point to assess subnational priority sites as well as the measures required in each one of them.

It is suggested that the results be combined with other tools that can be used to conduct a thorough review of priority sites, e.g. cost-benefit analysis and/or economic feasibility of measures to be implemented in the territories, and the contribution of each selected strategic action toward the emission reduction goals of the program, among others.

The results of the multi-criteria models provide us with valuable information on sites with diverse perspectives where measures to implement ENDE-REDD + could be most needed or urgent. The following is a summary of the main results and their link with the strategic lines and actions to implement the ENDE-REDD + Program.

Economic Model

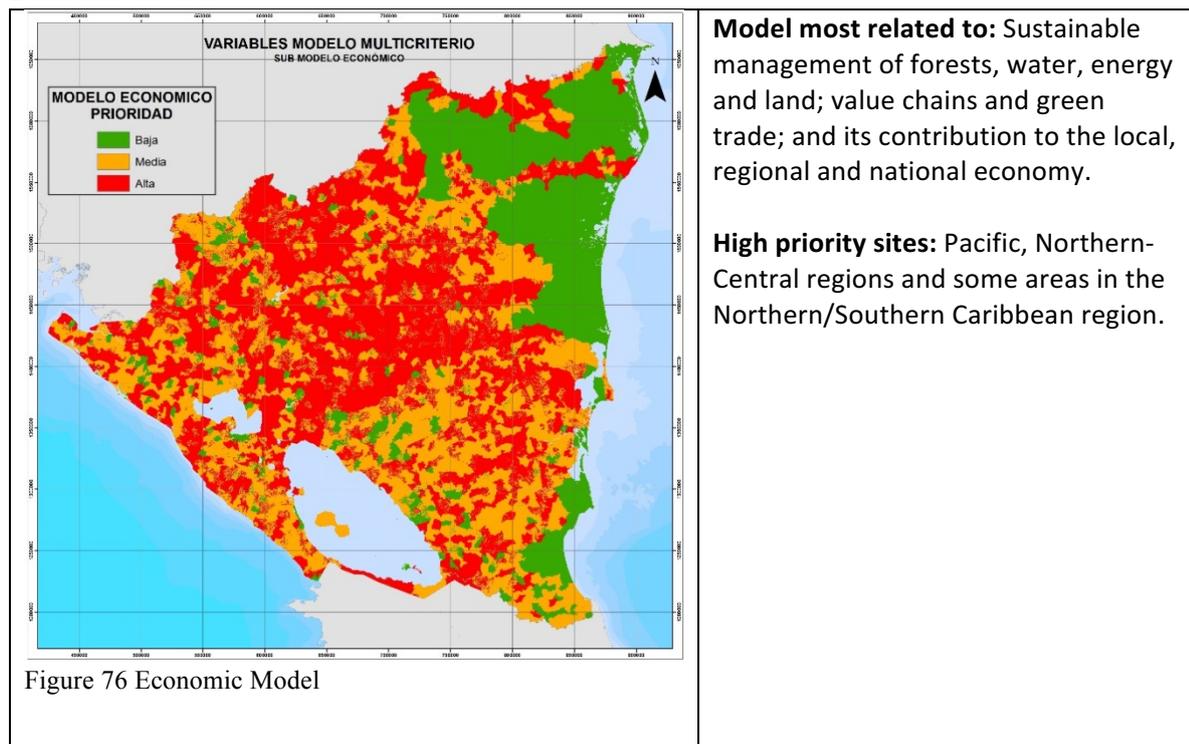


Figure 76 Economic Model

Social Model

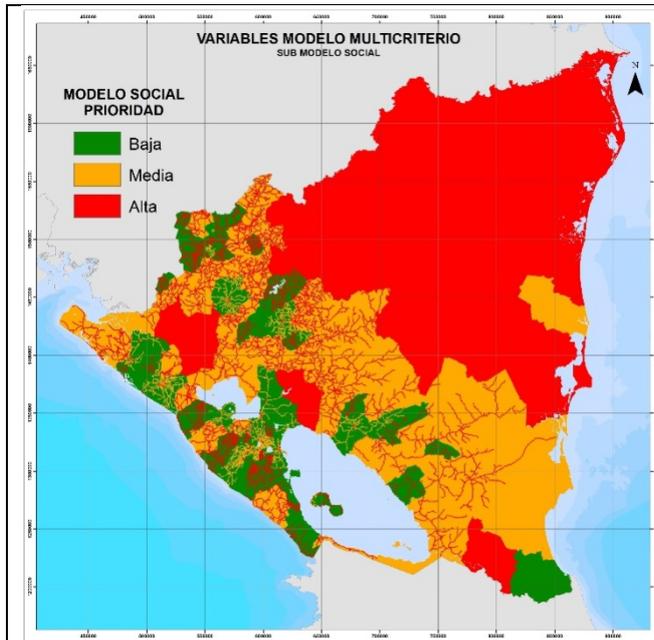


Figure 77 Social Model

Model mostly related to: Improving natural resource governance and increasing climate change resilience of the population and ecosystems.

