Mexico's Forest Reference Emission Level Proposal

Contents

Acronyms

BUR: Biennial Update Report

UNFCCC: United Nations Framework Convention on Climate Change

CTC: Technical Advisory Committee on REDD+

CONAF: National Forestry Council (Consejo Nacional Forestal in Spanish)

CONAFOR: National Forestry Commission (Comisión Nacional Forestal in Spanish)

AD: Activity Data

ENAREDD+: REDD+ National Strategy (Estrategia Nacional REDD+ in Spanish)

ENCC: National Climate Change Strategy (Estrategia Nacional de Cambio Climático in Spanish).

FAO: Food and Agriculture Organization of the United Nations

EF: Emission Factors

FRA: Global Forest Resources Assessment

FCC: Fuel Condition Class

GHG: Greenhouse Gases

WG: Working Groups

INECC: National Institute of Ecology and Climate Change (Instituto Nacional de Ecología y Cambio Climático in Spanish).

INEGEI: National Inventory of Greenhouse Gas Emissions (Inventario Nacional de Emisiones de Gases de Efecto Invernadero in Spanish).

INEGI: National Statistics and Geography Institute (Instituto Nacional de Estadística y Geografía in Spanish).

INFyS: National Forest and Soils Inventory (Inventario Nacional Forestal y de Suelos in Spanish).

LGCC: General Climate Change Law (Ley General de Cambio Climático in Spanish).

LGDFS: General Law for the Sustainable Development of Forests (Ley General de Desarrollo Forestal Sustentable in Spanish).

MRV: Measurement, Reporting, and Verification System.

MASL: Meters Above Sea Level.

NFREL: National Forest Reference Emission Level

IPCC: Intergovernmental Panel on Climate Change

LULUCF: Land Use, Land Use Change and Forestry

REDD+: Reducing Emissions from Deforestation and Forest Degradation, and the role of Conservation, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks.

PSU: Primary Sampling Units.

SSU: Secondary Sampling Units.

1. Introduction

In response to the invitation of the United Nations Framework Convention on Climate Change (UNFCCC), Mexico voluntarily presents a proposal for its National Forest Reference Emission Level in accordance with decision 1/CP.16, paragraph 71(b), as part of the country's adoption of the measures mentioned in paragraph 70 of the same decision (UNFCCC, 2011), for its technical assessment in accordance with the guidelines and procedures adopted in decision 13/CP.19 (UNFCCC, 2014), where the National Forest Reference Emission Level (NFREL) may be technically assessed in the context of results-based finance.

This proposal was prepared in adherence to the guidelines for presenting information on National Forest Reference Emission Levels as indicated in the Annex to 12/CP.17 (UNFCCC, 2012). The information provided follows the guidelines of the Intergovernmental Panel on Climate Change (IPCC), and it includes:

(a) Information used to construct the NFREL;
(b) Transparent, complete, consistent, and accurate information, including methodological information used in constructing the NFREL;
(c) Pools and gases, and activities listed in decision 1/CP.16, paragraph 70, of which were included in the NFREL;
(d) The definition of forest used in the construction of the NFREL.

2. National Context

a) Legal Framework

Mexico has a solid legal framework providing novel tools and structures to meet national objectives on climate change, including those relevant to REDD+. This framework includes the General Law for the Sustainable Development of Forests (DOF, 2003) and the General Climate Change Law (DOF, 2012).

The General Climate Change Law (LGCC, for its acronym in Spanish), published in June 2012, constitutes the main legal instrument establishing the foundations for implementing the mechanisms that will regulate mitigation and adaptation actions in the long term.

Regarding mitigation, the LGCC mandates the National Forestry Commission (CONAFOR, for its acronym in Spanish) to design strategies, policies, measures, and actions to transition to a rate of zero-percent carbon loss in original ecosystems, and to integrate them into forest policy planning, taking into account sustainable development and community forest management[1].

1 Third Transitory Article of the LGCC

As a planning instrument, the LGCC commands the development of the National Climate Change Strategy (ENCC, for its acronym in Spanish), which provides a road map for medium- and long-term national policy to address the effects of climate change and advance toward a sustainable and competitive low-carbon economy (DOF, 2013). Additionally, it establishes a 40-year vision and sets progressive ten-year objectives to realize it.

To increase and maintain forest carbon stocks, the ENCC promotes the expansion of improved agricultural and forestry practices through the design and implementation of plans, programs, and policies oriented towards reducing deforestation and forest degradation under a REDD+ strategy.

On the other hand, the General Law for the Sustainable Development of Forests (LGDFS for its acronym in Spanish) gives CONAFOR the mandate to develop and integrate the information related to the National Forest Monitoring System, e.g. the INFyS. Finally INEGI has the mandate develop the cartographic information of land use and vegetation, according to the Statistic and Geographic National Information System Law[2] .

b) Forest Land Cover

Mexico's territory has a total land area of 1,964,375 square kilometers (km^2), which include a continental area of 1,959,248 km^2 and an insular area of 5,127 km^2.[3] According to CONAFOR (2014), around 45% of the forested area of the country is under a common property regime.

Mexico is considered a megadiverse country, as it is among the 12 States whose territories contain about 70% of the world's biodiversity.

The following paragraphs describe the different vegetation groups found in Mexico according to the classification system proposed by Rzedowski (1978). This grouping is based on the ecological affinities of the vegetation (INEGI, 2009). All the woody vegetation groups are included in the NFREL:

- Coniferous Forest: Plant formations in humid, sub-humid, and temperate zones composed of perennial gymnosperms. In Mexico, they are found from sea level to the timber line (3,000 MASL).
- Oak Forest: Plant communities composed of the genus *Quercus* (oaks). They are found almost from sea level to 2,800 MASL, except in very arid lands. They are highly linked to pine forests, forming a series of mixed forests with species of both genera.
- Mountain Cloud Forest: This plant ecosystem is characterized by the presence of dense arboreal vegetation, epiphytes and ferns. It is located mainly in mountains, cliffs, and places with favorable moisture conditions and fog. In Mexico, it is located at an altitude between 600 and 3,200 MASL.
- Evergreen Forest: It groups tropical plant formations in which more than 75% of their elements retain leaves during the driest period of the year.

2 http://www.diputados.gob.mx/LeyesBiblio/ref/lsnieg.htm
3 www.inegi.org.mx

- Semi-Deciduous Forest: Plant formations in which 50% to 75% of their components lose their leaves during the driest period of the year.
- Deciduous Forest: These are plant formations of arid and tropical origin in which more than 75% of the species that inhabit them lose their leaves during the dry period of the year.
- Xeric Shrublands: This plant ecosystem is characteristic of the arid and semiarid zones of Mexico and is composed of microphyllous and spiny shrub communities.
- Hydrophilous Vegetation: This ecosystem is composed of plant communities that inhabit swamplands and floodlands with shallow brackish or fresh water.

3. Information Used

This NFREL was constructed using information from official sources, mainly the Land Use and Vegetation Series issued by the National Institute of Statistics and Geography (INEGI, 1996, 2005, 2010, and 2013) (table 1), and the National Forest and Soils Inventory (INFyS, for its acronym in Spanish) produced by the National Forestry Commission (CONAFOR, 2012).

a) INEGI's Land Use and Vegetation Series

The INEGI is in charge of providing official statistical and cartographic data at the national level, including Land Use and Vegetation Maps over time (also known as Series)[4]. These maps show the distribution of the different groups and types of vegetation and of land areas used for agriculture, livestock production, and forestry. They include accurate information on the botanical species representative of the vegetation cover and allow experts to identify the state of the vegetation cover throughout the national territory. They are issued on a 1:250,000 scale with a minimum mapping unit of 50 hectares (see Annex d). To date, INEGI has issued 5 Series[5], whose characteristics are shown in Table 1.

Table 1. Main characteristics of the INEGI Series.

	SERIES II	SERIES III	SERIES IV	SERIES V
Publication Date	1996	2005	2010	2013
Remote Sensing Data Dates	1993	2002	2007	2011
Field Data Dates	1993-1998	2002-2003	2007-2008	2012-2013
Scale	1:250,000	1:250,000	1:250,000	1:250,000
Minimum mapping unit	50ha	50ha	50ha	50ha

[4]Declared as information of national interest through an agreement published in the Official Gazette of the Federation (DOF). (http://dof.gob.mx/nota_detalle.php?codigo=5324032&fecha=02/12/2013)

[5]Series I was not analyzed for this REL because the vegetation and land use classes used in this series are not completely compatible with that used in subsequent series.

(Vegetation)				
Resolution	50 m per pixel in origin, interpretation on printed image, 1:250,000 scale	27.5 m per Pixel	10 m per Pixel	27.5 m per Pixel
Data	Georeferenced Printed Maps	LANDSAT TM (30 m)	SPOT 5 (10 m)	LANDSAT TM (30 m)
Methodology	Analog Technology	Digital Technology	Digital Technology	Digital Technology
Information	5 Layers	14 Layers	13 Layers	14 Layers

b) CONAFOR's National Forest and Soils Inventory

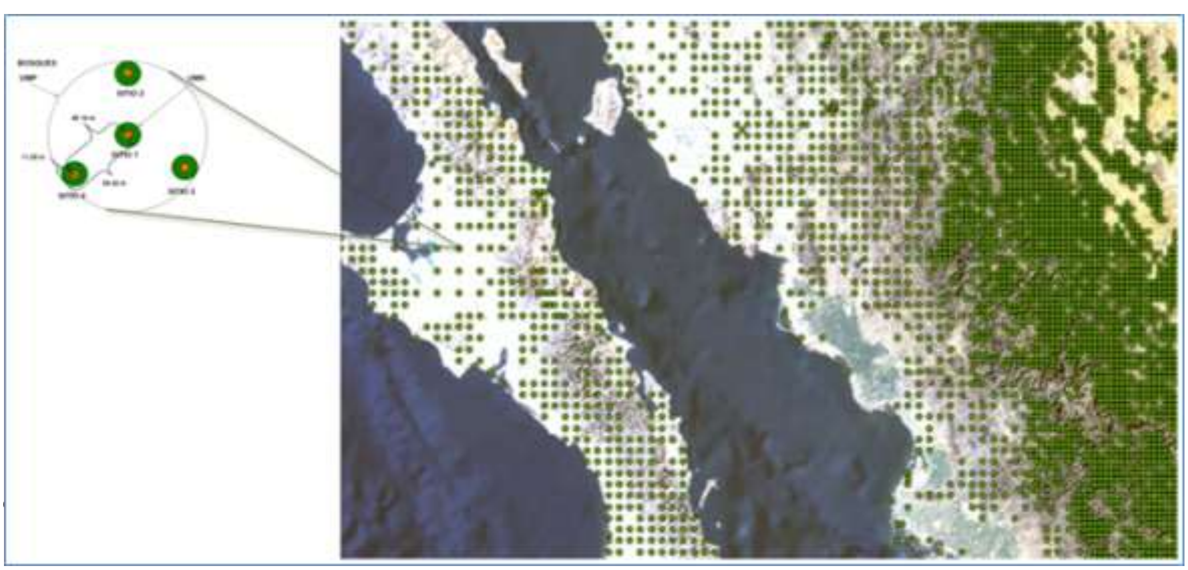
The National Forest and Soils Inventory (INFyS), issued by CONAFOR, is an instrument for forestry management mandated by the General Law for the Sustainable Development of Forests (LGDFS for its acronym in Spanish).

The INFyS is the main input for estimates in some categories of land use, especially those related to forestry. It comprises 26,220 plots distributed systematically throughout the country (Figure 1) in 5x5 km spacing in forests and jungles, 10x10 spacing in semiarid communities, and 20x20 km spacing in arid communities. Each plot consists of four sub-plots of an area of 0.04 hectares each in which the dasometric information is collected in the field (CONAFOR, 2012).

The INFyS has a five-year cycle for gathering field data. To this date, two cycles have been completed: the first from 2004 to 2007 and the second from 2009 to 2013.

For INFyS sampling and re-sampling, there is information available at the sub-plot level concerning the dasometric measurements of all trees.

Figure 1. Layout of INFyS plots and sub-plots and their systematic distribution



4. Estimation Methods

a) Activity Data (Consistent Representation of Lands)

The classification and hierarchical structure of INEGI's cartography was used to establish correspondence between the vegetation cover classes used in the country and the categories of the IPCC (2003) (INEGI, 2009).

Ensuring consistency with the inventory included in the Biennial Update Report (INECC-CONAFOR, 2014) to be submitted to the UNFCCC, the grouping proposal for the Land Use, Land Use Change, and Forestry (LULUCF) sector includes 19 groups in forest lands, 6 in grasslands, 2 in croplands, 1 in wetlands, 1 in settlements, and 1 in other lands. Figure 2 graphically represents how classes in the INEGI Series were grouped into IPCC categories.

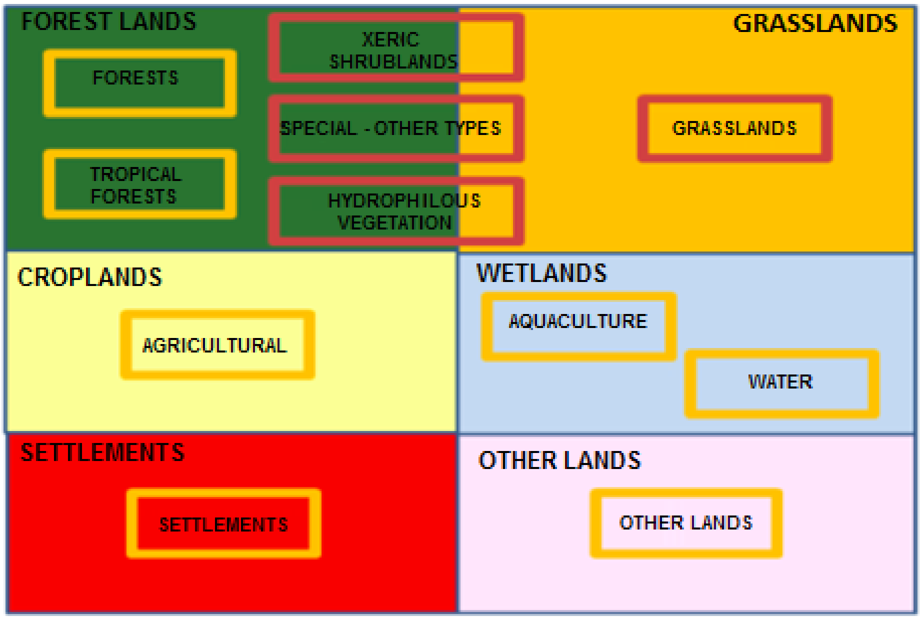


Figure 2. Graphic representation of the INEGI Series vegetation groups classified into IPCC Categories.

The criteria to define the vegetation groups and types[6] that correspond to the category of forest land that were used in this report to estimate gross deforestation are:

- INEGI Vegetation Group, which refers to a hierarchical level above vegetation types and types of agroecosystems
- Stage (Primary and Secondary)
- INEGI Development Phase (arboreal, shrub and herbaceous)
- Separation of vegetation groups (according to INEGI) into subcategories corresponding to a dominance of woody (arboreal and shrub) elements and non-woody (herbaceous) elements at different phases of development (IPCC-INEGI).
- IPCC Criteria (IPCC, 2003) for Land Use, Land Use Change, and Forestry (LULUCF) Categories

The forest land category includes all land with woody vegetation within the thresholds used to define forest land in the National Inventory of Greenhouse Gas Emissions (INEGEI). These vegetation systems are subdivided nationally into cultivated and uncultivated lands and by type of ecosystem, as specified in the IPCC guidelines. This category also comprises systems with woody vegetation currently below the forest land category threshold, including any land with the ecological capacity to reach this threshold. Table 2 shows the categories regarded as forest land.

Table 2. INEGI vegetation groups and development stage included in the IPCC Forest Land Category criteria, with corresponding vegetation types of INEGI.

Vegetation Group (INEGI-IPCC)	Vegetation Type (INEGI)
Coniferous Forest (Primary and Secondary Arboreal Vegetation)	Primary Fir Forest, Arboreal Secondary Fir Forest, Primary Cypress Forest, Arboreal Secondary Cypress Forest, Primary Juniper Forest, Arboreal Secondary Juniper Forest, Primary Pine Forest, Arboreal Secondary Pine Forest, Primary Mixed Pine-Oak Forest, Arboreal Secondary Mixed Pine-Oak Forest, Primary Douglas Fir Forest, Arboreal Secondary Douglas Fir Forest, Primary Conifer Shrub land

[6] The description found in the Guide for Interpreting Land Use and Vegetation Cartography (INEGI, 2009) was considered.