High priority sites: Northern Caribbean Coast and part of the Southern Coast region. Some areas in the Pacific, Northern-Central region. Indigenous territories as well as areas with higher poverty rates are the priority sites.

Biophysical Model

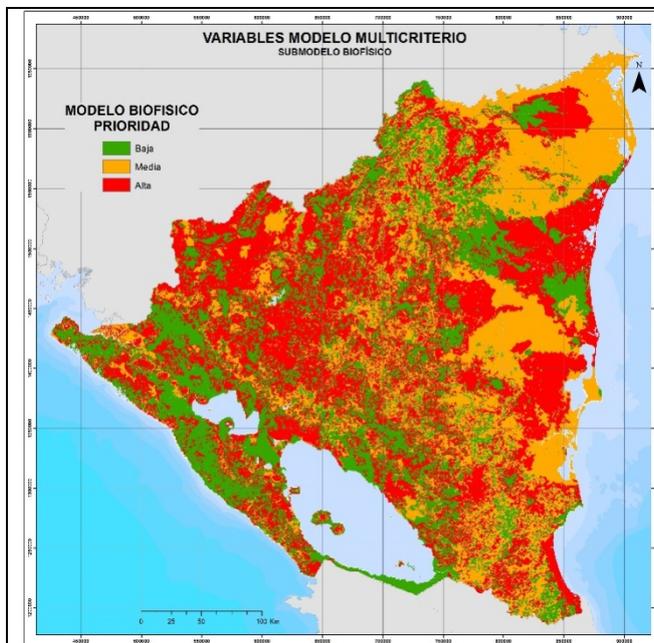


Figure 78 Biophysical Model

Model mostly related to: Sustainable management of forests, water, energy and land; value chains and green trade; and its contribution to the local, regional and national economy.

High priority sites: Northern Caribbean Coast and part of the Southern Coast region. Some areas in the Pacific, Northern-Central region. Indigenous territories as well as areas with higher poverty rates are the priority sites.

Soil cover model

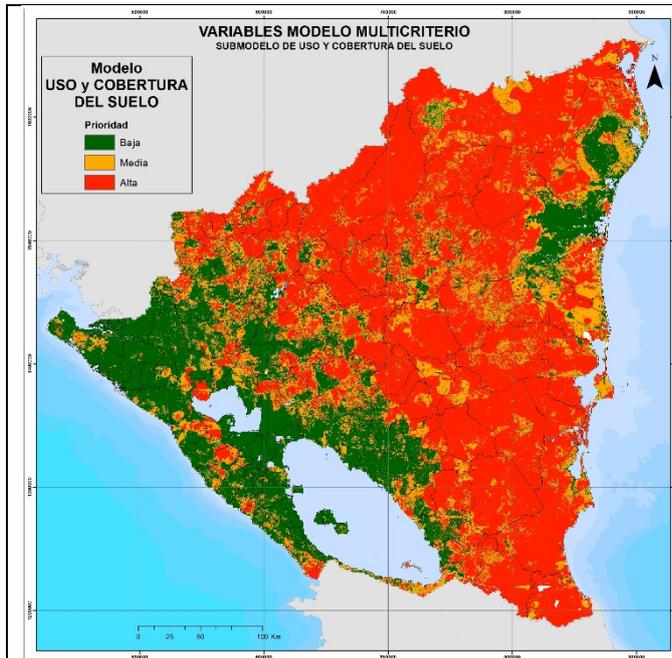


Figure 79 Use and cover model

Model mostly related to: *Reducing deforestation and forest degradation as well as increasing ecosystem goods and services in the country.
*Sustainable management of forests, water, energy and land; value chains and green trade; and its contribution to the local, regional and national economy.

High priority sites: The Northern and Southern Caribbean Coast regions. Some areas in the Pacific, Northern-Central region. Indigenous territories and the areas with the largest natural forest are the priority sites.

Environmental Model

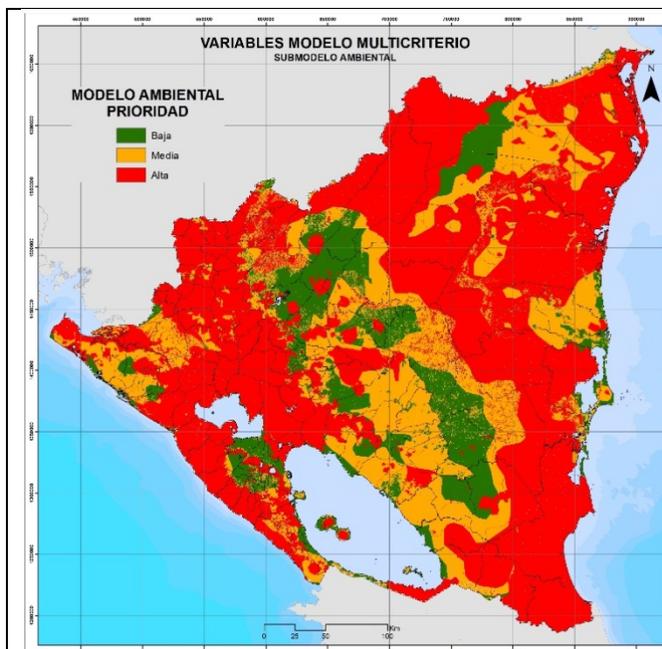


Figure 80 Environmental Model

Model mostly related to: *Adaptive management of natural resources and reconverting productive systems at a national scale.

*Reducing deforestation and forest degradation as well as increasing ecosystem goods and services in the country.

High priority sites: Northern Caribbean Coast and part of the Southern Coast region. Pacific and Northern regions.

The areas where natural forest remnants are located or where forest cover has been recently lost, protected areas and areas vulnerable to or threatened by deforestation and degradation are the priority sites.

Combined Model (all aspects)

This model combined all resulting economic, social, biophysical, soil cover and environmental models.

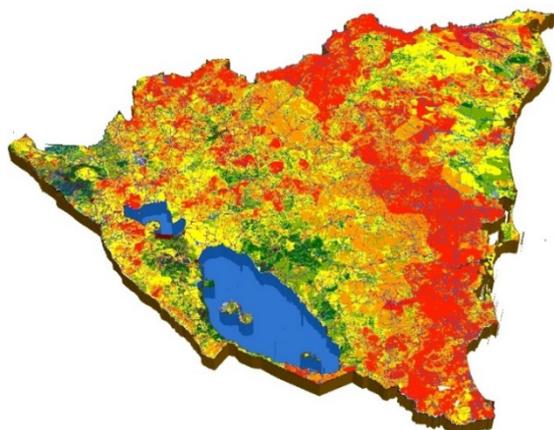


Figure 81 Combined model

A model that merges the goals of presented models:

*Reducing deforestation and forest degradation as well as increasing ecosystem goods and services in the country.

*Sustainable management of forests, water, energy and land; value chains and green trade; and its contribution to the local, regional and national economy.

*Improving natural resource governance and increasing climate change resilience of the population and ecosystems.

*Adaptive management of natural resources and reconverting productive systems at a national scale.

High priority sites:

Northern and Southern Caribbean Coast regions, Bosawas and Indio Maiz biosphere reserves, Wawashang, other neighboring protected areas and smaller areas in the Pacific, Northern-Central regions.

VII. Conclusions and Recommendations

Conclusions

1. The main direct causes of deforestation in Nicaragua are the Extensive Livestock and Agriculture both subsistence and commercial, phenomena also known as "Advancement of the agricultural frontier." It should be noted that Nicaragua has historically sustained its economy in the primary sector, mainly in the agricultural and livestock sectors.
2. The main causes of forest degradation are the consumption of fuelwood and coal, illegal logging, illegal logging, forest fires and environmental emergencies (pests and diseases and hurricanes)
3. Deforestation and forest degradation are reducing the environmental goods and services of the main forest ecosystems in Nicaragua, reducing the possibilities of adaptation of Nicaraguans to the adverse effects of climate change.
4. The links of the different production chains in Nicaragua are mostly disjointed, with low performance and low added value. However, there is a strong potential for articulation in value chains, taking advantage of the model of dialogue, alliance and consensus promoted by the Government of Nicaragua.

5. The country's economic growth model is based on the incremental exploitation of natural resources through a model based on activities of low efficiency and low value added. In the future this model faces constraints of sustainability since, on the one hand, resources are limited and on the other, these activities have little chance of increasing productivity.

Recommendations

It is recommended that the results of the study of the causes of deforestation and forest degradation be considered as the main inputs to elaborate a strategy aimed at reducing these phenomena within the framework of adaptation to climate change and poverty reduction in Nicaragua.

This national strategy should include in its lines of action elements related to environmental education, the improvement of institutional capacities, the strengthening of the application of laws and instruments related to land resources, as well as actions to increase the value of Forests through incentives for afforestation, reforestation and natural regeneration. These actions must also go hand in hand with the strengthening of value chains with a focus on sustainable markets and the promotion of low-emission agricultural and forestry production.