Secondary Conifer Forest (Secondary Shrub and Herbaceous)	Shrub Secondary Fir Forest, Herbaceous Secondary Fir Forest, Shrub Secondary Cypress Forest, Herbaceous Secondary Cypress Forest, Shrub Secondary Juniper Forest, Herbaceous Secondary Juniper Forest, Shrub Secondary Pine Forest, Herbaceous Secondary Pine Forest, Shrub Secondary Mixed Pine-Oak Forest, Herbaceous Secondary Mixed Pine-Oak Forest, Shrub Secondary Douglas Fir Forest, Herbaceous Secondary Douglas Fir Forest, Secondary Conifer Shrub land.
Primary Oak Forest	Primary Oak Forest, Arboreal Secondary Oak Forest, Primary Mixed Oak-Pine Forest, Arboreal Secondary Mixed Oak-Pine Forest
Secondary Oak Forest	Herbaceous Secondary Oak Forest, Shrubby Secondary Oak Forest, Secondary Shrubby Mixed Oak-Pine Forest, Herbaceous Secondary Mixed Oak-Pine Forest
Primary Mountain Cloud Forest	Primary Mountain Cloud Forest, Arboreal Secondary Mountain Cloud Forest
Secondary Mountain Cloud Forest	Shrubby Secondary Mountain Cloud Forest, Herbaceous Secondary Mountain Cloud Forest
Primary Evergreen Tropical Forest	Primary Evergreen Tropical Forest, Arboreal Secondary Evergreen Tropical Forest, Thorny Primary Semi-Evergreen Tropical Forest, Thorny Arboreal Secondary Semi-Evergreen Tropical Forest, Primary Semi-Evergreen Tropical Forest, Arboreal Secondary Semi-Evergreen Tropical Forest,
Secondary Evergreen Tropical Forest	Shrubby Secondary Evergreen Tropical Forest, Herbaceous Secondary Evergreen Tropical Forest, Shrubby Secondary Semi-Evergreen Tropical Forest, Herbaceous Secondary Semi-Evergreen Tropical Forest, Thorny Shrubby Secondary Semi-Evergreen Tropical Forest, Thorny Herbaceous Secondary Semi-Evergreen Tropical Forest,
Primary Semi-Deciduous Tropical Forest	Primary Semi-Deciduous Tropical Forest, Arboreal Secondary Semi-Deciduous Tropical Forest,
Secondary Semi-Deciduous Tropical Forest	Shrubby Secondary Semi-Deciduous Tropical Forest, Herbaceous Secondary Semi-Deciduous Tropical Forest,
Primary Deciduous Tropical Forest	Primary Subtropical Shrubland, Primary Deciduous Tropical Forest, Arboreal Secondary Deciduous Tropical Forest, Thorny Primary Deciduous Tropical Forest, Thorny Secondary Deciduous Tropical Forest, Primary Tropical Mezquite Shrubland, Arboreal Secondary Tropical Mezquite Shrubland
Secondary Deciduous Tropical Forest	Shrubby Secondary Deciduous Tropical Forest, Herbaceous Secondary Deciduous Tropical Forest, Thorny Shrubby Secondary Deciduous Tropical Forest, Thorny Herbaceous Secondary Deciduous Tropical Forest, , Shrubby Secondary Tropical Mezquite Shrubland, Herbaceous Secondary Tropical Mezquite Shrubland, Shrubby Secondary Subtroptical Shrubland, Herbaceous Secondary Subtroptical Shrubland,
Primary Xeric Shrubland	Primary Succulent Shrubland, Primary Microphyllous Desert Shrubland, Rosette-Like Microphyllous Desert Shrubland, Primary Tamaulipan Thorny Shrubland, Primary Xeric Mezquite Shrubland, Chaparral, Primary Coastal Rosette-Like Desert Shrubland, Primary Sarcocaulous Shrubland, Primary Sarco-Succulent Shrubland, Primary Submountainous Shrubland, Arboreal Secondary Submountainous Shrubland, Primary Misty Sarco-Succulent Shrubland,
Secondary Xeric Shrubland	Shrubby Secondary Succulent Shrubland, Herbaceous Secondary Succulent Shrubland, Shrubby Secondary Microphyllous Desert Shrubland, Herbaceous Secondary Microphyllous Desert Shrubland, Shrubby Secondary Rosette-Like Desert Shrubland, Herbaceous Secondary Rosette-Like Desert Shrubland, Thorny Shrubby Secondary Tamaulipan Shrubland, Thorny Herbaceous Secondary Tamaulipan Shrubland, Shrubby Secondary Xeric Mezquite Shrubland, Herbaceous Secondary Mezquite Shrubland, Shrubby Secondary Chaparral, Shrubby Secondary Coastal Rosette-Like Shrubland, Herbaceous Secondary Coastal Rosette-Like Shrubland, Shrubby Secondary Sarcocaulous Shrubland, Herbaceous Secondary Sarcocaulous Shrubland, Shrubby Secondary Sarco-Succulent Shrubland, Herbaceous Secondary Sarco-Succulent Shrubland, Shrubby Secondary Submountainous Shrubland, Herbaceous Secondary Submountainous Shrubland, Shrubby Secondary Misty Sarco-Succulent Shrubland, Herbaceous Secondary Misty Sarco-Succulent Shrubland
Primary Hydrophilous Vegetation	Primary Gallery Vegetation, Primary Gallery Forest, Arboreal Secondary Gallery Forest, Primary Peten Vegetation, Arboreal Secondary Peten Vegetation, Primary Gallery Tropical Forest, Arboreal Secondary Gallery Tropical Forest, Primary Mangrove Forest, Arboreal Secondary Mangrove Forest
Secondary Hydrophilous Vegetation	Shrubby Secondary Gallery Forest, Herbaceous Secondary Gallery Forest, Shrubby Secondary Peten Vegetation, Herbaceous Secondary Peten Vegetation, Shrubby Secondary Gallery Tropical Forest, Herbaceous Secondary Gallery Tropical Forest, Shrubby Secondary Gallery Vegetation, Herbaceous Secondary Gallery Vegetation, Shrubby Secondary Mangrove Forest, Herbaceous Secondary Mangrove Forest,
Special - Other Primary Types	Primary Mezquite Forest, Arboreal Secondary Mezquite Forest, Primary Natural Palm-Tree Forest, Arboreal Secondary Natural Palm Tree Forest, Induced Tree Plantation
Special - Other	Shrubby Secondary Mezquite Forest, Herbaceous Secondary Mezquite Forest, Induced Palm-Tree Forest,

Primary Secondary Types	Herbaceous Secondary Natural Palm-Tree Forest, Shrubby Secondary Natural Palm-Tree Forest
Planted forest	Tree Plantation

The cartographic information contained in the Land Use and Vegetation maps at a scale of 1:250,000 in Series II, III, IV, and V prepared by the INEGI were originally issued and are currently distributed in vector format, where Land Use and Vegetation units are represented with polygons.

In annex d it the process to develop each one of the INEGI series is described, it is important to highlight each map is actualized based in the previous one, the minimum cartographical unit was always the same from series I (50ha), and are developed based on visual interpretation of change areas, and field verification; no semi-automatic or automatic methods were used to do these maps.

The process to analyze the cartographic products converted by INEGI from analog to digital format considered that the mechanisms for perception and analysis of digital data differ from those used for analog data, and even though they can be visualized on graphic monitors, their analysis was performed fundamentally through a combination of statistical and geometric methods and database inquiry.

Geospatial data was processed using the software ArcGIS 10.1© (ESRI©, 2012). The first step was to integrate the vector data from the Land Use and Vegetation Maps (scale 1:250,000) of Series II, III, IV, and V.

Fields were added to the database of each Series in order to assign the categories and subcategories of the national land system applicable to the six LULUCF categories of the IPCC. Subsequently, vector databases were restructured, leaving only the information of the national land classification system applicable to the six LULUCF categories of the IPCC. All the Series were joined spatially by geometrically overlaying and intersecting them through the command "UNION" in ArcGIS©.

After performing the data analysis in vector format, it was determined that using a *raster* format with a cell size of 100x100 meters (one hectare) would eliminate most problems related to displacements between Series. Consequently, vector data was converted to raster format using a cell size of 100x100 meters and the IPCC categories as the main field. This analysis rendered the following land use and vegetation change matrix (Figure 3).

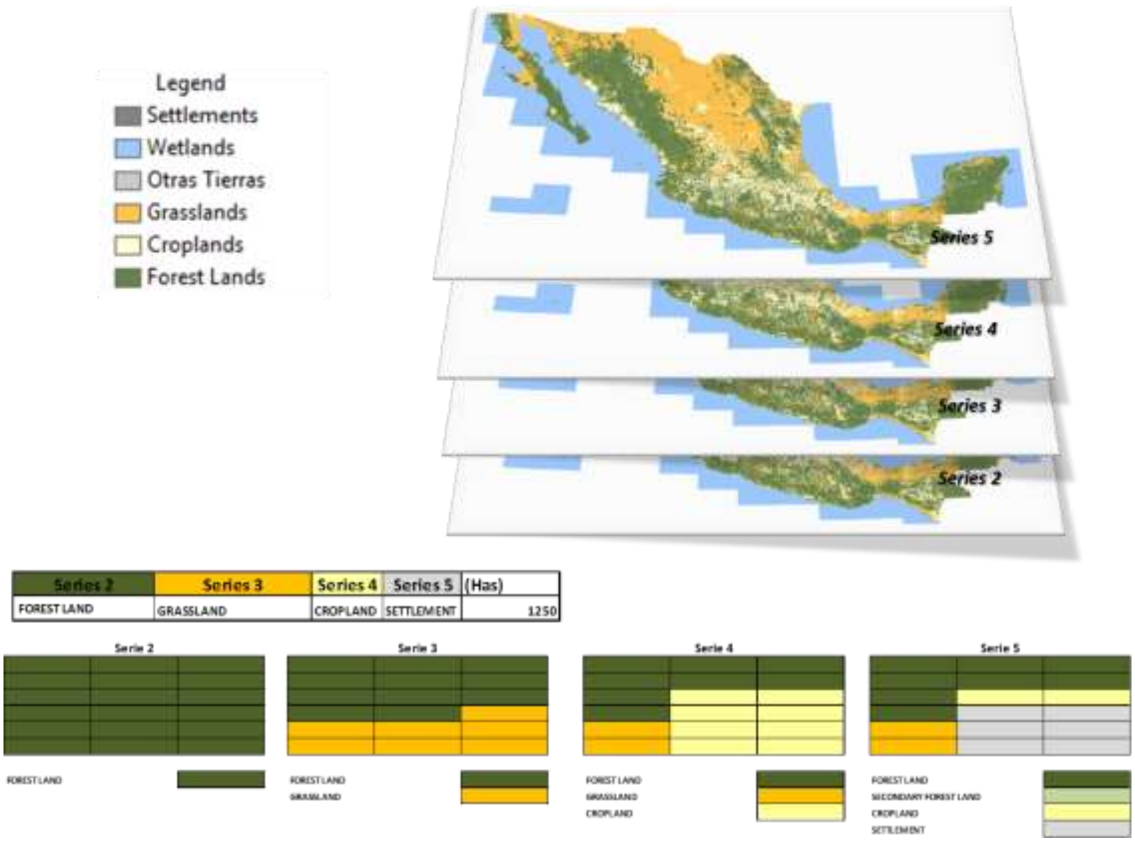


Figure 3. Raster files and the attribute table of the combination of Series II to V

The results were presented in three change matrices, each describing a period of comparison between Series table 3:

- Period 1. Comparison between Land Use and Vegetation of Series II and III
- Period 2. Comparison between Land Use and Vegetation of Series III and IV
- Period 3. Comparison between Land Use and Vegetation of Series IV and V

Table 3. Annual deforestation by vegetation group for each period of time

ANNUAL AREA DEFORESTED (Ha)			
VEGETATION GROUP	**1993-2002**	**2002-2007**	**2007-2011**
Primary Conifer Forest	41,358	46,767	8,698
Secondary Conifer Forest	20,177	24,744	9,668

Primary Oak Forest	28,339	43,374	14,360
Secondary Oak Forest	31,788	39,934	14,728
Primary Cloud Forest	4,327	3,283	1,025
Secondary Cloud Forest	5,944	3,871	1,917
Special - Other Primary Woody Ecosystems	7,971	3,030	1995
Special - Other Secondary Woody Ecosystems	1,916	2,473	1842
Primary Woody Xeric Shrublands	57,386	58,644	54,091
Secondary Woody Xeric Shrublands	14,904	24,113	27,374
Primary Deciduous Tropical Forest	55,385	73,341	50,723
Secondary Deciduous Tropical Forest	92,797	147,842	45,573
Primary Evergreen Tropical Forest	55,100	68,034	35,488
Secondary Evergreen Tropical Forest	54,446	63,440	28,086
Primary Semi-Deciduous Tropical Forest	13,323	23,495	19,156
Secondary Semi-Deciduous Tropical Forest	24,272	32,561	28,835
Primary Woody Hydrophilous Vegetation	13,265	9,526	4,202
Secondary Woody Hydrophilous Vegetation	164	266	252
Total	522,862	668,738	348,013

The database resulting from the integration of the Land Use and Vegetation Series II, III, IV, and V using the report categories in the National Greenhouse Gas Emissions Inventory (INEGEI) was exported to MS Excel, as this format and application allows for the use of dynamic tables to aggregate land use and vegetation changes between Series.

Figure 4 illustrates the matrix used to identify the surface area values for each category of change. The matrix identifies the areas whose primary condition changed to a secondary one, implying a loss of carbon on forest lands (degradation). It also identifies the different categories of forest lands that changed to non-forest lands due to the expansion of agriculture and human settlements, indicating deforestation.

In contrast to the previous processes, the matrix shows the areas whose secondary condition changed to a primary one, indicating processes of forest recovery. Moreover, it records the areas where non-forest lands changed to forest lands (primary or secondary) through reforestation processes.

Finally, this matrix shows the areas with no recorded changes in land use (cells in yellow).

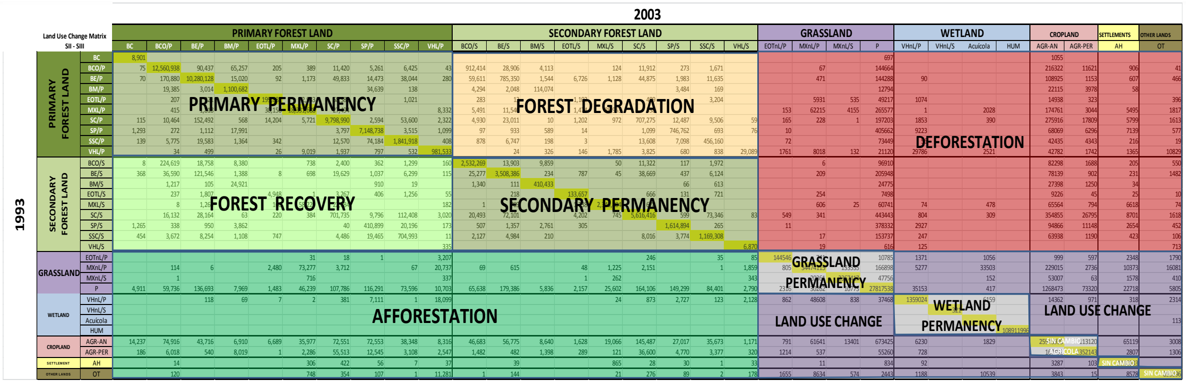


Figure 4. Matrix used to identify the different transitions of land use change

The methodology for the consistent representation of lands is documented in greater detail as part of the formulation of the INEGEI for the BUR (Reinforcing REDD+ Readiness in Mexico and Enabling South-South Cooperation, 2014a)

b) Emission Factors

The estimation process of emission factors (EF) included three stages: the first stage involved obtaining the carbon values of each tree measured by the INFyS; the second stage involved grouping INFyS plots into the land use and vegetation groups defined as forest lands; the third stage consisted in estimating the EF and their uncertainties (those associated with carbon in live biomass) for each of the classes defined as forest lands.

The content of carbon in live biomass at tree level was calculated using the stem measurements (>7.5 cm of diameter at breast height) of woody plants (trees and shrubs) collected by INFyS field samplings between 2004 and 2007 (CONAFOR, 2012). The estimate used the dasometric data measured in 18,780 Primary Sampling Units (PSU), which included 70,868 Secondary Sampling Units (SSU) with dasometric data from 1,137,872 records of live woody plants (trees and shrubs) and 68,300 records of standing dead woody plants (trees and shrubs).

Prior to estimating tree-level carbon, a quality control protocol was applied to INFyS records of woody plants (tree and shrubs). This protocol included: a) reviewing the nomenclature of species, and b) debugging the dasometric information.

To estimate the biomass contained in each live woody plant, an algorithm was employed to assign allometric models (Figure 5). A total of 83 allometric models (available at the level of species, genera, or vegetation type) suitable for the country in ecological, statistical, and spatial terms were used (Reinforcing REDD+ Readiness in Mexico and Enabling South-South Cooperation, 2014b). The allometric model database used to perform biomass estimation is available for review at: http://www.mrv.mx/index.php/es/mrv-m/areas-de-trabajo/2013-09-17-22-03-45

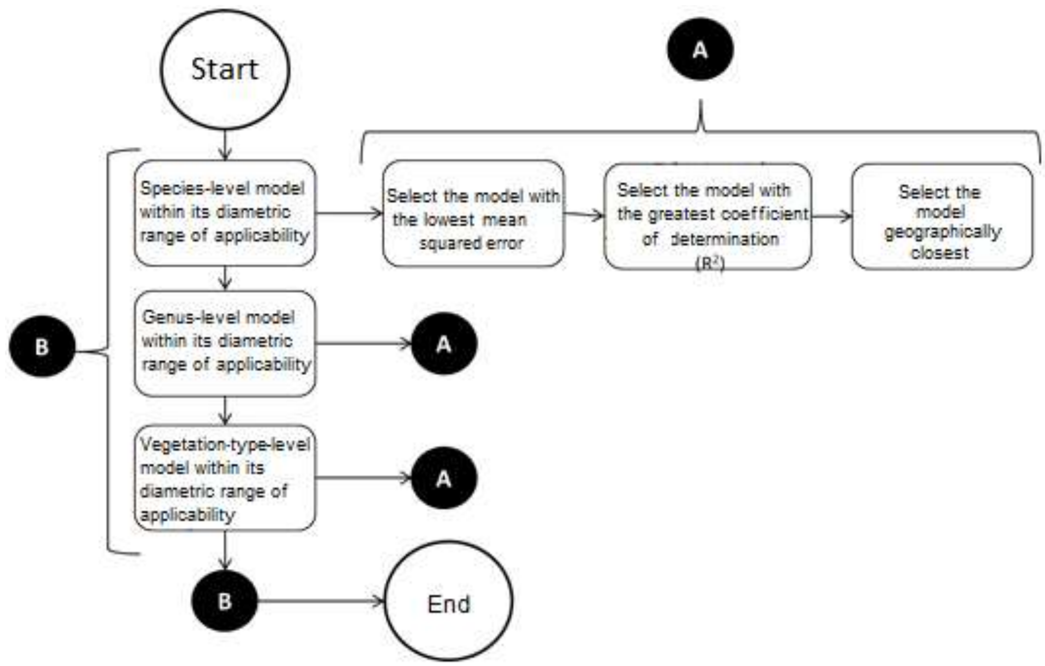


Figure 5. Decision tree algorithm used to assign allometric models to estimate tree-level biomass

To quantify below-ground biomass (roots), the allometric equations of Cairns *et al* (1997) were employed as a function of above-ground woody biomass by type of ecosystem; it is important to notice that the equations reported by Cairns are the same that are in the IPCC 2003, chapter 4.

Using the biomass estimates obtained, a carbon fraction was assigned to each record (species, genus, and plant group) from the 56 carbon fractions found in the literature that are applicable to species in the country. When there was no carbon fraction available for a given record at the level of the species, genus, and/or vegetation type, an average fraction of 0.48% was assigned. This number was calculated from the data obtained from the records of carbon fractions found in literature at the national level[7].

Once aboveground woody biomass carbon was estimated at tree-level, the carbon of all the trees measured within each INFyS sub-plot was added to obtain the total aerial biomass at the sub-plot level (Figure 6). To estimate the total carbon (at the sub-plot level) in root biomass, a procedure analogous to the one used for above-ground woody biomass was followed.

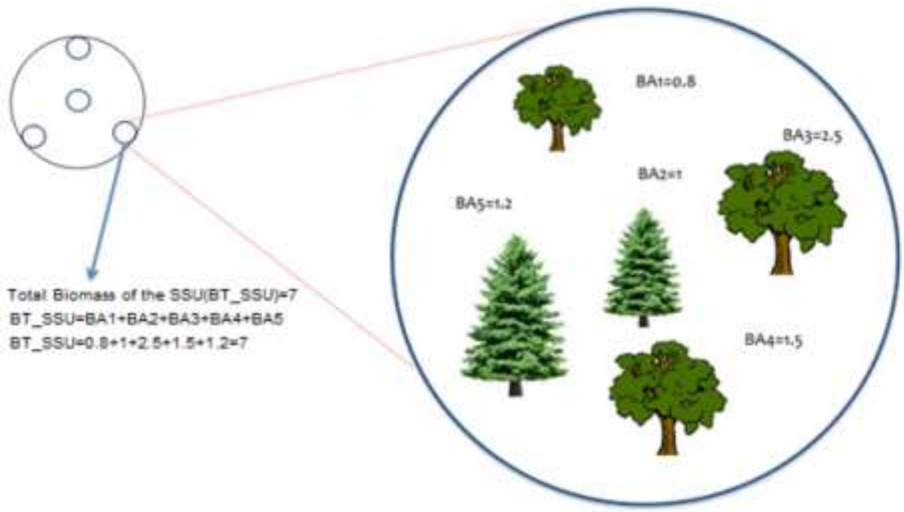


Figure 6. Estimate of total above-ground woody biomass at the sub-plot level

After estimating the total carbon at the sub-plot level for each carbon stock (above-ground woody biomass and roots), the INFyS plots were grouped according to their forest vegetation groups. Since the plots are georeferenced, it was possible to identify the vegetation group to which each one belonged using INEGI Series IV. Table 4 shows the grouping of INFyS plots and sub-plots by vegetation groups.