VIII. References

- ARNOLD F, 2010; Análisis de factores históricos de cambio de uso forestal a otros usos en Nicaragua. FEA/INAFOR.
- BAIRAMIS SF. The End of the Agricultural Frontier in Nicaragua and its Impact on National Development. Managua, Nicaragua
- MARENA 2000. Cambios en la cobertura forestal de Nicaragua. Turrialba Costa Rica.51 pág.
- CEPAL, et al, 2010; La economía del cambio climático en Centroamérica. Síntesis 2010.
- CIESIN, CIAT. Gridded Population of the World Version 3. Center for International Earth Science Information Network and Centro Internacional de Agricultura Tropical. 2005
- Di Lallo, G.; Mundhenk, P.; Zamora López, S.E.; Marchetti, M.; Köhl, M. REDD+: Quick Assessment of Deforestation Risk Based on Available Data. *Forests* **2017**, *8*, 29. <http://www.mdpi.com/1999-4907/8/1/29>
- Flores S., Barrera J., Bastiaensen J, Castro A., Martinez S. E., Polvorosa J.C. Las cadenas de lácteos y su interacción con la dinámica de género: La experiencia en Matiguás y en Muy Muy, Nicaragua.
- Francis Smith, J. Las cadenas de valor en Nicaragua: Quequisque, Forestal y Lácteos. Tres estudios de caso. UNIFEM, Managua: 2004
- FUNICA, 2012; Estado actual oportunidades y propuestas de acción del sector agropecuario en Nicaragua. Managua. 108 pág.
- Gómez,L.,Munk Ravnborg, H., Castillo, E. 2011. "Gobernanza en el uso y acceso a los recursos naturales en la dinámica territorial del Macizo de Peñas Blancas -Nicaragua". Documento de Trabajo °82. Programa Dinámicas Territoriales Rurales. Rimisp, Santiago, Chile.
- GIZ, 2012; Análisis de las causas de la deforestación y avance de la frontera agrícola en las zonas de amortiguamiento y zona núcleo de la reserva de biosfera de BOSAWAS. RACCN Nicaragua.86 pág.

<http://faostat3.fao.org/browse/Q/QA/S>

http://www.iica.int.ni/Estudios_PDF/Estrat_Des_Rural.pdf
http://www.iica.int.ni/Estudios_PDF/Estrat_Des_Rural.pdf

INAFOR, 2004. Expansión de la frontera agrícola. Managua, Nicaragua

INAFOR, 2008. Inventario nacional forestal 2007-2008. Managua, Nicaragua 229 pág.

INIDE & MAGFOR 2011. IV Censo Nacional Agropecuario. Informe Final (IV CENAGRO, 2011). 70 p.

INIDE, 2006. Cifras oficiales del VIII censo de población y IV de vivienda. Managua. 40 pg.

INETER (2000a). Ciudades y comarcas (shapefile). Escala 1:50000. Instituto Nacional de Estudios Territoriales.

INETER (2000b). Red nacional de caminos (shapefile). Escala 1:50000. Instituto Nacional de Estudios Territoriales.

INETER, 2015. Atlas de Nicaragua, uso actual de la tierra. Managua, Nicaragua

Kauppi, P., R.J. Sedjo, M. Apps, C. Cerri, T. Fujimori, H. Janzen, O. Krankina, W. Makundi, G. Marland, O. Masera, G.J. Nabuurs, W. Razali, and N.H. Ravindranath, 2001: Technical and economic potential of options to enhance, maintain and manage biological carbon reservoirs and geo-engineering. In Mitigation 2001. The IPCC Third Assessment Report, [Metz, B., et al., (eds.)], Cambridge, Cambridge University Press.

Kissinger, G., M. Herold, V. De Sy. 2012 Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers. Lexeme Consulting. Vancouver Canada, August 2012. 46 p

Lezama, M. 2007. El Índice de Capital Natural como instrumento de análisis de pérdida de biodiversidad en Nicaragua.

MAGFOR 1983. Cobertura forestal 1983 (shapefile). Escala 1:250000. Ministerio Agropecuario y Forestal.

MAGFOR 2000. Cobertura forestal 2000 (shapefile). Land use map of Nicaragua in 2000. Escala 1:250 000. Ministerio Agropecuario y Forestal.

MAGFOR, 2004. Política sectorial agropecuaria. 2004-2006

MAGFOR, 2012. IV Informe final censo nacional agropecuario. Managua. 60 pg.

MARENA-MAGFOR, 2011. Mapa de uso del suelo actual 2011 (shapefile). Scale 1:250000. Ministerio del Ambiente y Recursos Naturales, Nicaragua and Ministerio Agropecuario y Forestal.

MARENA, 2007. III Informe del Estado del Ambiente GEO 2003-2006.

MARENA, 2010. IV Informe del Estado del Ambiente GEO 2007-2008. Sistema Nacional de Información Ambiental de Nicaragua (SINIA). Ministry of the Environment and Natural Resources (MARENA) 274 p.

MARENA, 2011. Plan de Manejo conjunto de la Reserva Biosfera BOSAWAS. Citando a (Stocks, et al. 2005 Managua, Nicaragua

MARENA, 2013. Readiness Preparation Proposal (RPP), Managua Nicaragua. 261 pág.

MARENA, 2013. Readiness Preparation Proposal (R-PP). Managua. Nicaragua 261 pág.

MARENA, 2015. Emission Reductions Program Idea Note (ER-PIN), Managua Nicaragua. 87 pág.