Table 4. Number of plots sampled for the National Forest and Soils Inventory (INFyS) with available information by forest vegetation group category

Vegetation groups	Sampling (2004-2007)	
	Number of Plots	Number of Sub-plots
Primary Conifer Forest	4404	16800
Secondary Conifer Forest	1137	4203
Primary Oak Forest	3365	12756
Secondary Oak Forest	1466	5477
Primary Cloud Forest	357	1145

[7] Protocol to Estimate Carbon Contents and Changes in Carbon Contents, Project to Strengthen REDD+ Capabilities and South-South Cooperation, CONAFOR 2014

Secondary Cloud Forest	160	553
Special - Other Primary Woody Ecosystems	32	123
Special - Other Secondary Woody Ecosystems	31	120
Primary Woody Xeric Shrublands	1484	5811
Secondary Woody Xeric Shrublands	198	767
Primary Deciduous Tropical Forest	939	3495
Secondary Deciduous Tropical Forest	613	2293
Primary Evergreen Tropical Forest	2375	9030
Secondary Evergreen Tropical Forest	585	2060
Primary Semi-Deciduous Tropical Forest	993	3826
Secondary Semi-Deciduous Tropical Forest	491	1848
Primary Woody Hydrophilous Vegetation	246	919
Secondary Woody Hydrophilous Vegetation	17	66
Total	**18,901**	**71,320**
Source: Prepared with data from the INFyS (2004-2007) and Series IV with INEGI vegetation groups into the subcategories of the National Greenhouse Gas Emissions Inventory.		

The EF ratio estimators and their uncertainties were calculated for each carbon stock (above-ground woody biomass and roots biomass) in forest lands based on the grouping of INFyS sampling plots described above.

The EF was estimated for "Forest Lands" that changed to "Other Land Uses." Therefore, to obtain the estimators, it was assumed that the lands subject to such deforestation process lost all the carbon (from both above-ground woody biomass and roots) they stored. Accordingly, the average carbon densities (ton/ha) and their uncertainties were estimated for each vegetation groups and it was assumed that these values, calculated at the national level, represent local-level emissions in deforestation zones.

To obtain these estimates, carbon data at the sub-plot level from the first INFyS cycle (2004-2007) was used, having filtered beforehand the plots that do not belong to "Forest Lands" according to the IPCC (2003) classification of "Lands Uses". In this manner, the estimators were constructed using a total sample size of 18,901 plots with 71,320 sub-plots out of the 26,220 plots present in the INFyS (Figure 6 and Table 3).

After identifying the subset of plots with which the estimation would be carried out, the estimators and their uncertainties were obtained.

The expression of this estimator is shown in the following equation:

$$\widehat{R}_k = \frac{\sum_{i=1}^{n_k} y_{ik}}{\sum_{i=1}^{n_k} a_{ik}} \qquad \text{Eq (1)}$$

In which:

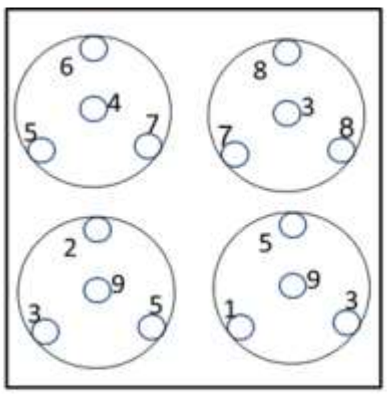
$\widehat{R}_k$ = Carbon estimator of stratum k.

y_{ik} =Total carbon in the sub-plot/site (or SSU) i of stratum k.

a_{ik} =Surface area sampled in the sub-plot/site (or SSU) i (400m2) of stratum k.

n_k =Total number of sites in stratum k.

The plot “ratio estimator” is directly used in calculating carbon content for each vegetation group of forest land defined for the country. The procedure consists of using the group of plots belonging to each vegetation group to determine the carbon content adjusted to their areas in order to obtain the emission and removal factors at the national level (Velasco-Bautista *et al*., 2003). Figure 7 illustrates a group of plots forming a stratum and how they are aggregated to quantify carbon using ratio estimators.



$$\widehat{R} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} a_i}$$

$$\hat{R} = \frac{5+6+4+7+7+8+3+8+3+2+9+5+1+5+9+3}{0.04 \times 16}$$

$$\hat{R} = \frac{85}{0.64} = 132.8$$

Figure 7.Example of the use of ratio estimators to calculate carbon with an INFyS data for each vegetation group.

The 2006 IPCC Guidelines were followed to estimate the uncertainties of each EF. Accordingly, Equation 3 bellow shows the expression used to estimate them:

$$U_k = \frac{{IC_k}/{2}}{\bar{R}_k} \times 100 \qquad \text{Eq (2)}$$

In which:

U_k: Uncertainty of the carbon estimator of vegetation group$k$.

$\bar{x}_k$: Carbon estimator of vegetation group$k$.
IC_k: Interval of the carbon estimator of vegetation group k.

Where IC_k is in function of the variance of $\hat{R}_k$:

$$\hat{R}_k - 1.96\sqrt{\hat{V}(\hat{R}_k)} \leq R_k \leq \hat{R}_k + 1.96\sqrt{\hat{V}(\hat{R}_k)}$$

And $\hat{V}(\hat{R}_k)$ is defined as shown in Equation 3 (Velasco-Bautista *et al.*, 2003):

$$\hat{V}(\hat{R}_k) = \left(\frac{1}{n_k(n_k-1)\bar{a}^2}\right)\left(\sum_{i=1}^{n_k} y_{ik}^2 - 2\,\hat{R}_k \sum_{i=1}^{n_k} y_{ik}a_{ik} + \hat{R}_k{}^2 \sum_{i=1}^{n_k} a_{ik}^2\right) \qquad \text{Eq (3)}$$

Where:

$\hat{R}_k$, y_{ik}, a_{ik} and n_k were defined previously.

$$\bar{a} = \frac{\sum_{i=1}^{n} a_i}{n}$$

The management of the databases and estimation processes was programmed and executed using the statistical software R.

Table 5, shows emission factor estimates and their respective uncertainties related to above-ground woody biomass and root carbon for the lands that changed from "Forest Lands" to Other Land Uses (grasslands, croplands, statements, other lands). As observed, the estimates behave in a consistent manner between subcategories and within subcategories (primary/secondary). For example, the carbon content averages of coniferous forests are higher than averages found in oak forests; within the vegetation group of oak forests, the average carbon in primary forests is greater than that of secondary forests. Additionally, Table 5 provides evidence of estimates being obtained from large sample sizes, rendering low uncertainties (Reinforcing REDD+ Readiness in Mexico and Enabling South-South Cooperation, 2014c). These values estimated with national data are consistent with IPCC (2006) default data presented in table 3A.1.2 (our values are under the IPCC range, after the conversion to C).

Table 5. Emission factors and their uncertainties for carbon from above-ground woody biomass and roots from "Forest Lands" that changed to "Other Uses"

Vegetation group	Carbon in Above-ground Woody Biomass (ton/ha)	Uncertainty (%)	Carbon in Roots (ton/ha)	Uncertainty (%)
Primary Conifer Forest	33.6	2	8.0	2
Secondary Conifer Forest	22.1	5	5.4	5
Primary Oak Forest	20.7	3	5.6	3
Secondary Oak Forest	14.7	5	4.0	5
Primary Cloud Forest	37.7	10	9.4	9
Secondary Cloud Forest	18.1	19	4.7	18
Special - Other Primary Woody Ecosystems	3.5	95	0.8	92
Special - Other Secondary Woody Ecosystems	4.6	56	1.2	53
Primary Woody Xeric Shrublands	4.3	9	1.1	8

Secondary Woody Xeric Shrublands	3.2	29	0.8	27
Primary Deciduous Tropical Forest	17.4	5	4.3	5
Secondary Deciduous Tropical Forest	12.6	8	3.1	7
Primary Evergreen Tropical Forest	40.4	3	9.5	3
Secondary Evergreen Tropical Forest	19.7	9	4.8	9
Primary Semi-Deciduous Tropical Forest	30.2	5	7.3	4
Secondary Semi-Deciduous Tropical Forest	16.1	9	4.0	8
Primary Woody Hydrophilous Vegetation	13.3	22	3.2	21
Secondary Woody Hydrophilous Vegetation	8.1	66	2.0	64

For the estimations made for the conversion from forestland to grassland, based on the documentation consulted, it's considered that there is not an increase in woody biomass in the year immediately after the conversion; the IPCC 2006 guidelines consider that if there's any increase, it is generally in non woody biomass. It is widely known that the conversion from forestland to grass land leaves the soil surface fragile and exposed to erosive processes that cause low productivity, affecting the recovery process and the capacity of storing carbon in the woody component.

Biomass stocks in grasslands tend to level off after a few years after conversion, depending on the type of land conversion (IPCC, 2003), indicating that it is not immediate. Most prairie especially in growing native grasses absorb considerably less carbon than almost all forest land and agricultural systems (FAO, 2007). Additionally, as the information used corresponds to country information of the categories Forest land and grassland, it was decided that it was best to avoid the combination of this national factors with default factors.

In order to be consistent with the estimations of the methodological framework used for the transition of forest land to grassland; the same approach was considered for the other transitions of forestland. This means that if the forest changed to another land use (croplands, statements and other lands) the first year after the conversion did not have any growth.

c) Propagation of Uncertainty

The propagation of uncertainty was developed from the combination of uncertainties of the annual variations in carbon for each transition grouped in the transition "Forest Lands" that changed to "Other Land Uses."

To combine the uncertainties of the annual carbon variations at the level of transition, first the uncertainties were estimated for each variation by vegetation group (carbon in above-ground woody biomass and roots). To do this, the EF and their respective uncertainties (whose estimation is described in the Emission Factors section) were taken as an input. These EF and uncertainties are reported according to the vegetation groups (classes) defined in the Activity Data (AD) section.

The propagation method used was the analytical method (*Method 1: Error Propagation)* of the IPCC (2006). It was chosen because it is easy to implement and suitable for the information related to EF available. It is worth mentioning that, currently, the uncertainties related to Activity Data are unavailable, this was another reason for choosing Method 1 of the IPCC. Consequently, the complete propagation of uncertainties for all levels was carried out by consecutively implementing the combination of uncertainties for addition and subtraction as indicated by IPCC in one of the combination options of Method 1.

Combination of Uncertainties at the vegetation group in the Deforestation Transition

The estimate for carbon variations at the level of this transition was obtained by adding the variations in the above-ground woody biomass and in the root biomass for each vegetation group. The variations in each of these transitions (deforestation) resulted from weighting the EF of each class by their respective area (see Equation 4).

$$ABVA_{kij} = FA_{BVA_{kij}} \times A_{BVA_{kij}} \qquad \text{Eq (4)}$$

Where:

$ABVA_j$: Carbon variation in above-ground live biomass of vegetation group j of the transition analyzed
FA_{BVA_j}: Carbon Emission Factor of the live biomass of vegetation group j of the transition analyzed
A_{BVA_j}: Area of FA_{BVA_j} of transition j of the vegetation group analyzed

As observed in the equation above, the variation in carbon of the above-ground live biomass (ABVA) was the result of multiplying a variable (the EF) and a constant (the area). Therefore, the uncertainty of the ABVA directly inherits the properties of the EF's uncertainty, as the area is a constant. Additionally, the uncertainties are in function of the variance of the estimator; therefore, the properties of the variance for the EF were used to propagate the uncertainties. The EF for this IPCC transition were obtained from the ratio estimators (Velasco, 2003) and this estimator has the property that, when weighted by a constant, the product variance ($FA_{BVA_{ij}} \times A_{BVA_{ij}}$) is equal to the EF variance multiplied by the square of the constant (Velasco, 2003). This process is shown in Equation 5.

$$var(ABVA_j) = \left(A_{BVA_j}\right)^2 \times var\left(FA_{BVA_j}\right) \qquad \text{Eq (5)}$$

Where:

$Var(ABVA_j)$: Variance of $ABVA_j$.

$var\left(FA_{BVA_j}\right)$: Variance of FA_{BVA_j},, defined in the protocol for estimating emission factors and uncertainties (Reinforcing REDD+ Readiness in Mexico and Enabling South-South Cooperation, 2014c)

Once the variance of ABVA was obtained for each vegetation group, its uncertainties were estimated by following the IPCC Guidance (2003) as laid out in Equation 6.

$$U_{ABVA_j} = \frac{1.96 \times \sqrt{var(ABVA_j)}}{ABVA_j} \times 100 \qquad \text{Eq (6)}$$

Where:

U_{ABVA_j}: Uncertainty of ABVA of vegetation group j of the transition analyzed.
$var(ABVA_j)$ and $ABVA_j$: Previously defined.

It must be mentioned that, at the class level, uncertainties for variations in root biomass carbon (ABVR) were estimated in a manner analogous to what is displayed for ABVA.

To obtain live biomass by class, the above-ground woody biomass and the biomass in roots were added up. Therefore, after estimating the uncertainties of the ABVR and the ABVA, they were propagated by combining the uncertainties through addition, as indicated in Method 1 of the IPCC. In this manner, the uncertainties of ABV by transition (deforestation) were estimated as shown in Equation 7.

$$U_{ABV_j} = \frac{\sqrt{\left(U_{ABVA_j} \times ABVA_j\right)^2 + \left(U_{ABVR_j} \times ABVR_j\right)^2}}{\left|ABVA_j + ABVR_j\right|} \qquad \text{Eq (7)}$$

Where:

U_{ABV_j}: Uncertainty of carbon changes of live biomass of vegetation group j of the transition analyzed
$ABVR_j$: Carbon changes of biomass in roots of vegetation group j of the transition analyzed
U_{ABVR_j}: Uncertainty of $ABVR_j$.
U_{ABVA_j} and $ABVA_j$: Previously defined

In the case of "Forest Lands" that changed to "Croplands," the EF of "Croplands" was subtracted from the EF of the estimated live biomass at the transition level. Therefore, the EF used for this transition was the result of a subtraction, hence, the uncertainty of this subset of factors was obtained by propagating its respective uncertainties as shown in Equation 7, but for the subtraction.

Propagation of Uncertainty of Variations at the Transition Level due to Deforestation

The estimate of variations at the transition level results from the addition of the variations at the vegetation group level (see Equation 8).

$$ABV = \sum_{j=1}^{n_i} ABV_j \qquad \text{Eq (8)}$$

Where:

ABV: Total carbon change for live biomass of the transition analyzed
ABV_j: Carbon change of live biomass of vegetation group j of the transition analyzed
n_i: Number of vegetation groups in the transition analyzed

As observed in Equation 9, the ABV of the transition analyzed is the result of the addition of ABV of each one of its transitions. Therefore, the uncertainty was propagated by combining the uncertainties through the addition shown in IPCC Method 1:

$$U_{ABV} = \frac{\sqrt{(U_{ABV_1} \times ABV_1)^2 + (U_{ABV_2} \times ABV_2)^2 + \cdots + (U_{ABV_{n_i}} \times ABV_{n_i})^2}}{|ABV_1 + ABV_2 + \cdots + ABV_{n_i}|} \qquad \text{Eq (9)}$$

Where:

U_{ABV}: Uncertainty for total carbon change for live biomass of the transition analyzed
U_{ABV_1}: Uncertainty of the ABV of vegetation group 1 of the transition analyzed
U_{ABV_2}: Uncertainty of the ABV of vegetation group 2 of the transition analyzed
$U_{ABV_{n_i}}$: Uncertainty of the ABV of vegetation group n of the transition analyzed
ABV_1: Carbon variation of live biomass of vegetation group 1 of the transition analyzed
ABV_2: Carbon variation of live biomass of vegetation group 2 of the transition analyzed
ABV_{n_i}: Carbon variation of live biomass of vegetation group n of the transition analyzed

5. Activities, Pools and Gases

a) Activities

This NFREL include the emissions associated with gross deforestation only. Emissions from degradation are not included in this NFREL, but are estimated and presented in annex a. For estimating degradation, the emissions associated with the losses of carbon in primary forest lands were calculated, based on the definition of degradation of the LGCC, which establishes that this occurs when there is a reduction in the carbon content in the natural vegetation due to human intervention. The emissions derived from forest fires are not included as part of the NFREL, but are estimated and presented in annex b

It should be noted that an effort has been made to estimate emissions by degradation and forest fires. It recognizes that it is a preliminary analysis whose methodological support will be improved as new data from the third cycle of the National Forest and Soils Inventory (INFyS) is obtained. Nevertheless, it demonstrates that a significant activity is not being excluded from the NFREL.

For other actions, such as those related to the enhancement of carbon stocks and the sustainable management of forests, according to the provision included in the decision 2/CP.17 on the step-wise approach, Mexico will improve its Reference Level incorporating all activities as more cost-efficient methods become available for that purpose.

b) Pools

The treatment of carbon stocks is consistent with the national GHG emissions inventories submitted by Mexico in its national communications. We included emissions and removals of the following stocks: above-ground woody biomass and biomass in roots for estimating deforestation and degradation; soil organic carbon (SOC) in deforestation, detritus and dead wood stocks for calculating emissions from forest fires (Table 5).

Table 6. Carbon Reservoirs

Activity/ Disturbance	**Reservoir**	**Description**
Deforestation and degradation[8]	Above-ground woody biomass	Trees and shrubs greater than 7.5 cm (normal diameter)
	Biomass of roots	Fine roots
	Soil[9]	Soil organic carbon
Wildfires[10]	Dead wood	Fallen woody material found in litter with a diameter larger than 7.5 cm
	Litter	Dead biomass that is not in an advanced state of decomposition; it includes needles, leaves, lichens and woody material of less than 7.5 cm lying above the mineral soil.
	Fermentation	Dead biomass that is in an advanced state of decomposition; it includes needles, leaves, lichens and woody material of less than 7.5 cm lying above the mineral soil
	Herbaceous	Herbaceous vegetation above ground, including grasses, herbs, and non-woody shrubs
	Shrubs	Low-height vegetation located above ground with a diameter of less than 7.5 cm

[8] Degradation is not included in the FREL, the analysis is included in annex a
[9] This pool is not included in the FREL, because it is not significant, the analysis is included in an annex c.
[10] This activity is not included in the FREL, the analysis is included in annex b

C) Gases

This section includes the results of the total historical emissions of CO2 eq for the entire period of analysis with the information available (1995-2010). Only the fire estimations include gases other than CO2, which are CH4 and NO2 converted into CO2 eq.

Figure 8 shows the relative importance of estimated emission sources for the forestry sector. It shows that deforestation is currently the most important source, and remains as the most important source for the entire historical period; followed by degradation, fire, and finally loss of soil carbon from deforestation. The soil organic carbon is a large sink, but due to the rate of change in the conversion (20 years) its contribution is not significant. Therefore it is concluded that the most important emissions to mitigate in the forestry sector are related to deforestation activities.

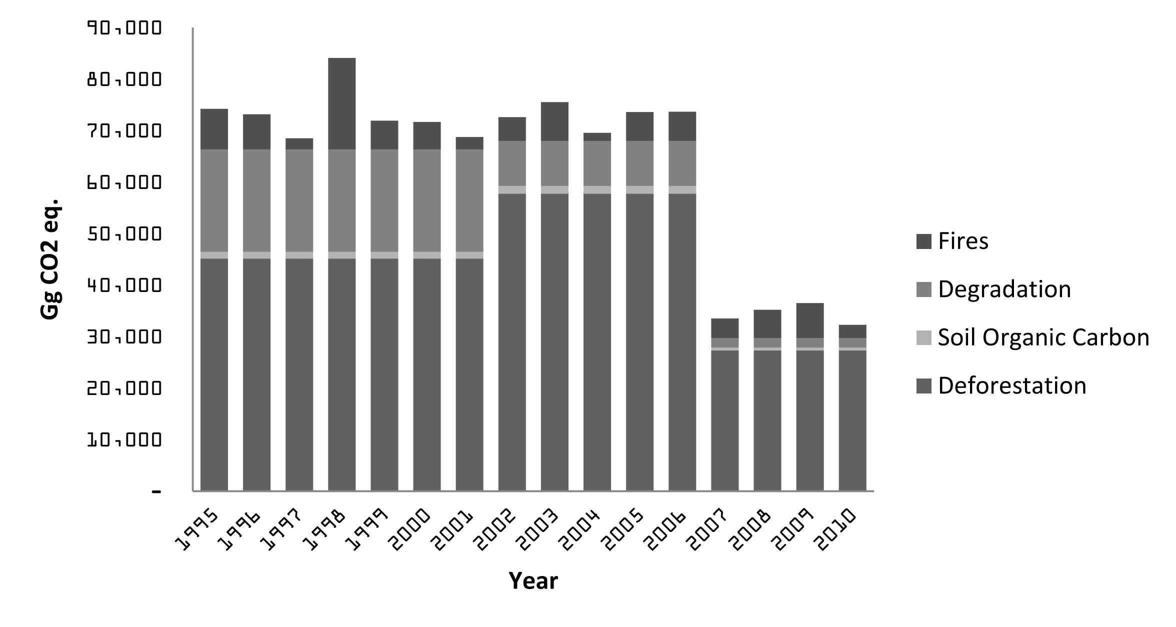


Figure 8.Total emissions

6. Definition of Forest

The forest definition used in the Mexican NFREL has been established following the IPCC guidelines and methodologies, considering as inputs the definitions included in the existing legislation framework in the country, mainly the General Law of Sustainable Forest Development (LGDS for its acronym in Spanish).

In the LGDFS, the definition of "forest land" comprises all lands covered by "forest vegetation", and "forest vegetation" is defined as "the set of plants and fungi that grow and develop naturally, forming temperate forests, tropical forests, arid and semi-arid areas, and other ecosystems."

According to the definition above, forest is defined as all "Forest Lands"[11] with a canopy cover of more than 10 percent, with trees of more than 4 meters in height[12] −or trees able to reach this height *in situ*−and a minimum mapping unit of at least 50 hectares[13] . It does not include lands subject to a land use that is predominantly agricultural or urban."

This definition is exactly the same one used in the development of the INEGEI, which is included in the BUR to be presented at UNFCCC.

The definition of forest is consistent with the progress in the national REDD+ Readiness Process, and responds to commentaries and suggestions made by the various actors involved in this process (CTC, GT-ENAREDD+ CONAF, among others), who recommended using the broadest definition of forests to accomplish the objective of implementing REDD+ in an inclusive manner in Mexico (ENAREDD+, 2014).

It should be noted that the forest definition used for the FREL and presented here, considers as forest some vegetation types that are in the Forest Resource Assessment (FRA), are included separately in the categories of Forest and Other Wooded Land. These vegetation types are considered as forest in the FREL as long as they meet the parameters described previously to build the forest definition, as well as the inputs used.

Finally, it´s important to highlight that Mexico is currently undertaking actions to generate and analyze new information[14], which will allow adjusting the parameters used, as a continuous process to improve the consistency between the forest definitions across national reports

7. Forest Reference Emission Level

a) Definition of the National Forest Reference Emission Level

Even when there is available data a longer period of time, this NFREL is constructed using the historical period of 2000 to 2010. This period is a benchmark for changes in policies in the forest sector as well as for the strengthening of the institutions implementing them nationwide. Hence, the NFREL to be used for results-based payments for the period 2011-2015 corresponds to the average emissions from gross deforestation for the period 2000-2010. This assumes that policies adopted and implemented in this period were the same as those implemented in the following years and that mitigation actions were undertaken under these policies (Annex e).

[11] According to LGDFS http://www.diputados.gob.mx/LeyesBiblio/ref/lgdfs.htm
[12] To set the parameter of height we analyze the data from the INFyS in each subcategory of analysis.
[13] According to INEGI Series characteristics (see the Information Used section, and annex d)
[14] See Short Term Methodological Improvements section

One of Mexico's largest developments in forest policy was the creation of CONAFOR in 2001 and the development of incentive programs aimed to improve the situation of the forestry sector in the country prioritizing the sustainable development of forests (Del Angel-Mobarak, 2012).

The incentive programs implemented by CONAFOR are applied at the national level in forests land or in potential forest lands, located in focalized areas, with the objective of supporting small owners, communities and ejidos (agrarian communities under a common property regime), who own the majority of Mexican forests.

Among CONAFOR programs the following stand out:

- *Community Forestry Program*[15], through which activities are supported to promote, strengthen, and consolidate community institutions and local development processes for collective and sustainable management of forest resources, including, among other things, conducting participatory rural appraisals; the development and strengthening of community statutes to regulate the use of collective forest resources; the holding of seminars between communities and other activities to exchange knowledge between communities or ejidos at different levels of the organization; the holding of workshops and training courses for members of the communities or ejidos and the personnel of community forestry companies on issues related to forest management, forestry, environmental sustainability, business management, and the processing and marketing of forest products and services.
- *Forestry Development Program* [16], through which activities are carried out to support communities and ejidos to strengthen their capacity to manage productive forests sustainably, including, among others: studies to prepare environmental impact assessments and forest management plans based on official regulations necessary to obtain borrowing permits to extract timber and non-timber forest products; forestry activities aimed at ensuring the regeneration of forests and the enhancement of forest productivity; assessments to certify the environmental and social sustainability of forestry operations on the basis of national and international standards.
- *Production Chain Integration Program* [17]*, which includes* carrying out activities to promote and strengthen forest value chains created by community businesses to add value to their forest products, expand access to markets, and improve competitiveness.
- *Environmental Forest Services Program*[18], through which support is given to communities or ejidos through a payment in exchange for providing environmental services that benefit people distinct from land users in eligible areas, such as services generated by forest ecosystems in water supply and disaster prevention; services generated by forest ecosystems in biodiversity conservation.
- *Reforestation Program.* Promotes restoration of forest ecosystems through the execution of soil conservation and reforestation works on degraded lands, targeting of actions in critical areas as a relevant criterion.

The main legal framework of the country's forest policies and mentioned programs, is the LGDFS (General Law for the Sustainable Development of Forests), issued on February, 2003. Since its

[15] For additional information: http://www.conafor.gob.mx/web/temas-forestales/silvicultura-comunitaria/
[16] For additional information: http://www.conafor.gob.mx/web/temas-forestales/silvicultura-y-manejo-forestal/
[17] Para mayor información consultar: http://www.conafor.gob.mx/web/temas-forestales/cadenas-productivas/
[18] Para mayor información consultar: http://www.conafor.gob.mx/web/temas-forestales/servicios-ambientales/

inception, the sustainable development of forests has been considered a high-priority area in the national development agenda.

The main objective of the sustainable development of forests is to achieve a sustainable management of forest ecosystems through promoting a more eco-efficient system of production and the conservation of forests, improving social wellbeing −particularly in rural areas−, and maintaining the capacity of timber and non-timber production, as well as environmental services, which it is reflected in the approach of the supports considered in the programs for the period 2000-2010.

On the other hand, the year taken as the end of the historical period for this NFREL was marked by several events. Firstly, the 16th session of the Conference of the Parties (COP) of the UNFCCC, which conclude with the signing of the Cancun Agreements, took place in Mexico. During this international meeting, Mexico announced its “Vision of Mexico on REDD+” (CONAFOR, 2010), thereby expressing its firm interest in implementing mitigation actions in the forestry sector under a REDD+ mechanism.

The Mexico REDD+ vision highlights the importance of an inter-sectorial approach that links forests to agriculture and other public policies. It also emphasizes that forests contribute to society's coping capacity to reduce vulnerability in poor communities to natural disasters and adverse changes in the economic situation

In addition, between 2010 and 2012 a series of projects were designed to support Mexico’s preparation process for REDD+ and for the implementation of mitigation actions in the forestry sector. These projects include: the Local Governance Project for the Implementation of REDD+ Early Actions Areas, financed the European Commission through the Latin American Investment Facility (LAIF); the Forests and Climate Change Project, funded by the World Bank; the Forest Investment Program; and the Reinforcing REDD+ Readiness in Mexico and Enabling South-South Cooperation project, funded by the Government of Norway; among others.[19]

Finally, in June 2012, the General Climate Change Law (LGCC, for its acronym in Spanish)[20] was enacted and came into force in October of the same year. One of the objectives of this Law is to regulate emissions from greenhouse gases and compounds in order to stabilize their concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system, considering, where appropriate, the provisions of Article 2 of the UN Framework Convention on Climate Change (UNFCCC) and other provisions arising from it.

b) National Forest Reference Emission Level

The NFREL of Mexico for gross deforestation activities derived from historical average from the period 2000-2010 is of 44,388.62 GgCO2/year for the 2011-2015 periods. As shown in table 7 and

[19] http://www.conafor.gob.mx/web/temas-forestales/bycc/
[20] Available at http://www.diputados.gob.mx/LeyesBiblio/pdf/LGCC_291214.pdf

figure 9, it includes only emissions by deforestation in aboveground woody biomass and biomass in roots.

Additionally, as part of the stepwise approach, Mexico will include other activities and pools according to the existing capacities and the information that is being developed and that be collected in the future.

Table 7. Total annual emissions due to deforestation, the average represent the forest reference emission level

Year	Emissions GgCO2.	Uncertainty (%)
2000	45,162.17	1.50
2001	45,162.17	1.50
2002	57,760.70	1.52
2003	57,760.70	1.52
2004	57,760.70	1.52
2005	57,760.70	1.52
2006	57,760.70	1.52
2007	27,286.75	1.55
2008	27,286.75	1.55
2009	27,286.75	1.55
2010	27,286.75	1.55
Average	**44,388.62**	

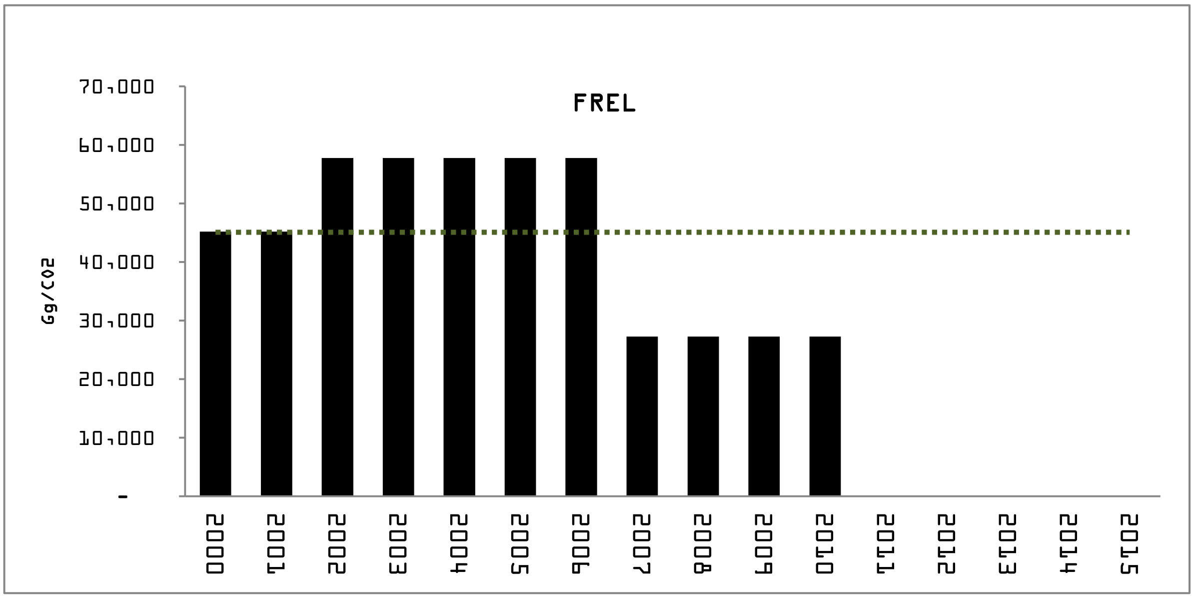


Figure 9. Total annual emissions due from deforestation and the average representing the forest reference emission level

8. Short Term Methodological Improvements

a) Monitoring Activity Data for Mexico (MAD-Mex)

As part Mexico's REDD+ readiness process, capacities are being built for the development and implementation of the National Forest Monitoring System (NFMS). This process includes the development of a system for the semi-automatic classification of satellite images, which is expected to render cartographic products similar to the INEGI Series but with greater spatial and temporal resolution.

MADMex is an automatized system based on Landsat and RapidEye imagery processing. The processing includes a workflow of automated and connected processing steps including initial scene identification based on the criteria time period and maximum cloud cover. Subsequent processing includes Landsat scene pre-processing, cloud/shadow and no-data masking, feature generation, image segmentation, feature extraction and dimensionality reduction, class to object mapping and outlier elimination, classificator training and classification, and finally result validation.

The scales for the products are 1:100,000 using Landsat and 1:20,000 using RapidEye. MADMex produces maps with a maximum of 35 classes; these classes can be collapsed to 20, 12 or 8 classes depending of report requirements such as FRA-FAO, IPCC, etc.

The reference years of Landsat classifications are: 1993, 1995, 2000, 2005 and 2010; for RapidEye images the products cover 2011 until 2015.

The first results of land cover maps showed a global accuracy around 70 to 85%, while the accuracy per forest classes is around 60 to 80%. A description of its methodology and these preliminary results can be found at Gebhardt, *et al* 2014.

The biggest gain with this system is a reduction of the minimum mapping area from 50 to 1 hectare, allowing for more appropriate forest data activity evaluations in the forest sector. Additionally, this system has an algorithm to detect forest cover changes directly from the images, which is expected to improve information on forest cover change at a national level. As is the case for coverage maps, change maps will also present an accuracy assessment to better estimate the uncertainties associated with each product. Currently, work is being conducted to look for the best approach to determine the change dynamic. The change maps have the same Landsat and RapidEye reference years mentioned above and annual change reports are expected to be generated. This process is being documented and a technical report will be issued upon completion. The final products will be available in 2016 for an institutional use.

Finally the MADMex will integrate the canopy cover percentage algorithm developed by Matt Hansen from the University of Maryland as an input for measuring degradation in forests. With all these products, the MADMEX system is expected to improve the estimates for deforestation and degradation rates in the country.

b) National Forest and Soils Inventory (INFyS)

The information gathering for the second INFyS cycle (2009-2013) ended in 2013. This second cycle had originally excluded the sampling units that were not sampled in the first cycle due to inaccessibility (which accounted for more than 10% of the sample size). However, in 2014, CONAFOR decided to recover information from these sampling units to maintain the original sample size design of the INFyS and get better estimations.

In the third INFyS cycle (2015-2019), which began early in 2015, the inventory experienced a re-engineering process. One important feature in the third cycle is the establishment of permanent plots to monitor changes in the main components and reservoirs. The re-engineering considered the most important carbon variables, and included special modules to cover all stocks (biomass, dead organic matter and forest soils) and information to characterize the sources from forest fires (fuel beds).

The improvements in the third INFyS cycle will ensure the completeness of all the carbon stocks and disturbance characterizations (Fires). Additionally, the fire control and prevention management area are implementing changes to the fire reports in order to better describe the fire regimes (localization, extent, intensity and severity) and improve the estimations of emissions due to fire. This new information will allow the country to improve the fire emissions estimations toward a tier 2.

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10. Annexes

a) Degradation

Measuring forest degradation depends on the definition chosen to describe this phenomenon. The General Law for the Sustainable Development of Forests indicates that deforestation refers to "the process of reducing the capacity of ecosystems to provide environmental services and to produce goods." In the context climate change mitigation in Mexico, forests are considered a regulator of the carbon cycle and degradation, according to the General Climate Change Law, refers to the "reduction of the carbon content in the natural vegetation, ecosystems or soils due to human intervention, in relation to that of same vegetation, ecosystem or soils in the absence of such intervention."

Focusing on these perspectives, the calculation of degradation estimates at the national level considered two elements. Firstly, the primary stage (defined as vegetation phase that is predominantly arboreal) comprised both primary and secondary vegetation groups in arboreal phase as indicated at in the INEGI Series; and the secondary stage comprised the categories of vegetation development which are currently undergoing a shrub and herbaceous stage. The vegetation groups pertaining primary and secondary forest lands are described in the section on coherent representation of lands and the change matrix presented therein. In this manner, a criterion was developed to identify degradation based on what the cartographers of the INEGI Series visually detected as an area presenting a loss in tree cover density. This allows us to know that a loss of biomass and carbon occurred in a certain area as recorded by each change matrix for the forest land category, as presented in the diagonal cells where degradation was detected (Figure 10).