MARENA, 2016. Mapa de cobertura de uso del suelo, elaborado por proyecto REDD/GIZ, revisado y homologado a las clases de uso del suelo oficiales en Nicaragua por el Programa ENDE-REDD+ / MARENA

Milán, J; 2010. Apuntes sobre el cambio climático en Nicaragua. Managua, Nicaragua

NITLAPAN, 2006; El desarrollo ganadero en Nicaragua y su influencia sobre: El bienestar socioeconómico de las familias, la biodiversidad y los servicios ambientales.

PALGRAVE, 2003. La República Conservadora de Nicaragua, 1858-93 / Arturo J. Cruz. Clasificación: Libro 972.85. Publisher: New York. Edición: 1a. ed.

POLVOROSA, J; 2015; IX Congreso Interdisciplinario de Investigación | Universidad Centroamericana Ganadería y deforestación en Nicaragua: entendiendo la relación entre el boom lechero y el avance de la frontera agrícola. Managua, Nicaragua Pág. 46

ROBLETO, G; SOLORZANO, A; LACAYO, L; 2015. IX Congreso Interdisciplinario de Investigación | Universidad Centroamericana, Los asentamientos del Pacífico urbano de Nicaragua. Managua Nicaragua. pág. 29

SINIA-MARENA. 2011; Medio Ambiente en Cifras 2004-2011. Nicaragua

Zamora Lopez, Sheila Edith. 2017 Doctoral Thesis, in press. Hamburg University.

IX. Annexes

Annex 1. Description of the Ecological Regions of Nicaragua (From: <http://www.fao.org/docrep/007/j0602s/j0602s02.htm>)

Description of the Ecological Regions of Nicaragua
<p>Ecological region I (Pacific Region)</p> <p>It is the driest and warmest in the country. From a standpoint of vegetation features and floristic composition, it is comprised of several vegetation categories (deciduous, sub-deciduous and evergreen forest formations) and a vast diversity of native vegetation species. The following ecosystems were identified:</p> <ul style="list-style-type: none">- Pacific estuary, SA1c(1)(a)- Scarcely vegetated beach, VIB1a(1)- Pacific loam mangrove, IA5b- Pacific loam mangrove, IA5b- Sedge swamp, VD1b- Inshore deciduous forest, IB1a(1)- Sub-mountainous deciduous forest, B1ab(1)- Scarcely vegetated lava, VIAd- Landslide successions, VIA2- Deciduous shrub savannah, VA2b(2)- Savannah without ligneous cover, submontane or montane, VA2c- Freshwater vegetation mosaic, VII- Floating meadow (gamalotales), VIIA1a- Lake and lagoon reed bed swamp, VIIB <p>Ecological region II (Northern-Central Region)</p> <p>It is the most temperate region in the country with annual average temperatures below 24°C, except for the small warm land areas. The following ecosystems were identified:</p> <ul style="list-style-type: none">- Deciduous shrub land, IIIB1- Seasonal evergreen shrub land, IIIA1

- Semi-deciduous forest, IA3a(1)(a)
- Semi-deciduous alluvial gallery forest, IA3f(4)
- Semi-deciduous swamp forest, IA3g(a)
- Seasonal submontane evergreen forest, IA1b(1)
- Seasonal, low submontane evergreen forest IA1c(1)
- Seasonal, submontane evergreen pine forest, IA2b(2)
- Seasonal submontane evergreen mixed forest, IA2b(1/2)

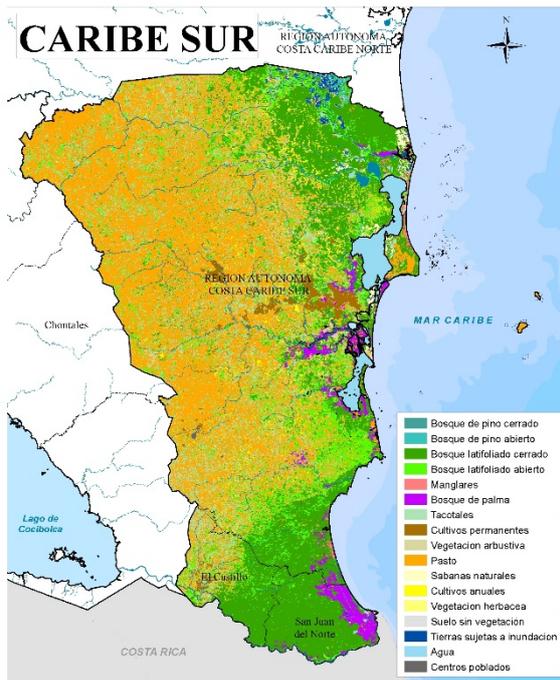
Ecological region III (Central Region)

It is characterized for being a transition area between the ecological regions I, II, IV. It is the most humid, cold region of the country at the lowest altitudes, which results in the generation of several types of moderately warm, temperate and cold rainforest; the vegetation and floristic groups in the region are very diverse. The following ecosystems were identified:

- Caribbean coral mangrove, IA5a(2)
- Caribbean loamy mangrove, IA5a(1) and mangrove with *Pelliciera*, IA5a(1)(a)
- Scarcely vegetated Caribbean tropical beach, VIB1a(1a)
- Coastal transitional swamp vegetation, VIB3b
- Seasonal evergreen forest dominated by palm trees, IA2g(2)
- Flooded seasonal evergreen rainforest, IA2f(3)(a)
- Seasonal evergreen gallery rainforest, IA2f(4)
- Seasonal evergreen riverside rainforest, IA2f(1)
- Flooded seasonal evergreen rainforest dominated by bamboo, IA2f(3)(c)
- Moderately drained seasonal evergreen rainforest, IA2a(1)(b)
- Well-drained seasonal evergreen rainforest, IA2a(1)(a)
- Mixed, well-drained, inshore seasonal evergreen rainforest, IA2a(1/2)(b)
- Saturated savannah with pine trees, Va2d
- Seasonal low mountainous evergreen rainforest, IA2
- Swampy evergreen forest, IA1g(1)

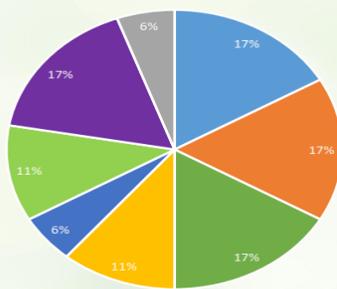
o About 600 thousand to 1 million board feet (50 thousand cubic meters/year) are extracted.

RACCS, Current Use 2015



Durante la sesión de trabajo participaron 18 protagonistas.

- SERENA
- MARENA
- GRACCS
- CRACCS
- GTI
- Banco Mundial
- Programa ENDE
- MHCP



Results from the contextual analysis of deforestation in RACCS

- When using level curves in the 2015 map, it was identified that higher elevation areas still conserve forest patches.
- It has been identified that agroforestry can be used in combination with the remaining blocks of forest.
- The indigenous communities are protecting Forest remnants.
- The program should consider the areas located outside of the protected reserves where indigenous communities are protecting the forests.
- Land use conflicts between settlers and indigenous communities are a direct threat in the forests. Hence, resulting in high probability of deforestation.
- Changing the use for oil palm is in a halt due to the mandatory technical regulations applied at the national level; hence, it is not considered a cause of deforestation.
- Palm plantations were established in degraded areas from 2010 to 2015.
- *The relationship between palm companies and GRACCS is good and they may be potential investors for forest conservation.*
- **In the present, what municipalities show highest deforestation?** Tortuguero, Cruz de Rio Grande, Pearl Lagoon, Karawala, Wawashang.
- Participants' opinions were verified through the land use maps and forest cover from the year 2015, where forest reduction was evidenced (deforestation is caused by cattle ranching).

X. Glossary⁴⁹

Afforestation

Establishment of forest by means of planting and/or not directed sowing in land that, to that moment, had not been classified as forest.

Reforestation

Re-establishment of forest by means of planting and or deliberate sowing in land classified as forest.

Afforestation

Conversion, by direct human activity, of lands that lacked forests for a minimum of 50 years into forest land by means of planting, sowing or anthropogenic promotion of natural seedbed.

Reforestation

Conversion, by direct human activity, of non-forest lands into forestlands by means of planting, sowing or anthropogenic promotion of natural seedbeds in lands formerly forested, which are currently deforested.

Deforestation

Conversion, by direct human activity, of forest lands into non-forest lands.

Forest degradation

Partial elimination and loss of ecosystem functions. For ENDE-REDD+, degradation is deemed the change from closed forests into open forests.

Direct causes of deforestation and forest degradation

Human activities or actions that have a direct impact on forest cover and carbon loss.

Underlying causes of deforestation and forest degradation

Complex interactions among fundamental processes of social, economic, political, cultural and technological nature.

National forest monitoring system

A system used to keep track and monitor land use in the country and generate data that shows greenhouse gas (GHG) emission levels and the elimination of these gases linked to the forests.

Forest reference emission levels

Forest reference emission levels are a comparative basis to assess the performance of each country in implementing the activities under the REDD+ initiative.

Safeguard

The term safeguarding is often related to the processes or policies designed to mitigate risks.

Policies and measures within the CMNUCC context

The actions adopted or dictated by the governments. Within the REDD+ context.

Forest

⁴⁹ Technical concepts were taken from

INAFOR. 2006, "Elaboración de planes de manejo y planes operativos de aprovechamiento en bosques húmedos latifoliados". Managua, Nicaragua 165 pg.

FAO.2010, Evaluación de los recursos forestales mundiales 2010.Roma. 30 pg.

ONU-REDD.SF, Capítulo 2 Entender REDD+ y la CMNUCC. 18 pg.

ONU-REDD.SF, Capítulo 3 Impulsores de la deforestación y la degradación forestal. 20 pg.