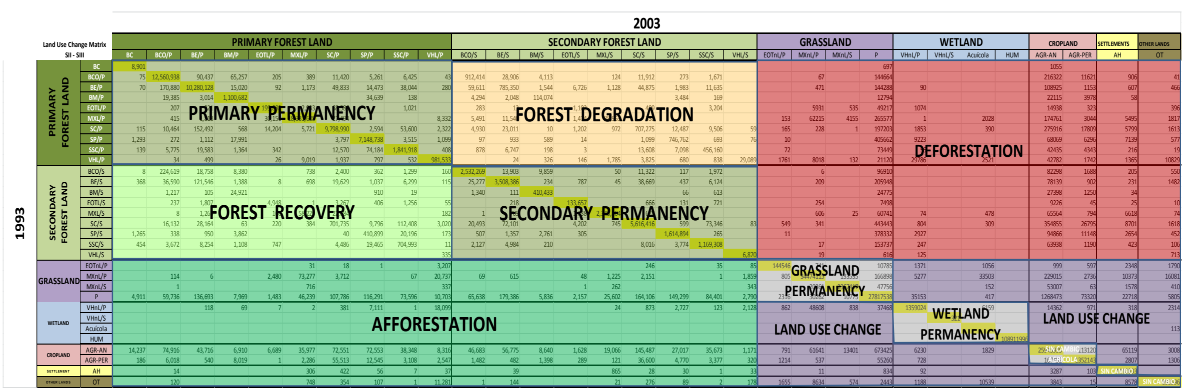

Figure 10. Matrix of change where degradation is identified

Table 7 Annual area degraded per vegetation group for each period

ANNUAL AREA DEGRATED (Ha)

VEGETATION GROUPS	1993-2002	2002-2007	2007-2011
Primary Conifer Forest	101,228	78,056	5,739
Primary Oak Forest	86,982	55,764	1,339
Primary Cloud Forest	12,700	4,155	746
Special - Other Primary Woody Ecosystems	122	52	63
Primary Woody Xeric Shrublands	9,878	13,841	4,694
Primary Deciduous Tropical Forest	78,210	83,962	8,332
Primary Evergreen Tropical Forest	82,755	54,824	23,716
Primary Semi-Deciduous Tropical Forest	50,300	27,701	14,458
Primary Woody Hydrophilous Vegetation	3,240	1,645	443
Total	**425,415**	**320,000**	**59,530**

Secondly, the data from INFyS plots with vegetation groups of primary forest lands that lost biomass was used to build a model for forest degradation, as described in the following paragraphs.

The INFyS has very few plots available to robust estimate EF for "Forest Lands" that changed to "Degraded Forest Lands" (that is, for those lands that changed from a primary to a secondary condition). Therefore, Proxy Lineal Models for Losses (MLPP, for its acronym in Spanish) were developed to obtain these estimates. These models are adjustments of the mean of the variable *gross decrease of carbon* at the plot level reclassified according to the re-measurement periods. The variable *gross decrease of carbon* at a plot level was constructed using only the negative cases for the variable *gross carbon change at the plot level* (for each plot, *gross carbon change at the sub-plot level* were averaged, and those averages were expanded to the hectare), as shown in Figure 11.

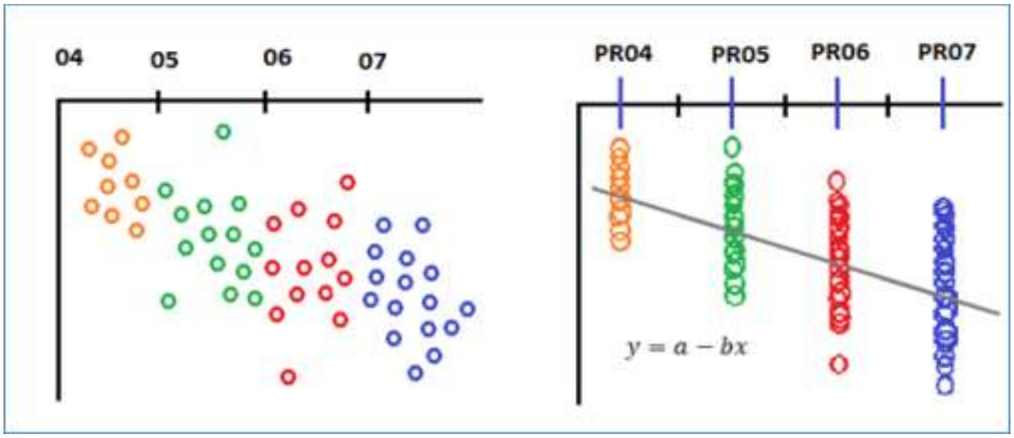

Figure 11. Process to develop the linear models for losses. (a) Diagram of dispersion of gross carbon decrease at plot level (negative cases of gross carbon change at plot level). (b) Graph of values of gross carbon decrease grouped at plot level by categories of re-measurements (absolute time difference between the measuring/remeasuring events) and linear adjustment of its averages.

Subsequently, the plots were categorized into "re-measurement periods", which means that each plot was categorized according to the lapsed time between re-measurements (1 to 7 years). This continuous variable was converted into a categorical variable, as shown in Figure 16. Then, a linear model was adjusted in each subcategory for the *gross carbon decrease* averages, Figure 16. The slope parameter of the model is the rate of loss, and this value was used as a proxy for the EF of "Forest land" that became "Degraded forest lands."

Table 14 shows the emission factors for degradation assigned for each year in the areas where lands changed categories from primary to secondary vegetation groups in the matrix of change.

Table 8. EF used to estimate emissions due to degradation.

Vegetation Groups	N	Carbon in above-ground woody biomass (tonC/ha/year)	Carbon in roots (tonC/ha/year)
Coniferous forest – Primary	292	-0.09	-0.02
Oak Forest – Primary	818	-0.24	-0.06
Mountainous cloud Forest – Primary	67	-0.26	-0.06
Special - Other Woody Vegetation Types – Primary	ND	ND	ND
Wood Xeric Shrublands – Primary	501	-0.47	-0.12
Deciduous Tropical Forest – Primary*	169	-2.21	-0.54
Evergreen Tropical Forest – Primary	577	-1.94	-0.43
Semi-Deciduous Tropical Forest – Primary	169	-2.21	-0.54
Hydrophilous Woody Vegetation – Primary	43	-1.58	-0.36

* The slope of the model originally used for data in this vegetation group displayed a carbon increase and this was not consistent with the carbon loss assumed for degradation. Hence, the factor obtained for primary semi-deciduous tropical forest was assigned to this vegetation group, considering that it is the most similar vegetation group in terms of composition and structure.

The annual rates of loss of carbon (in tons) were assigned to the area values obtained from the space analysis of matrices where a change in categories from primary to secondary forest was observed. The emissions in carbon dioxide were calculated for the matrices related to the three comparison periods, resulting in annual emissions of 19,872 Gg for the period 1993-2001; 8,696 Gg for the period 2002-2006; and 1,812 Gg for 2007-2011. This denotes a trend of decreasing emissions from degradation as the carbon dioxide emissions due to a degradation processes related to changes in the density of tree-dominated vegetation have been reduced in the last two periods analyzed.

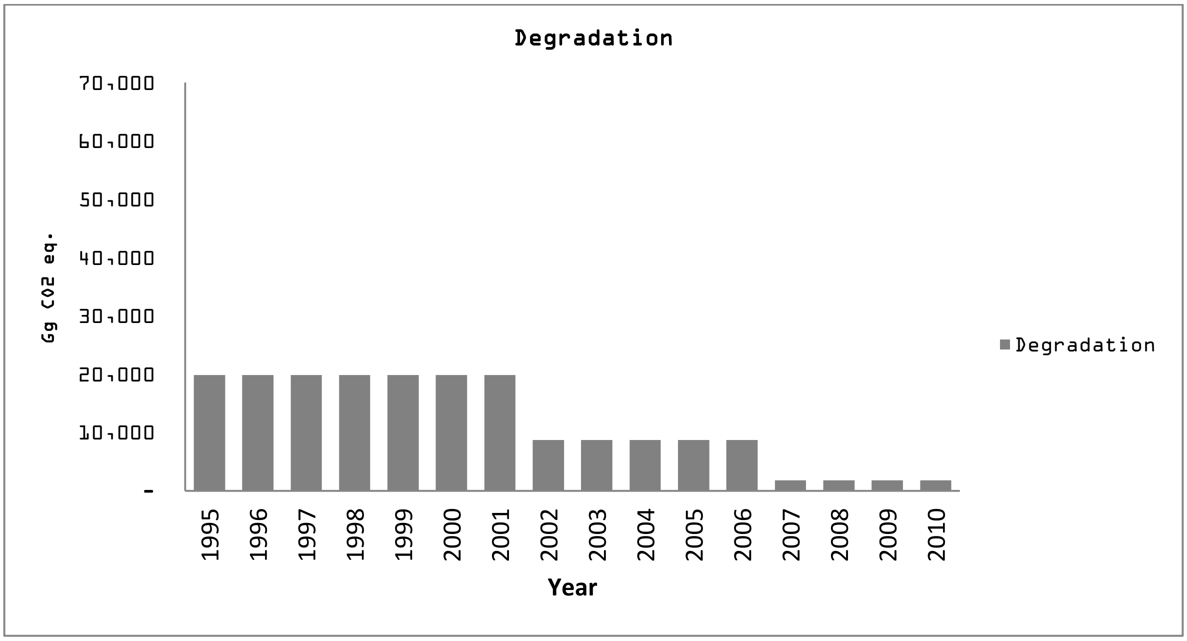

Figure 8. Historical emissions due to forest degradation

b) Forest Fires

Forest fires is an important event of disturbance in Mexican forest, each year around 250,000 ha of forest areas are affected by fire in Mexico; even when it is not possible to identify when the fires lead to deforestation, according to the Mexican regulation (SEMARNAT-SAGARPA 2007), different kind of forest are sensitive (tropical forest) while other are independent (shrublands) or adapted to fire (conifer forest) (Figure 15).

A possible approach is considering emissions from fires in sensitive ecosystems as degradation, fires in other kind of forest can be estimated in other REDD+ activities (conservation or enhancement of carbon stock, even in sustainable management of forest) in the future.

The estimate for emissions due to forest fires is divided into two large groups. The first part of this section concerns CO_2 emissions from the loss of biomass due to fires on forest land. The second part consists of non-CO_2 gas emissions from *in situ* biomass combustion.

The general calculation of GHG emissions from forest fires (spontaneously caused) was made using the following general equation found in the guidance of the IPCC for LULUCF (IPCC, 2003):

$$Lfire = A \bullet B \bullet C \bullet D \bullet 10^{-6}$$

Where:

Lfire = Quantity of greenhouse gases due to forest fires, megagrams

A = Area burnt, hectares
B = Mass of “available” fuel, kg of dry matter ha^{-1}
C = Combustion factor (fraction of biomass consumed), dimension-less
D = Emission Factor

Area Burnt by Forest Fires (A)

The analysis of the area affected by fires was performed using official data from the CONAFOR for the period 1995-2013[21]. These reports record the areas affected by fires fought. These reports do not include fires were not fought, which may lead to an underestimation of this type of disturbance. The affected areas are disaggregated by federal state, year, and stratum of the vegetation affected; the latter are classified into arboreal, shrubs, and herbaceous (Table 9). Generally, fires are superficial, burning mainly dead matter, shrubs and grasses (Estrada, 2006).

Table 9. Example of the database report on fires that occurred in different dominant strata by federal state

	AREA IN HA			
	1998			
STATE	**Herbaceous**	**Shrub**	**Arboreal**	**Total**
Aguascalientes	5	99	63	167
Baja California	2,482	3,009	3	5,494
Baja California Sur	17	2	7	26

[21] http://www.conafor.gob.mx/web/temas-forestales/incendios/

Campeche	182	0	5,271	5,453
Chiapas	85,335	47,590	65,883	198,808
Chihuahua	10,435	7,996	9,071	27,502
Coahuila	2,004	10,397	2,093	14,494
Colima	85	1,078	28	1,191
Federal District	4,705	714	316	5,735
Durango	24,191	24,347	20,422	68,960
Guanajuato	134	1,029	1,648	2,811
Guerrero	11,672	5,509	2,012	19,193
Hidalgo	5,984	5,222	3,351	14,557
Jalisco	8,208	6,121	3,867	18,196
State of Mexico	9,616	12,350	3,881	25,847
Michoacán	8,553	11,315	5,922	25,790
Morelos	336	1,778	246	2,360
Nayarit	231	276	1,777	2,284
Nuevo León	502	25,076	2,556	28,134
Oaxaca	144,704	61,803	35,143	241,650
Puebla	5,745	8,860	5,230	19,835
Querétaro	776	15,612	1,136	17,524
Quintana Roo	880	3,920	1,409	6,209
San Luis Potosí	4,058	13,780	9,343	27,181
Sinaloa	2,757	859	4,595	8,211
Sonora	1,194	380	93	1,667
Tabasco	5,436	5,369	3,133	13,938
Tamaulipas	466	14,846	2,514	17,826
Tlaxcala	4,819	2,617	1,396	8,832
Veracruz	1,730	3,814	4,146	9,690
Yucatán	2,454	2,008	935	5,397
Zacatecas	2,546	1,127	997	4,670
Yearly Total	88,956	105,014	115,117	309,087

The reported area by state was related to the vegetation group which is or has been affected by fires in each state, as not all vegetation groups are susceptible to burning. For this analysis, the phases related to dominant vegetation strata were disaggregated into arboreal, shrub, and herbaceous as described by the INEGI in order to link the INEGEI categories to the affected stratum surfaces reported by the CONAFOR. The aforementioned procedure was performed in order to infer the surface area by vegetation group at the state level, as geographical information (polygons) are not available for this activity data.

To select the subcategories historically affected by fires, the spatially explicit data issued by CONAFOR's Office for the Protection against Forest Fires were used as an indicator. A quality control was performed on the georeferenced data of fires registered between 2005 and 2013. This allowed us to locate 45,433 events (57%) out of the 79.465 recorded between 1995 and 2014. Such records were used as an indicator to weight the occurrence of fires for each vegetation group by state where fires may occur (Figure 13). Once each vegetation group of occurrence was located by state, it is possible to know upon what amount of surface area and in which affected vegetation strata we may proportionally assign the area affected by forest fires for the whole historical period.

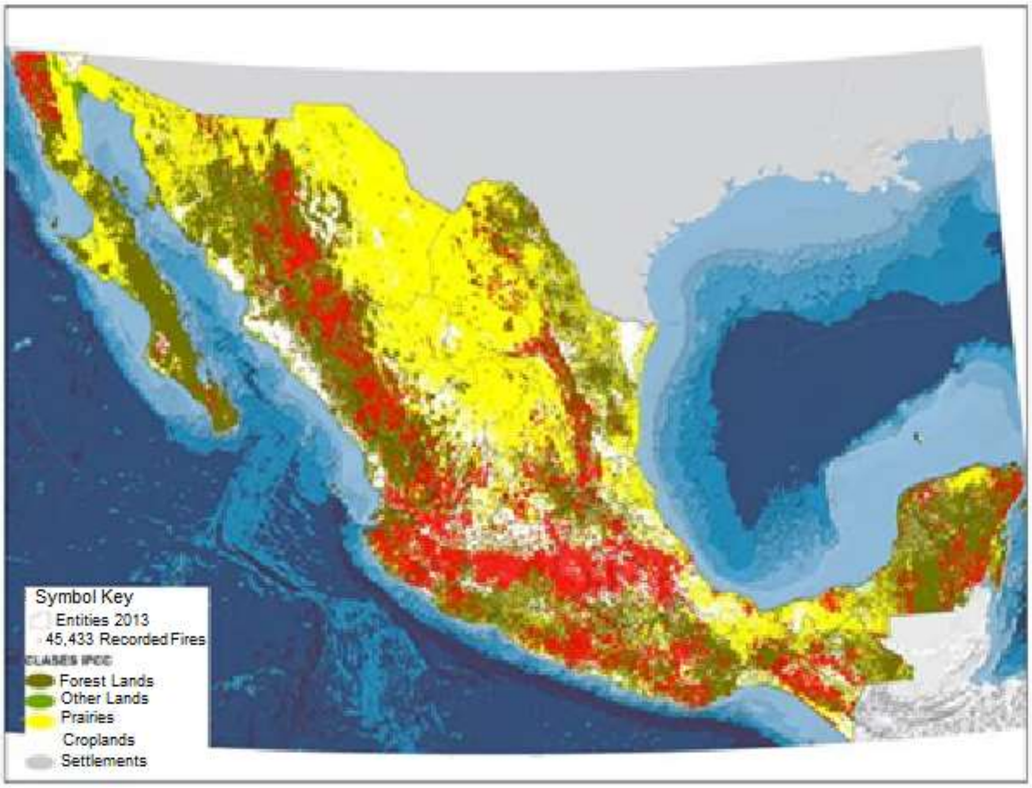

Figure 9. Georeferenced fires by state for the period 2005-2013 using IPCC classes

Using the Land Use and Vegetation data from each of the Series evaluated, the surface areas were quantified by INEGEI vegetation group, development phase, and state with the objective of determining the contribution of each stratum affected by fire. The surfaces and their relative areas were obtained according to the time period corresponding to each INEGI Series. Consequently, the areas affected by fires in 1995-2002 were assigned to the relative surface area by state for each vegetation group in Series II; the areas affected in 2003-2007 were assigned to Series III; the areas affected in 2008-2011 were assigned to Series IV; and the areas affected in 2012-2013 were assigned to Series III (Table 10).

Table 10. Example of the surface area calculated by state (Aguascalientes) and its relative area by affected stratum (arboreal, shrub, and herbaceous)

	1993	2002	2007	2011		1993	2002	2007	2011
Vegetation group	**SII**	**SIII**	**SIV**	**SV**		**SII**	**SIII**	**SIV**	**SV**

BE/S	882,957,518	478,462,589	514,287,541	508,007,967		46.24%	40.21%	43.44%	43.21%
MXL/P	303,340,556	300,773,069	190,146,461	188,469,733		15.89%	25.28%	16.06%	16.03%
MXL/S	95,830,915	88,558,123	181,431,851	181,431,851		5.02%	7.44%	15.32%	15.43%
SC/S	627,258,992	322,073,945	298,085,129	297,659,897		32.85%	27.07%	25.18%	25.32%
	1,909,387,981	1,189,867,726	1,183,950,982	1,175,569,448					

In order to distribute the annual surface area affected by fires in each vegetation group and stratum by state, the relative area (%) was multiplied by the affected surface in each stratum affected annually for each INEGEI subcategory. The result is the annual proportional surface area affected by fires by vegetation group (Figure 14) and state. To finish determining the surface areas affected by surface fires in each vegetation group, the figures by state were added to obtain the national total per year.