Land larger than one hectare with trees higher than four meters tall and a canopy cover over 20 % or trees that can reach said height *in situ*. It does not include land used for agricultural or urban purposes.⁵⁰

Other forestlands

Land not classified as "forest" which is larger than 0.5 hectares and has over five-meter-tall trees and a canopy cover ranging from five to ten percent, or trees that can reach the above minimum limits *in situ*, or which have a mixed cover higher than ten percent and made up of bushes, shrub land and trees. It does not include land subjected to a predominantly agricultural or urban use.

Other lands

All land, which was not classified as "forest" or "other forestlands."

Other lands with tree cover (sub-category of "other lands")

Land classified as "other land" which is larger than 0.5 hectares and has a canopy cover higher than ten percent, with trees that can reach five meters tall at maturity.

Forest property

It often refers to the legal entitlement to use, control, transfer or otherwise benefit from the forest, in a free and exclusive manner. Property can be acquired through handoffs, such as sale, donation or inheritance.

Continental waters

Continental waters often include the main rivers, lakes and reservoirs.

Rights to manage and use forests

The right to manage and use public property forests for a specific time span.

Public property

State-owned forest, or public administration's management units, or public administration-owned institutions or companies.

Private property

Forests owned by individuals, families, communities, cooperatives, companies and other private business entities, private religious institutions, private schools and private pension or investment funds, non-governmental organizations (NGOs), nature conservation associations and other private institutions.

Protected areas

Areas that have been specifically designated to protect and preserve the biological diversity and other related natural and cultural resources, which are ruled by legal tools or other effective instruments.

Production

Forest area designated primarily for production of timber, fibers, bioenergy and/or non-timber forest products.

Protection of soil and water resources

Forest area designated primarily to protect its soils and water resources.

Biodiversity conservation

Forest area designated primarily for biodiversity conservation. Including, but not limited to, the areas designated for biodiversity conservation within protected areas.

Multi-use

⁵⁰ Results of the MRV working session from July 2016.

Forest area designated primarily for several purposes, neither of which can be considered as the prevailing purpose.

Permanent forest area

Forest area designated to be protected as forest, which cannot be used for other purposes.

Natural forest

Naturally regenerated forests of native species where no clear indicators of human activity can be found, whose ecological processes have not been significantly altered.

Naturally regenerated forest

Forest that is predominantly comprised of naturally regenerated trees.

Introduced species

Species, subspecies or lower taxon that is outside its natural distribution area (past or present) and potential dispersion (i.e. outside the area it would or could use by natural means without direct or indirect intervention of humans).

Primary forest

Naturally regenerated forest, made up of native species, where ecological processes have not been significantly altered and there is no clear evidence of human activities.

Planted forest

Forest predominantly made up of trees that were either planted and/or deliberately sown.

Planted forest with introduced species

Planted forest whose planted/sown trees are predominantly introduced species.

Palm forest

Forest area with palm plantations.

Mangrove forest

Forest and other forest areas with mangrove vegetation.

Bamboo forest

Forest and other forest areas whose vegetation is predominantly that of bamboo.

Topsoil biomass

All living biomass on top of the soil, including trunk, stump, branches, bark, seeds and leaves.

Subsoil biomass

All biomass in living roots. Small roots with less than 2 mm in diameter are not included because, in general, they are not easily distinguishable from topsoil organic matter or fallen leaves.

Dead wood

All dead ligneous biomass that is not part of fallen leaves, whether standing, on top of the soil or inside the soil. Dead wood includes wood laying on the surface, dead roots and stumps whose diameter is ten centimeters or larger — or any other diameter used in the country.

Carbon in topsoil biomass

Carbon in all living biomass on top of the soil, including trunk, stump, branches, bark, seeds and leaves.

Carbon in subsoil biomass

Carbon in all biomass of the living roots. Small roots with less than 2 mm in diameter are not included because, in general, they are not easily distinguishable from topsoil organic matter or fallen leaves.

Carbon in dead wood

Carbon in all dead ligneous biomass that is not part of fallen leaves, whether standing, on top of the soil or inside the soil. Dead wood includes wood laying on the surface, dead roots and stumps whose diameter is ten centimeters or larger — or any other diameter used in the country.

Carbon in the soil

Organic carbon in mineral and organic soils (including turf) at the depth specified by the country and coherently applied in all chronological series.

Forest fire

Any non-planned and/or uncontrolled vegetation fire.

Agricultural fire

A planned fire technique used before land productive activities take place.

Number of fires

Number of registered fires that affect the vegetation of the country on an annual basis.

Biological diversity

The variability of living organism from any source, including, among others, terrestrial and marine ecosystems as well as other water ecosystems and the ecological complexes they belong to; it also includes the diversity within each species and between the species and the ecosystems.

Disruption

The alteration caused by any other factor (biotic or abiotic), which adversely affects the forest's productive fullness and capacity, and that is not the direct result from human activities.