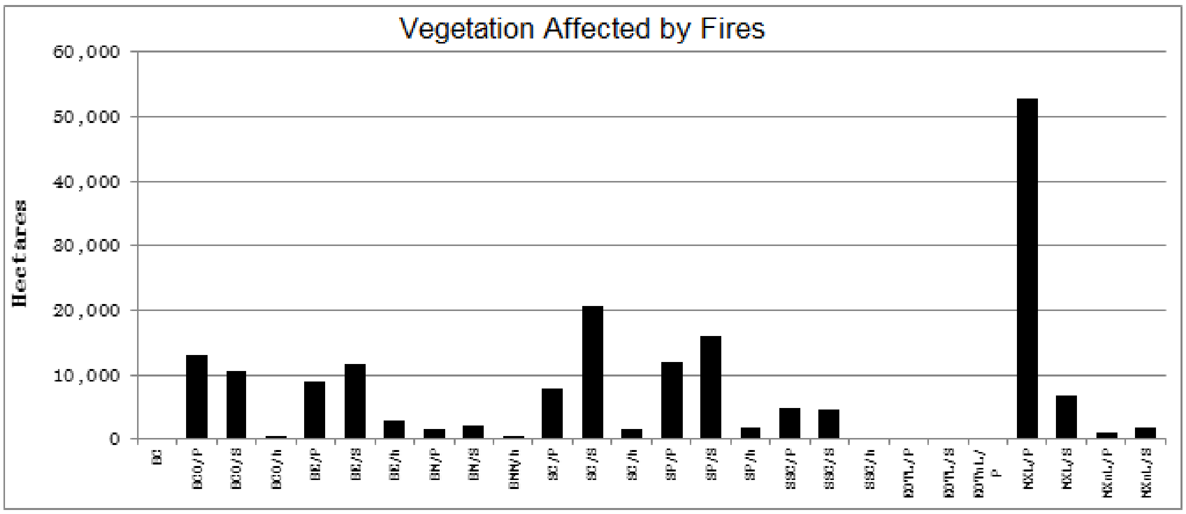

Figure 10. Surface area (ha) by vegetation group and development stage affected by fires

Mass of Available Fuel (B)

To quantify the available fuel, we will focus on the concept of "fuel bed," defined as a unit of vegetative material representing one or several combustion environments (Riccardi *et al.* 2007), for surface fires −which are the most common in Mexico−. It consists of the following strata: fermentation horizon, surface leaves, dead woody matter, vegetation of low height (herbaceous stratum), and shrubs.

Based on the above mentioned categories, the fuels (biomass and necromass) were quantified mainly using the photo series tool for quantifying forest fuels applicable to the ecosystems located in the Mexican territory (Alvarado *et al.* 2008, Ottmar *et al.* 2007, Ottmar *et al.* 2000), and which are used as a major source in the Fuel Characteristic Classification System (FCCS). Additionally, an exhaustive search was made in the scientific and gray literature (theses, reports, and conference proceedings) containing information on different types of vegetation and fuel components in various states of the Mexican Republic and the border states of the United States of America with which forest ecosystems are shared, so as to cover the maximum available information.

The literature review obtained 186 prototype fuel beds for different vegetation groups in Mexico (Table 11). With the aim of making generalizations at the national level, prototype fuel beds were aggregated according to the methods suggested by Hardy *et al.* 2000 to form fuel conditions representing each vegetation groups in a Fuel Condition Class (FCC).

Table 11. Vegetation groups in a Fuel Condition Class (FCC) and types of vegetation that represents it (N = Number of sites that represent the FCC).

Vegetation groups or FCC	INEGI Vegetation Type	Source	N (FCC)
Conifer Forest	Pine Forest	Alvarado *et. al* 2008, Alvarado (unpublished data), Estrada 2006, Navarrete 2006, Ordoñez *et al.* 2008, Ottmar *et al.* 2000, Ottmar*et al.* 2007, Pérez 2005, Stephens 2004, Villers-Ruiz *et al.* 2001	36
	Mixed Pine-Oak Forest	Alvarado *et al.* 2008, Camp *et al.* 2006, Estrada 2006, Fulé and Covington 1994, Navarrete 2006, Ordoñez *et al.* 2008, Pérez 2005, Rodríguez and Sierra 1995, Villers-Ruiz *et al.* 2001	7
	Oyamel Forest	Alvarado *et al.* 2008, Estrada 2006, Navarrete 2006, Ordoñez *et al.* 2008, Pérez 2005, Rodríguez y Sierra 1995	19
	Juniper Forest	Ottmar *et al.* 2000	9
Oak Forest	Oak Forest	Alvarado *et al.* 2008, Estrada 2006, Fulé and Covington 1994, Morales *et al.* 2000, Navarrete 2006, Ordoñez *et al.* 2008, Ottmar*et al.* 2000, Ottmar*et al.* 2007, Pérez 2005, Rodríguez and Sierra 1995, Villers-Ruiz *et al.* 2001	14
	Mixed Oak-Pine Forest	Villers*et al.* 2001, Alvarado *et al.* 2008, Ottmar*et al.* 2007, Estrada 2006	16
Mountain Cloud Forest	Mountain Cloud Forest	Alvarado *et. al* 2008, Asbjornsen *et al.* 2005	5
Evergreen Tropical Forest	High-Stature Evergreen Tropical Forest	Hughes *et al*. 2000, Hughes *et al.* 1999	22
Semi-Deciduous Tropical Forest	Medium-Stature Semi-Deciduous Tropical Forest	CONAFOR-USFS 2006, Harmond *et al.* 1995, Jaramillo *et al.* 2003, Whigham *et al.* 1991,	14
	Low-Stature Semi-Deciduous Tropical Forest	CONAFOR-USFS 2006	2
Deciduous Tropical Forest and Other Special Types (Mezquite Forest)	Low-Stature Deciduous Tropical Forest	Jaramillo *et al.* 2003, Romero-Duque, 2008	13
	Subtropical Shrubland	Pérez 2005, Navarrete 2006, Ordoñez *et al.* 2008	1

Xeric Shrubland	Chaparral	Ottmar *et al.* 2000	16
	Submountainous Shrubland	Alvarado *et. al* 2008, Rodríguez and Sierra 1995	3
	Xeric Shrublands (Various)	INE, 2006	5

Since there are few works available to represent the heterogeneity of Mexican ecosystems and the number of observations is varied for each FCC (in some cases, there are more than 20 observations and in others, only 3), the quantity of available fuel was obtained using the median as the measure of the central trend. This is more appropriate when there is few data or non-normal distributions, as it allows to avoid very extreme values and, if there is a normal distribution, it must be similar to the mean (Zar, 1999) as shown in Table 12.

Table 12. Median of the quantity of biomass (Mg m. s. ha^{-1}) of each category by FCC and fuel category. F=Fermentation Layer, Fo & SDWM= Foliage and Small Dead Woody Matter, LDWM= Large Dead Woody Matter, Her= Herbacious Plants, Shr= Shrubs.

Vegetation groups or FCC	**Categories Mg m. s. ha^{-1}**										
FCC	**F**	**N**	**Fo & SDWM**	**N**	**LDWM**	**N**	**Her**	**N**	**Shr**	**N**	**Total**
Conifer Forest	13.39	35	10.04	69	9.59	67	0.20	47	0.37	47	33.60
Shrubby Conifer Forest	13.39	35	10.04	69			0.20	47	0.37	47	24.00
Herbaceous Conifer Forest			10.04	69			0.20	47			10.24
Oak Forest	14.21	14	7.62	27	0.33	27	0.46	20	0.71	20	23.32
Shrubby Oak Forest	14.21	14	7.62	27			0.46	20	0.71	20	22.99
Herbaceous Oak Forest			7.62	27			0.46	20			8.08
Mountain Cloud Forest	11.93	5	2.02	5	6.94	1	0.15	1	0.19	1	21.23
Shrubby Mountain Cloud Forest	11.93	5	2.02	5			0.15	1	0.19	1	14.29
Herbaceous Mountain Cloud Forest			2.02	5			0.15	1			2.17
Evergreen Tropical Forest	ND		5.75	14	9.1	15	7.5	7	5	15	27.35
Shrubby Evergreen Tropical Forest	ND		5.75	14			7.5	7	5	15	18.25
Herbaceous Evergreen Tropical Forest			5.75	14			7.5	7			13.25
Semi-Deciduous Tropical Forest	ND		9.18	16	31.25	16	7.1	15	2.1	17	49.63
Shrubby Semi-Deciduous Tropical Forest	ND		9.18	16			7.1	15	2.1	17	18.38
Herbaceous Semi-	ND		9.18	16			7.1	15			11.28

Deciduous Tropical Forest											
Deciduous Tropical Forest/Special - Other Woody Types	ND		12.57	13	10.5	13	3.64	8	2.45	4	29.16
Deciduous Tropical Forest/Special - Other Shrubby Woody Types			12.57	13			3.64	8	2.45	4	18.66
Deciduous Tropical Forest/Special - Other Herbaceous Woody Types			12.57	13			3.64	8			
Xeric Shrubland - Woody and Non-Woody	2.97	2	5.78	6			1.44	3	26.34	24	36.53

Consumption Factors or Proportion of Consumed Biomass (C)

The Consumption Factors were taken by default from the values used in the software CONSUME 3, which were developed based on experimental empirical models in dry temperate forest ecosystems of the western United States that estimate the total consumption in the three combustion phases (Prichard *et al.* 2009).

The resulting Consumption Factors for each vegetation group of temperate forests are general and obtained by stratum and fuel category in order to be applied (where appropriate) to each vegetation group and its vegetation development phase as shown in Table 13.

Table 13. Consumption factors by vegetation group and fuel group obtained from CONSUME 3

Vegetation group	**Fermentation Horizon**	**Leaves and DWM <7.62 cm**	**DWM >7.62cm**	**Grasses**	**Shrubs**
Conifer Forest	0.79	0.93	0.55	0.93	0.89
Oak Forest	0.61	0.93	0.55	0.93	0.90
Mountain Cloud Forest	0.45	0.93	0.55	0.93	0.89
Xeric Shrubland	N/A	0.93	0.55	0.93	0.89

In tropical forests, information on consumption factors is rare or non-existent, and, for Mexico, only Kauffman *et al.* (2003) records values for the burning of low-stature deciduous tropical forests for land use conversion, which were used for dry tropical forests as they were the only source available. In the other groups of fuels from tropical forests, the values for proportion of biomass consumed provided by the IPCC guidelines in its LULUCF section (IPCC, 2003) were used, as shown in Table 14.

Table 14. Consumption factors by FCC and fuel group obtained from IPCC and Kauffman et al. 2003 for tropical forests and some types of shubland

Vegetation group or FCC	Fermentation Horizon	Leaves and DWM<7.62 cm	DWM>7.62cm	Grasses	Shrubs
Evergreen Tropical Forest[22]	0.50	0.50	0.50	0.50	0.50
Semi-Deciduous Tropical Forest[7]	0.50	0.50	0.50	0.50	0.50
Semi-Deciduous Tropical Forest and Special / Other Lands[23]	N/A	0.89	0.71	1	0.78

The consumption factors were assigned to each surface of vegetation group and their vegetation phase development according to the environment of combustion and its available mass (depending on the component).

Emission Factors (D)

Andreae and Merlet's EF (2001) were selected for this report as they comprise a thorough and up-to-date review of all publications about emission factors for CO_2 and CH_4, CO, N_2O and NO_x trace gases in forests, and provide general values in similar categories to those proposed by the IPCC for the LULUCF sector. Such categories include two biomes: extra tropical forests (temperate, boreal forests and temperate zone shrubs) and tropical forests (Table 13). Emission factors were applied to extra tropical forests on the subcategories of coniferous, oak, cloud mountain forests and xeric shrubs; and the EF of tropical forests were applied to evergreen tropical forests, low semi-deciduous tropical forest and deciduous tropical forests.

Table 13.Emission factors by biome and chemical species (Andreae and Merlet 2001).

Biomes	CO_2	CH_4	CO	N_2O	NO_x
Extra tropical forests	1569	4.7	107	0.26	3
Tropical forests	1580	6.8	104	0.2	1.6

To facilitate comparison between the sectors, and to be consistent with other sectors, information from CH_4 and N_2O emissions it should be reported in terms of CO_2 equivalent.

Emissions of CO_2 equivalent, is a form to compare the same radiative forcing issued equal to an amount of a greenhouse gas homogeneously mixed. We estimate CO2e emissions if multiplying the Global Warming Potential (GWP) to the Gg of each gas. For CH4 the GWP is 28 and for N_2O is

[22] IPCC 2003
[23]Kauffman *et al*. 2003

265 (IPCC, 2013). The Kyoto Protocol is based on the GDP from the rate of emissions over a time frame of 100 years.

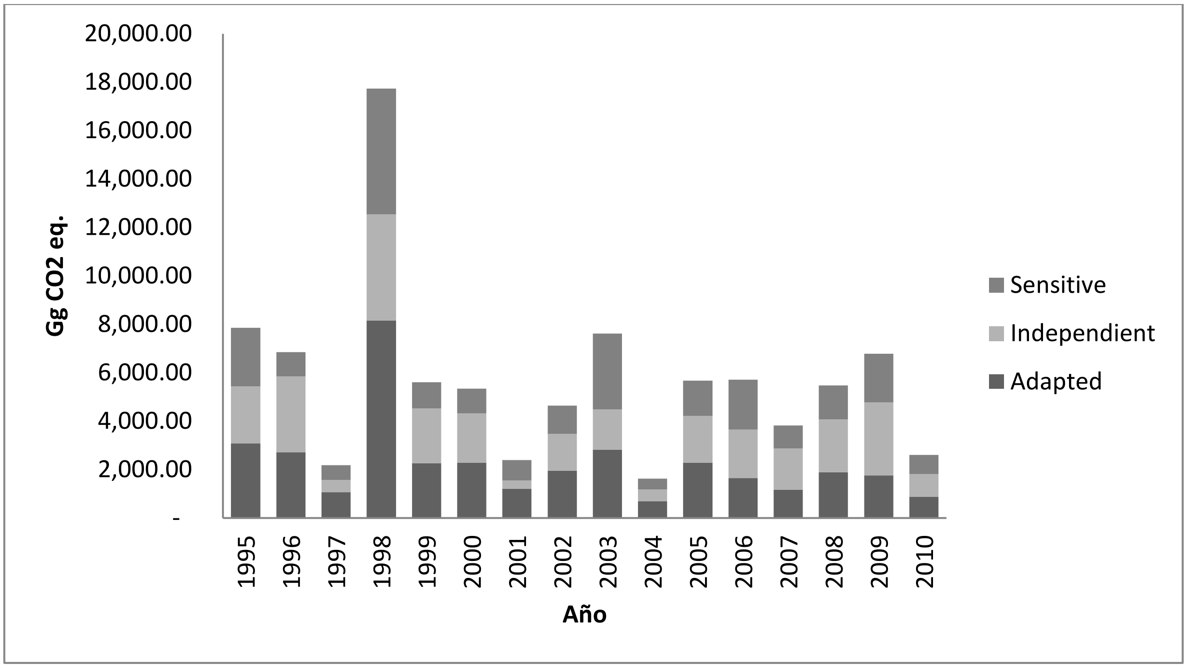

Figure 11 Emissions from Forest fires

c) Emissions in soils.

From the year 2002, Mexico conducted the first GHG emission estimate for the Land Use, Land Use Change and Forestry (LULUCF) and efforts have been made to estimate the emissions from mineral soils and farming areas. Taking as background previous inputs and work and aiming to provide information for the biannual update of INEGI, CONAFOR carried out a new estimate of emissions from mineral soils following the IPCC guidelines, considering a Tier 2 and integrating new available information as well as more adequate and transparent estimation methods.

Unlike the previous calculations for this warehouse, the new estimate took the following considerations into account:

a) The carbon inputs in the soil have a different temporary nature and accuracy.

b) There are information sources that are more complete and of better quality (CONAFOR 2009-2012) and with it, it is possible to calibrate the spatial variability of the soil.

c) The soil carbon data provided by INEGI and CONAFOR has different experimental designs. The first is addressed and oriented to the soil taxonomy and the second is systematically designed to quantify carbon in the different aerial, superficial and underground reservoirs.

d) Secondary vegetation soils usually have more carbon in terms of dry weight than the primary vegetation soils.

Inputs

Data of 61,959 profiles was gathered, and it came from 5 soil independent inventories, four were conducted by INEGI and one by CONAFOR. Each inventory was designed for different objectives and populations; thus, their sample designs are different. The INEGI inventories mainly focus on grasslands and agriculture, while the one from CONAFOR is oriented to forest lands (See Table 14 and Figure 16).

Table 14. Sampling design characteristics of the INEGI and CONAFOR soil inventories.

	Serie1-250/1	Serie2-250/2	Series 50/3	Series Ero/4	Series CCP/5
Study period (timeframe)	1969-2001	1999-2010	1969-1982	2009-2013	2009-2012
Observations with carbon value	5,987	2,805	15,166	2,472	3,061
Series II* 1968-1999	5,840	62	15,166	0	0
Series III* 2000-2004	147	1,900	0	0	0
Series IV* 2005-2009	0	843	0	229	2,007
Series V* 2010-2013	0	0	0	2,243	1,054
Average range size (km2)	30.07	28.84	2.46	48.8	Without base map
National coverage	93.63%	82.29%	32.29%	61.72%	58.81%
Distance between sites (km)	5.06	6.88	2.88	8.56	14.72
Site density (site/ 1000 km2)	3.07	1.44	7.79	1.27	1.57
Resampling of study sites	No	No	No	No	Yes
Repetition spacing	No	No	No	No	2 meters

/1234 Drafting conducted by INEGI. /5 Drafting conducted by CONAFOR.

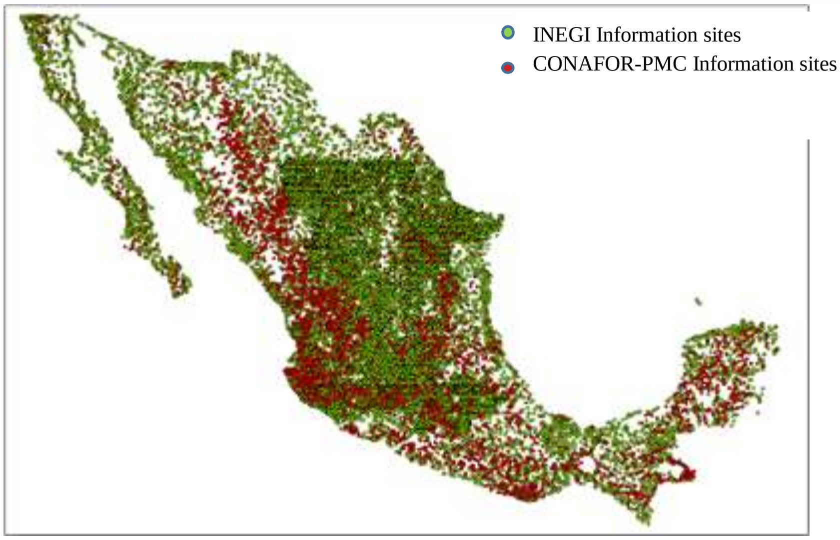

Figure 12. Location of sampling sites according to the information source.

Methods

Quality Control

For the estimation of the average organic carbon stocks in soils, first of all, the profile identification took place with data including date and consistent spatial positioning and on this subset they selected only those in which apparent density was directly or indirectly calculated. In the CONAFOR soil inventory, they refined the data that statistically was out of the reliable timeframe regarding the variables of the National Forestry and Soil Inventory (INFyS) highly related to the carbon value like the canopy coverage (alfa 0.08) and the amount of dead leaves (alfa 0.10). After a filtering process, it was determined that 29,611 profiles (47.8% of the original total) have complete, congruent and applicable information in the study's calculation processes.