Invasive species

Species that is exotic in a given ecosystem whose introduction and spreading causes or otherwise may cause sociocultural, economic or environmental harm, or may be harmful to human health.

Industrial wood

Volume of round wood extracted for the production of goods and services other than energy generation (firewood).

Fuel wood

Wood used to produce energy for industrial, commercial or household use.

Non-timber forest products

Physical, tangible goods of biological origin, other than timber, extracted from the forests.

Forest-related policy

Set of action guidelines and principles adopted by public authorities in alignment with national socioeconomic, environmental policies aimed at leading future decisions in connection with the organization, utilization and conservation of the forest and its resources for the benefit of society.

Forest-related laws (decree or code)

Set of rules enacted by the country's legislative authority to regulate access, organization, conservation and use of forest resources.

Forest income

Any income collected by the State, which comes from domestic production and trade of forest products and services. Forest products include round wood, sawn timber, wood boards, paste and paper, and non-timber forest products.

To the extent possible, it should include income collected at all levels of the State (i.e., central, regional, departmental and municipal level) but the income of public business entities should be excluded.

Tree

Perennial ligneous species with one main trunk or, in the case of low grass, with several stems whose canopy is somewhat defined.

Shrub

Perennial ligneous plant whose height typically surpasses 0.5 meters but does not reach five meters high at maturity and it does not have a defined canopy. Tree and bush height limits are to be interpreted with flexibility, in particular, the minimum tree height as well as the maximum bush height, which may vary from five to seven meters.

Canopy cover

Percentage of land used by the vertical projection of the outermost perimeter of the natural canopy extension of the plant. It should not exceed 100 times 100 (also known as cover closing). Equivalent to the canopy cover.

Forest degradation

A forest's decreased capacity to provide products and services.

Deforestation

Conversion of forests into other types of land use or the reduction of canopy cover to less than the 10% limit.

Plantations

Forest stands established by means of planting and/or sowing during the afforestation and reforestation processes.

Dense forest

Vegetation formations where trees are placed in one or several floors with overlapping canopies. Together with undergrowth, it spreads over a big portion of the terrain, resulting in the soil not having a continuous and dense layer of herbaceous vegetation.

Clear forest

Clear forests are formations with a discontinuous distribution of tree whose canopies do not overlap, but their canopy cover is of at least 10%.

Coniferous forest

Forest terrain where over 75% of its canopy cover is comprised of species from the gymnosperm botanic category. They are often called "softwoods."

Broadleaf forest

Forest terrain where more than 75% of its canopy cover is made up of species from the angiosperm botanic category. They are often called "hardwoods."

Mixed forest

Forests with other forestlands where neither coniferous, broadleaf trees, palm trees nor bamboo trees show more than 75% of canopy cover.

Biological diversity

The variability of living organism from any origin, including terrestrial and marine ecosystems as well as other water ecosystems and the ecological complexes to which they belong. It also includes the diversity within each species and between the species and the ecosystems.

Native species

Species, subspecies or lower taxon that is within its natural distribution area (past or present) and potential dispersion (i.e. within the area it would or could use by natural means without direct or indirect intervention of humans).

Ecosystem services or co-beneficiaries

Supply of food, water, wood, fibers and genetic resources; regulation of services such as climate, floods, diseases, water quality and waste treatment; cultural services, such as recreation and aesthetic and spiritual satisfaction; support services, such as soil formation, pollination and cycle of nutrients.

Reversion risks within the REDD+ context

When CO₂ is sequestered in the new woodland, there is always a risk that the forest may be cut down and/or burned, hence releasing CO₂ back to the atmosphere.

Forest management plan

A planning tool for the correct use and management of the forest, which is recorded in a document containing all aspects pertaining to the mid, long-term planning of the forest.

Management of forests

Activities led by the present and future generations of humankind toward the sustainable development of forests, including the process that values forest utilization as a permanent activity.

Floristic diversity

The total number of species of all sizes and all forms of life in a given area.

Floristic diversity

It is the distribution of individuals among the total number of present species. It is an indicator of mix intensity for forest stand.

Groups of forest species

A set of species using, in the same manner, one or various resources from the environment.

Primary successions

Those that occur over substrata that never had vegetation, such as volcanic materials, sediments deposited by the rivers in alluvial plains and materials that were exposed by landslides. Each substratum is colonized by natural vegetation, hence developing primary successions.

Secondary successions

Those that occur in abandoned sites after natural vegetation is destroyed. They often take place in lands that were cultivated for some time, which were subsequently abandoned. However, any natural phenomenon that destroys a forest prompts secondary succession. For example, the succession that takes place after a hurricane destroys a forest is secondary because there is soil and there used to be vegetation.

Indigenous peoples

Indigenous peoples are the descendants of the people who inhabited the country or a geographical region of the country, during the times of conquest and colonization or the establishment of the current State boundaries, who continue to maintain, regardless their juridical condition, some of the political, cultural, economic and social institutions that belong to them.