Soil CO estimates

Once the profiles to be analyzed are selected and a quality control is performed on the variables to be used, the next step was to estimate the carbon stocks on a profile level. For this, the Equation 3.2.16 was used, as indicated in the IPCC Guidance on good practices for CUTS (2003).

$$\mathrm{COS} = \sum_{\mathrm{horizonte}=1}^{\mathrm{horizonte}=n} \mathrm{COS}_{\mathrm{horizonte}} = \sum_{\mathrm{horizonte}=1}^{\mathrm{horizonte}=n} \left([\mathrm{COS}] * \text{Apparent density} * \text{Depth d} * (1 - \mathrm{frag}) * 10\right)_{\mathrm{horizon}}$$

In which:

COS, is the organic carbon content of the soil, expressed in carbon tons per hectare.

COShorizon or COSboring, is the organic carbon content of the soil for a horizon, layer or soil boring, in carbon tons per hectare.

[COS], is the organic carbon concentration in the soil for a given soil mass obtained through a lab analysis, expressed in terms of grams by soil kilogram.

Apparent density, also called AD, is the soil mass by sample volume, in soil tons per cubic meter (equivalent to Mg. m-3)-

Depth, of the horizon, layer or bore, in meters.

Frag is the percentage value of thick fragments/100, without dimensions. These fragments are thick because they didn't go through a number 10 sieve or mesh (10 threads each inch with effective spacing between 2.00 millimeter threads).

Reference stocks of vegetation subcategory and soil use

For estimating the reference stock's FE in soils for vegetation subcategory and soil use, it was necessary to group the carbon stock's estimates in soils (on a sampling unit/ profile level) according to the classes of the IV series of vegetation groups and subsequently obtaining the FE for each group using the weighted estimator proposed by Charles E. Thomson (1987) for the independent inventory combination:

$$\bar{x}_j{}' = \sum \frac{\bar{x}_i \, w_{ij}}{w} \qquad \text{Ec (1)}$$

Where:

$\bar{x}_j{}' =$ $Weighted\ mean\ of\ the\ subcategory\ j\ (expressed\ in\ carbon\ by\ hectare)$

$w_{ij} = \frac{1}{S_{i'j}}$

$$w = \sum_{j=1}^{n} w_{ij}$$

$S_{ij}{}' = Average\ Variance\ \bar{x} : \frac{S_{ij}}{n_{ij}}$

S_{ij} = Variance of the data in the inventory i in subcategory j
Sample size of the inventory I in subcategory j
Arithmetic average of carbon with data from inventory I in subcategory j

n_{ij}=

$\bar{x}_i = Arithmetic\ average\ of\ carbon\ with\ data\ from\ inventory\ I\ in\ subcategory\ j$

This estimator's implementation required the identification of inventories with similar sampling intensities. Thus, it was assumed that the Series 1 and 2 inventories have an analog sampling intensity (yellow squares in Figure 2). On the other hand, the Series 50 soil inventory has a sampling intensity higher than in the other three inventories. Therefore, in order to prevent biases due to the sampling density, the areas where the inventory was made were identified (grey squares in Figure 17).

Figure 17. Stratification of the country based on the sampling intensities of the soil inventories available in Mexico. The yellow areas represent the zones in the country in which the sampling intensity of the SERIES 1, SERIES 2 and CONAFOR's inventories go from 3 to 20 km. The grey areas represent the areas in which the sampling intensity of the SERIES 50 inventory is of 3 km and the ones from the other inventories are between 5 and 20 km.

Once the sampling densities were identified, the sampling units were re-stratified according to the vegetation groups. Thus, to obtain each class' FEs, first it was necessary to obtain a FE estimator per class per inventory within each sampling intensity zone and then they were combined according to Equation 1.

For the uncertainty estimate of the FEs the IPCC (2003) best practices were followed, which state that:

$$U_j = \frac{IC_j/2}{\bar{x}_j'} \times 100 \qquad \text{Ec (2)}$$

Where:

U_j: Uncertainty of the soil carbon average of the vegetation group *j*

$\bar{x}_j'$: Soil carbon average of the vegetation group *j*

IC_j: Reliability timeframe of the vegetation group carbon average *j*

In which IC_j depends on the variance of $\bar{x}_j'$:

$$\bar{x}_j' - 1.96\sqrt{\hat{V}(\bar{x}_j')} \leq \bar{x}_j' \leq \bar{x}_j' + 1.96\sqrt{\hat{V}(\bar{x}_j')}$$

And $\widehat{V}(\bar{x}_j')$ is defined as shown in Equation 3 (Charles E. et al, 1987):

$$var\ (\bar{x}_j') = \frac{1}{w}\left[1 + \frac{4}{w^2}\sum\frac{1}{n_i}\ (w_i\{w - w_i\})\right] \qquad \text{Ec (3)}$$

Where:

$var\ (\bar{x}_j') =$ Average of weighted variance estimated for vegetation group j

$n_i, w\ y\ w_i$ are indicated in the previous section.

The estimate of the soil carbon densities for each vegetation group is shown in Table 15.

Table 15. Soil carbon densities

Vegetation group	NON DENSE				DENSE				FE ESTIMATORS				
	Obs	Mean	DevSt	Wi	Obs	Mean	DevSt	Wi	W	**FE (tonC/ha)**	var(x)	sd(x)	**% Uncertainty**
Annual Agricultural	777	32.3	21.1	0	4697	33.2	12.7	0.01	0.01	32.9	118	10.86	65
Permanent Agricultural	61	54.9	22.4	0	78	38.3	9.22	0.01	0.02	40.8	66.6	8.16	39
Settlements	15	31.1	26.6	0	125	32.6	19	0	0	32.1	236.4	15.37	94
Cultivated Forest					4	17.8	3.47	0.08	0.08	17.8	12	3.47	38
Primary Coniferous Forest	572	36.2	20.5	0	743	51.8	21.1	0	0	43.8	214.2	14.63	66
Secondary Coniferous Forest	87	45.2	24.7	0	112	52.5	23.6	0	0	48.8	274	16.55	66
Primary Oak Forest	375	25.5	14.6	0	461	35.3	15	0	0.01	30.2	108.3	10.41	68
Secondary Oak Forest	105	37.7	15.9	0.01	289	32.1	12.9	0.01	0.01	34.6	90.5	9.51	54
Primary Mountain Mesophilic Forest	57	84.6	36.7	0	12	49.9	31.6	0	0	63.5	470.1	21.68	67
Secondary Mountain Mesophilic Forest	20	111	50.7	0	0				0	111	1860	43.12	76
Special Other Types Primary Woody	10	14.4	9.7	0.01	30	42.9	14.2	0.01	0.02	22.8	54.8	7.4	64
Special Other Types Secondary Woody	11	52.3	14.7	0.01	8	29.8	24.9	0	0.01	46.9	172.9	13.15	55
Special Other Types Primary Non Woody	14	8.14	5.23	0.04	2	19.5	9.16	0.01	0.05	10.8	27.1	5.2	95
Primary Woody Xerophilic Shrub	880	12.5	11.2	0.01	893	29.4	14.2	0	0.01	18.9	76.7	8.76	91
Secondary Woody Xerophilic Shrub	88	27.1	14.3	0.01	143	27.1	9.69	0.01	0.02	27.1	62.6	7.91	57
Primary Non Woody Xerophilic Shrub	1025	12.4	9.56	0.01	3236	23.7	10.2	0.01	0.02	17.6	48.4	6.96	77
Secondary Non Woody Xerophilic Shrub	39	18.3	15.3	0	553	19.9	5.82	0.03	0.03	19.7	29.4	5.42	54
Other Lands	46	10.5	5.88	0.03	51	8.07	3.36	0.1	0.13	8.67	8	2.83	64
Grassland	924	37.6	23.4	0	2431	28.4	11.3	0.01	0.01	30.1	103	10.15	66
Primary Deciduous Jungle	324	29.3	17.1	0	142	37.6	16.9	0	0.01	33.5	142.7	11.94	70

Secondary Deciduous Jungle	147	36	21.9	0	314	37.5	14.4	0	0.01	37.1	143.1	11.96	63
Primary Evergreen Jungle	265	60.7	29.5	0	0				0	60.7	844	29.05	94
Secondary Evergreen Jungle	57	83.9	27.9	0	0				0	83.9	644.5	25.39	59
Primary Sub-Deciduous Jungle	64	56.1	17.9	0	36	31	11.5	0.01	0.01	38.5	87.5	9.35	48
Secondary Sub-Deciduous Jungle	38	32.2	15.9	0.01	38	35.6	12.8	0.01	0.01	34.1	90.1	9.49	55
Primary Hydrophytic Woody Vegetation	43	97.2	50	0	3	101	54.6	0	0	98.8		42.16	84
Primary Hydrophytic Non Woody Vegetation	33	42	17.4	0	36	17	4.51	0.05	0.06	19	18.2	4.27	44

Note 1. Dense soil drafts are those with over 5.0 profiles per 100 km2 of surface. Note 2. Obs= Observations Mean= Weighted estimator of each vegetation group per information source. DevSt= Standard deviation of each vegetation group per information source. Wi= Variance of each vegetation group per information source. /1 The compound or combined estimator is represented as □i and is equal to the sum of □i□i / □, where □i = 1/□i,□i = average variance (□i) y □= □ (□i).

To create the charts on annualized GHG emissions required by the IPCC the IPCC UNFCCC_NAI_IS_132.software was used. Regarding grasslands, forest and farming lands with no changes, there was a transfer of area values (Aij) directly obtained from the Change Matrix of soil use and it was assumed that the FE was zero.

For some of the vegetation group within the categories of grasslands, forest and farming lands, that have presented changes, but within their same category, they proceeded by considering the change surface (Aij) for a typical year period (Tij=1) and a calculation of the change in an annual stock was conducted (□CMineral) considering the differences in the reference stocks (SOCj – SOCREF) of the native forest or grassland and of the forest or grassland found during the year of the report and later on, this difference was amortized in 20 years (which is the period suggested by the IPCC during which the total organic carbon emission of the soul is carried out in the land conversion). For the case of changes to another soil use or in type of vegetation, the area values (Aij) and carbon reference stocks (SOCREF) were taken into account.

Results

1. Mountain Mesophilic Forests and High Evergreen Jungles in the states of Oaxaca, Chiapas, Campeche and Quintana Roo, as well as the hydrophilic vegetation of Yucatán, are the reservoirs with the biggest Carbon Stock in Mexico (Figure 18).

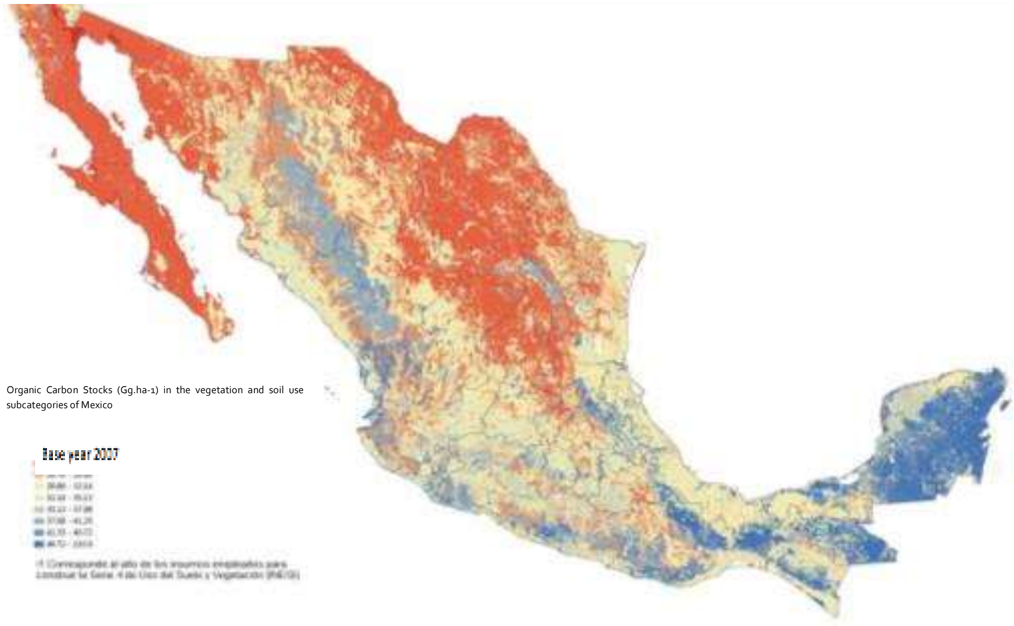

Figure 18. Organic Carbon Stocks in the mineral soils of Mexico. Base year 2007

2. The areas known as Other Lands that include areas with no vegetation and sandy deserts are the reservoirs with least Carbon Stock.

3. Overall, forests and jungles in primary phase have less carbon stock than those in secondary phase (Figure 19).

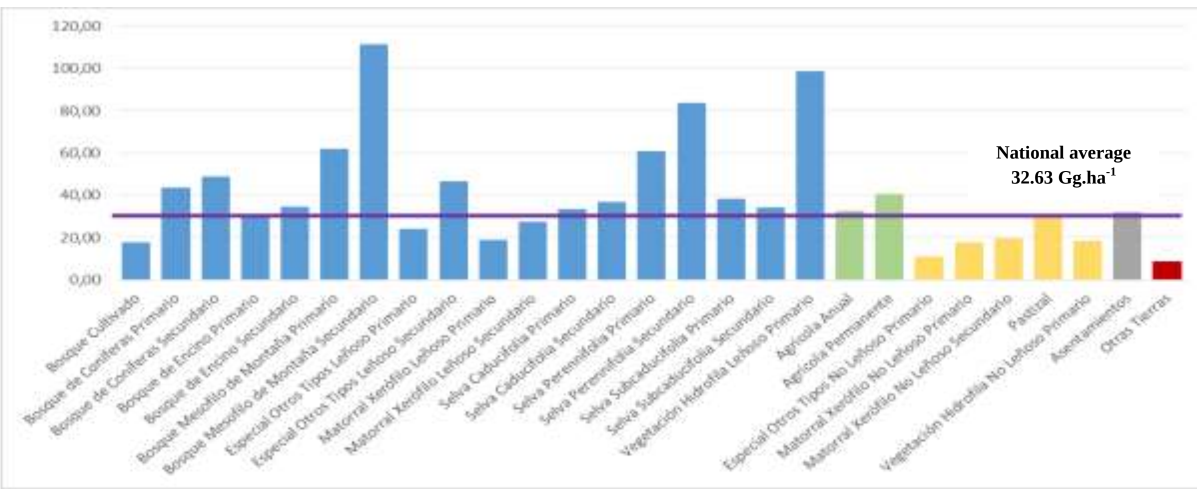

Figure 19. Organic carbon reference stocks in the soil according to the vegetation groups.

4. The estimates conducted in the 1993-2002 period indicate an emission average of 1,298 Cg CO2/year, while for the period of 2002-2006 indicate an average of 1,465 Cg CO2/year and for the

period of 2007-2013 show an average of 596 Cg CO2/year (Figure 20). The dimension of the emissions shown in Figure 5 proves that this stock provides very little in relation to the emissions due to the conversions to the aerial biomass.

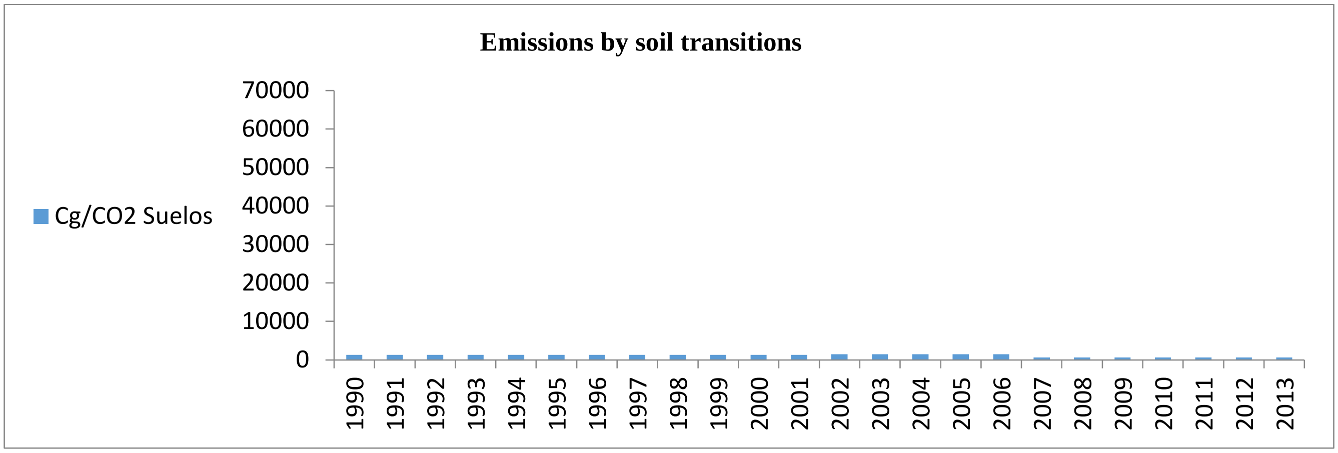

Figure 20. Organic carbon reference stocks in the soil according to the vegetation groups.

d) INEGI Cartography methods

Series II

Land Use and Vegetation Series II are designed to form part of a Geographic Information System, which is structured in data sets that are integrated into different covers or layers.

The techniques and tools used to generate Land Use and Vegetation information on a scale 1: 250,000 and the methodological process consider the following steps:

Preliminary Interpretation

An initial interpretation of the satellite maps was made in analog format (printed maps) by overlaying a transparency with the land use and vegetation polygons of Series I and then the polygons which displayed changes were identified; areas of interest to be verified in the field were identified, itineraries for the verification path were defined, and hypotheses on areas of change were proposed.

Field Verification

During the field check, work was done on two types of items: a) Verification points, which are those in which information is collected in detail; and b) Observation points, in which only qualitative data concerning the type of vegetation, specific characteristics of the terrain, etc., are taken

The field data points may contain information of agricultural activities carried out in a particular place or information concerning the type of vegetation (natural or introduced).

The verification was made on land and, when necessary, air support was received via helicopter. During this stage, samples of specimens of plant species representative and/or dominant in plant communities were collected, as this is important for backing the mapping information generated.

Analysis and Integration of Information

In this state, information obtained from the preliminary interpretation and field verification was analyzed, and hypotheses proposed during the preliminary interpretation are tested based on the results obtained during the field verification.

This information was displayed in the transparencies and relevant corrections and modifications were made to the polygons. The information obtained in the field was compared with the office background and updated information is acquired.

Publication

Subsequently the updated information is digitally published and once the file is obtained, it is disaggregated into 9 layers (Figure 20) comprising the vector information. This information is available to the user in digital or print format.

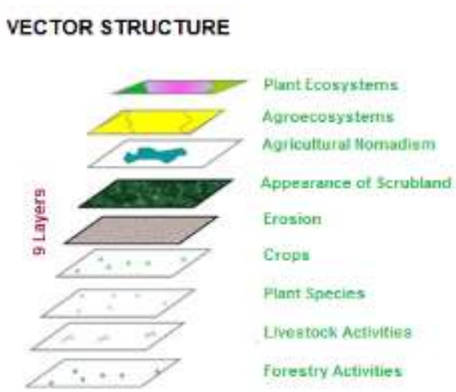

Figure 20. Structure of the 9 Vector Layers of the Series

Series III

The methodological process for preparing Series III on Land Use and Vegetation Information is basically the same as that used to generate Series II, save for some modifications and adjustments taking into account the use of new digital inputs (satellite images, thematic vector data, and vector data from previous series), digital format features, and the need to generate reliable high-quality information in the shortest time possible.

Preparing and Sending Inputs

The allocation of blocks consists of 2 or more sets of adjacent data. The allocation of each block is sent to the Regional Directorates and State Coordination in order to inform specialists and make deliveries to all those in charge of updating the following inputs:

- Satellite images
- Digital elevation model
- Vector data on Land Use and Vegetation from the previous series.
- Vector data from different thematic series: soil science, geology, climate, topography, and hydrology.

Preliminary Interpretation

During this process, the staff interpretation was made of the different units of Land Use and Vegetation Series II with the Landsat TM 2002 georeferenced image as a base in order to detect areas of change in vegetation cover, whether by natural causes or due to human activity, for which the support of various thematic layers was employed. The information resulting from this activity identifies the places to be visited during the field check.

Field Verification

Once the preliminary interpretation was completed, planning for field verification occurred, for which a route of areas to verify was established, the points to see can be located and are of three types:

- Verification Sites where information is gathered in order to document a change in vegetation cover.
- Observation Sites where observations are made to confirm a situation detected in the preliminary interpretation.
- Monitoring Sites that correspond to specific ecological situations and which correspond to protected areas, ecological buffer zones, areas of relict vegetation, and that merit a visit for each information update with the object of viewing their behavior.

These points were visited in the field, and a field report including the data obtained in the survey by the specialists on Land Use was issued, the check was conducted by land and eventually support from a helicopter was received.

During the gathering of information, the collection of plant species characteristic of the point was performed in order to confirm or modify the type of vegetation determined.

Analysis of Information

At this stage, the final changes were made to the vector data, the vector structure, and information attributes (change of labels). The resulting information was subjected to a thorough validation process. For this activity, the information obtained during the field check was used as well as the inputs mentioned in the section on preliminary information.

Identification of Plant Material

The botanical specimens, properly preserved in the field, were sent to the INEGI Department of Botany in order to proceed with the identification and prepare the respective list. This information was useful, as it supports updating work and it also characterized the observation point gathered by being included in the corresponding field reports.

Generation of Information Layers

Once the office update was made, the extraction of the different layers that make up the series according to their characteristics (polygons, points, or lines) took place. Once the layers are generated, all the blocks are joined in order to generate the National Set of each one of these. With the information validated by supervisors, it is then delivered to the Department of Land Use.

Thematic and Digital Validation

Upon receipt of the information at the Department of Land Use, thematic and digital validation takes place in order to ensure consistency and proper structure. In the event of inconsistencies, it is returned to the agencies that generated it in order to correct them.

Integration of National Sets

After verifying the information, the national sets for each layer of information contained in the Series are integrated.

Validation of Alphanumeric Information

As mentioned above, the properly georeferenced field information is located in the specific layers of species, crops, sites of ecological importance, and lines of ecological importance. This information is captured and is available to users who require it.

Release of Information

Once the national sets are integrated and validated, they are released and delivered to the Database Directorate to be integrated into the INEGI Geographic Database and then to be distributed and sold.

Series IV and V

The methodological process for the preparation of Series III, IV, and V on Land Use and Vegetation information is presented below in Figures 21, 22, 23.

It is worth noting that Series III and V were prepared by interpreting Landsat TM 5 images with a spatial resolution of 30x30 meters per pixel, and Series IV relied on SPOT 4 (2007 and 2008) with a spatial resolution of 20x20 meters per pixel. In order to produce comparable information between Series, the SPOT images were first resampled, changing their spatial resolution to 30x30 meters per pixel to integrate them into the map preparation processes.

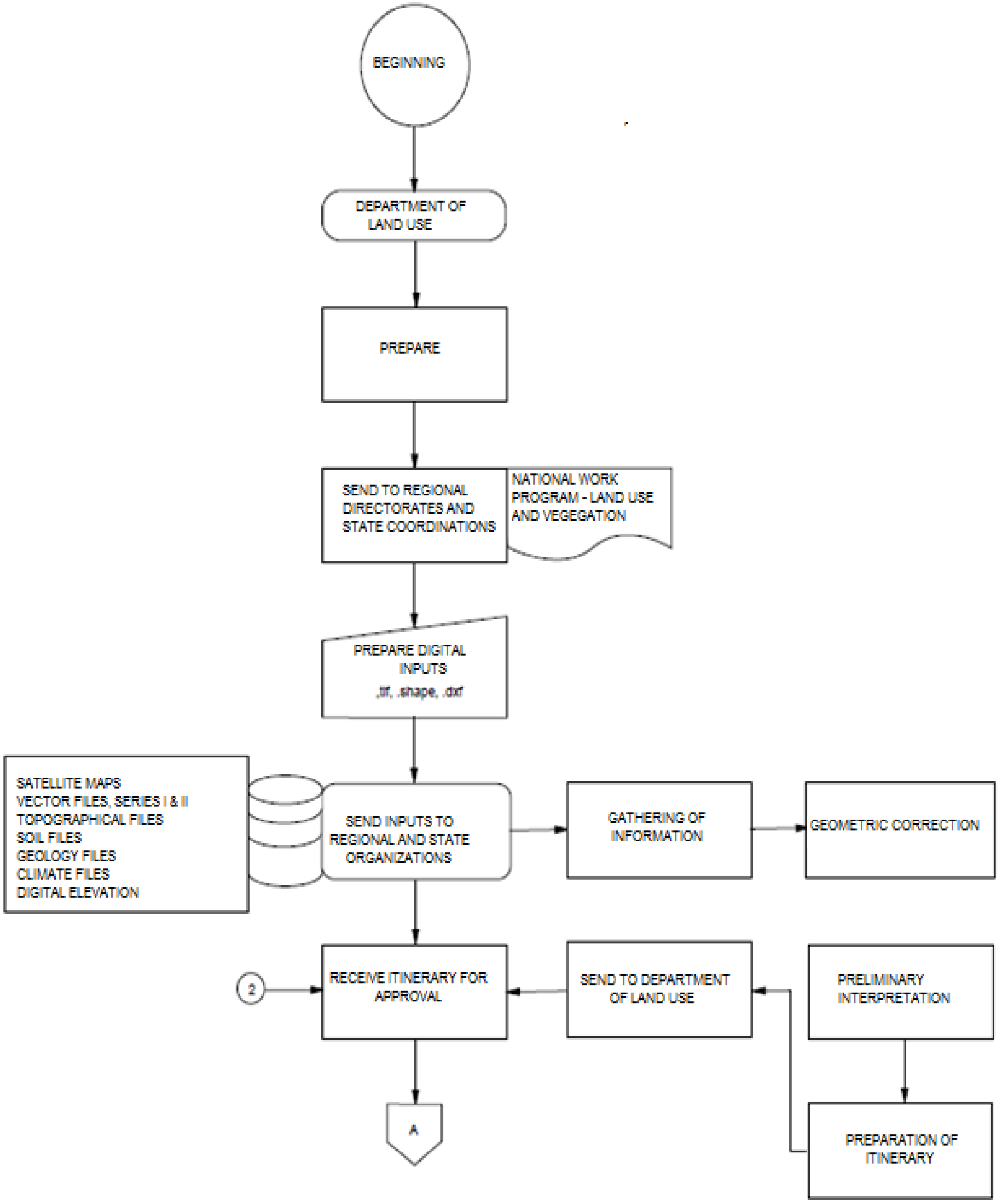

Figure 21. Methodological Process for the Preparation of Series III, IV, and V.

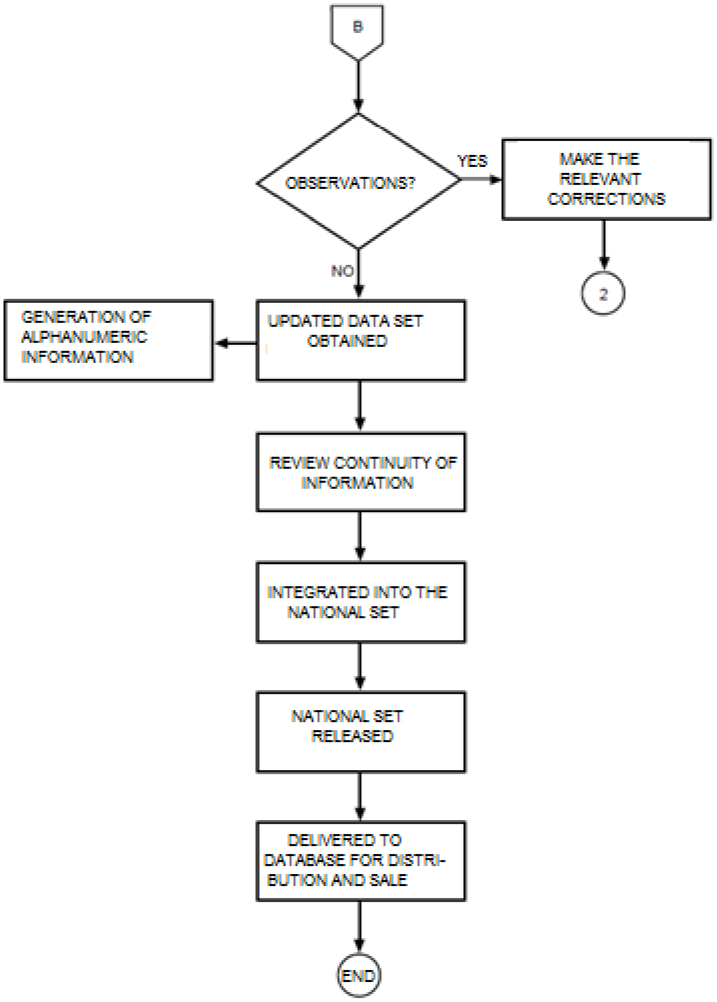

Figure 22. Methodological Process for the Preparation of Series III, IV, and V.

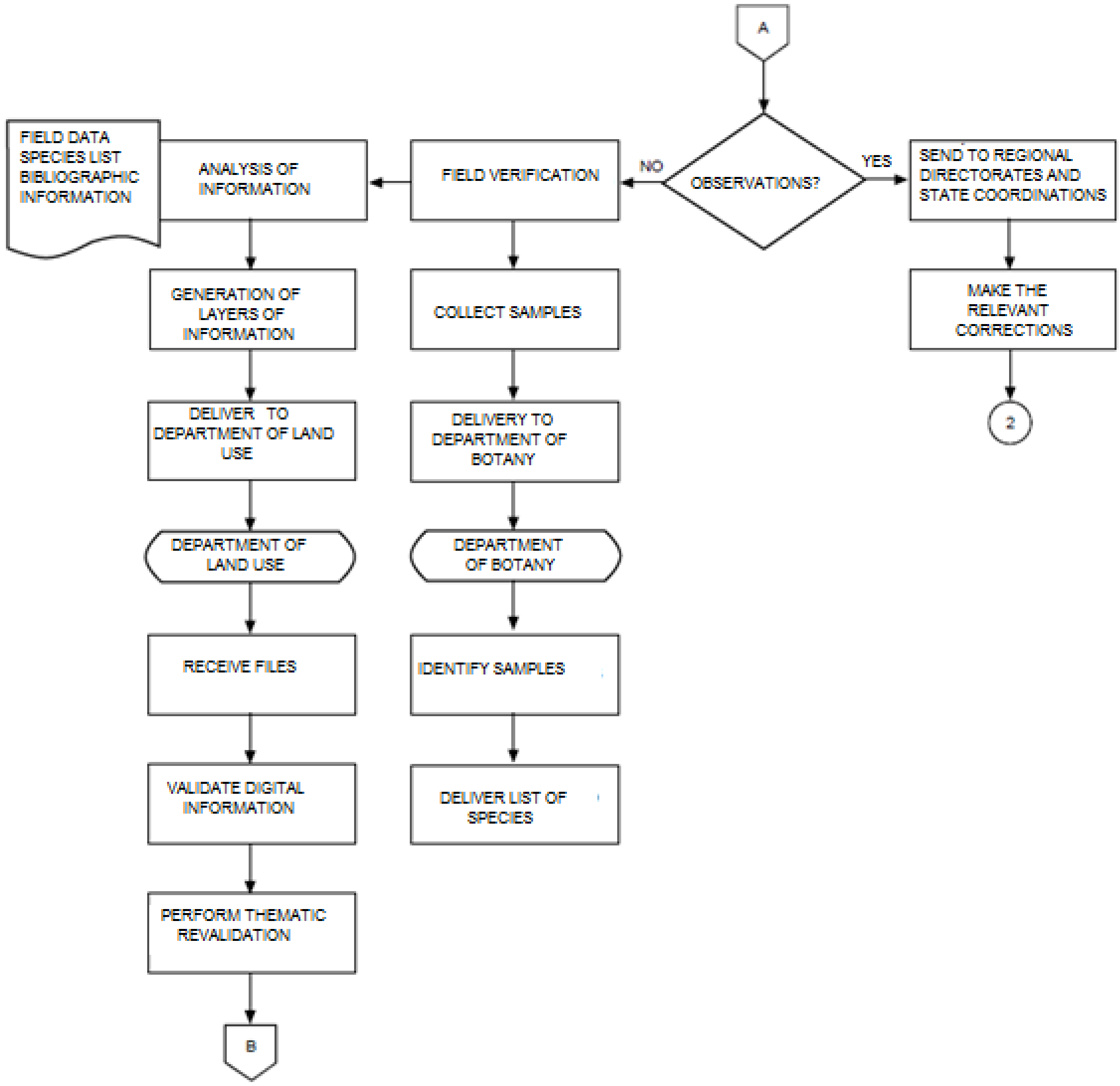

Figure 23. Methodological Process for the Preparation of Series III, IV, and V.

e) Forest National policy

The implementation of the 2014-2018 National Forest Program (PRONAFOR, for its acronym in Spanish is being carried out through 28 strategies and 124 courses of action that contribute to achieving five objectives and 13 strategic indicators which are aligned with the provisions of the 2013-2018 National Development Plan (NDP) and the 2013-2018 Sectorial Program of the Environment and Natural Resources (PROMARNAT, for its acronym in Spanish).

For the execution of the PRONAFOR, 12 specific strategies for institutional intervention have been designed and implemented as can be seen in the following table:

National Forest Program 2014-2018	
2014-2030 National Research and Technological Development Program	Training and Forest Culture Program
Forest Restoration and Productive Reconversion Program	National Forest Fire Prevention Program
Forest Health Program	Support Program for Indigenous Peoples and Gender Equality
Payment for Ecosystem Services Program	Program to Improve the Quality of Technical Assistance
National Sustainable Forest Management Strategy to Increase Production and Productivity	Program for Commercial Forest Plantations
REDD+ National Strategy and Intervention Model in REDD+ Early Action Areas	Financing Strategy for the Forestry Sector

National Sustainable Forest Management Strategy to Increase Production and Productivity.

It includes the articulation of five components:

- The first component is "Community Business Strengthening," which aims to facilitate community development and the installation of local capacities with a business approach from forest owners to generate social and human capital that strengthens and reinforces sustainable management of their forest resources.

- The second component is "Forestry and Forest Management," which is intended to promote forest management through the application of silvicultural techniques which allow for taking full advantage of the productivity of forests by applying biodiversity conservation practices.

- The third component is "Supply, Processing, and Markets," which is intended to improve the profitability of forestry companies. It involves carry out studies of supply basins to determine the flow of raw materials to propose an alternative and efficient order for production which considers extraction and primary processing at the beginning or the redesign of the current industry and its supply system, thereby seeking to reduce production costs for raw forest materials. Support for marketing will be given by trying to connect producers with new markets, promoting the development of new products in supply basins and identifying separate markets for this production, including the market for certified timber.

- The fourth component is transversal and refers to "Institutional Coordination," which aims to ensure the participation of the institutions involved at all three levels of government, such as the SEMARNAT, PROFEPA, CONABIO, CONANP, the Secretary of Environment or of Rural Development in the States, and State and Municipal Forestry Management Offices so that they contribute the fulfillment of the objectives and goals of the National Sustainable Forest Management Strategy to Increase Production and Productivity (ENAIPROS, for its acronym in Spanish) in the scope of their powers.

- The fifth component is "Monitoring and Assessment," through which a system of indicators will be established which allows for the monitoring of the results and impact of the ENAIPROS on each of the four above mentioned components.

Financing Strategy for the Forestry Sector

This strategy is aimed towards increasing financing for the forestry sector in the context of sustainable forest management through the development and improvement of conditions, mechanisms, and instruments that promote diversification of investments and payment for goods and services, complemented by innovative national and international models.

Support Program for Indigenous Peoples and Gender Equality

Encourage the participation of indigenous peoples in institutional activities of the forestry sector through individualized attention and recognition of their knowledge and practices in the use, management, and conservation of natural resources.

Payment for Ecosystem Services Program

Contribute to maintaining the provision of ecosystem services by strengthening the payment for environmental services (PES) scheme in order to move from a passive conservation scheme to an active one by strengthening the development of local mechanisms with competition from private resources, government institutions, and non-governmental organizations.

Intervention Model in REDD Early Action Areas

Curb deforestation and degradation to reduce GHG emissions through the implementation of sustainable practices aimed at sustainable rural development and that encourage improvement in the living conditions of the owners and users of the territories in rural areas.

2014-2015 National Research and Technological Development Program

Encourage and promote sustainable forest management through the use of appropriate and accessible technologies, considering the definition of specific lines of research to address the priorities of the forestry sector and the development and transfer of knowledge.

Training and Forest Culture Program

Sensitize, educate, and train producers and other stakeholders in the forestry sector on sustainable use of their resources through training and forest culture activities.

Forest Restoration and Productive Reconversion Program

Recover forest cover in forest land that is degraded and devoid of vegetation through promoting comprehensive restoration projects through targeting strategies in priority areas with a focus on micro-basins where specific projects are planned and carried out with a high-quality plant appropriate to the site which allows for the improvement of the conditions of ecosystems.

National Forest Fire Prevention Program

Reduce deterioration in forest ecosystems caused by harmful forest fires by transitioning from a strategy of suppression to a fire management strategy by strengthening local capacities and inter-institutional coordination.

Forest Health Program

Reduce the effects of pests and diseases on lands, nurseries, and forest plantations.

Program to Improve the Quality of Technical Assistance

Have forest technical service providers and certified and evaluated technical advisors that provide or intend to provide technical assistance to beneficiaries of CONAFOR programs.

Program for Commercial Forest Plantations

Increase production and sustainable forest productivity through promoting the development of commercial forest plantations in priority regions by using species and varieties suited to each region, implementing of efficient management practices, and encouraging organization for production.

ESTADOS UNIDOS MEXICANOS

SEMARNAT

SECRETARÍA DE
MEDIO AMBIENTE
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CONAFOR

COMISIÓN NACIONAL FORESTAL