Informative Note ENCCRV 09

NATIONAL STRATEGY ON CLIMATE CHANGE AND VEGETATION RESOURCES

Santiago, May 2017

In this edition

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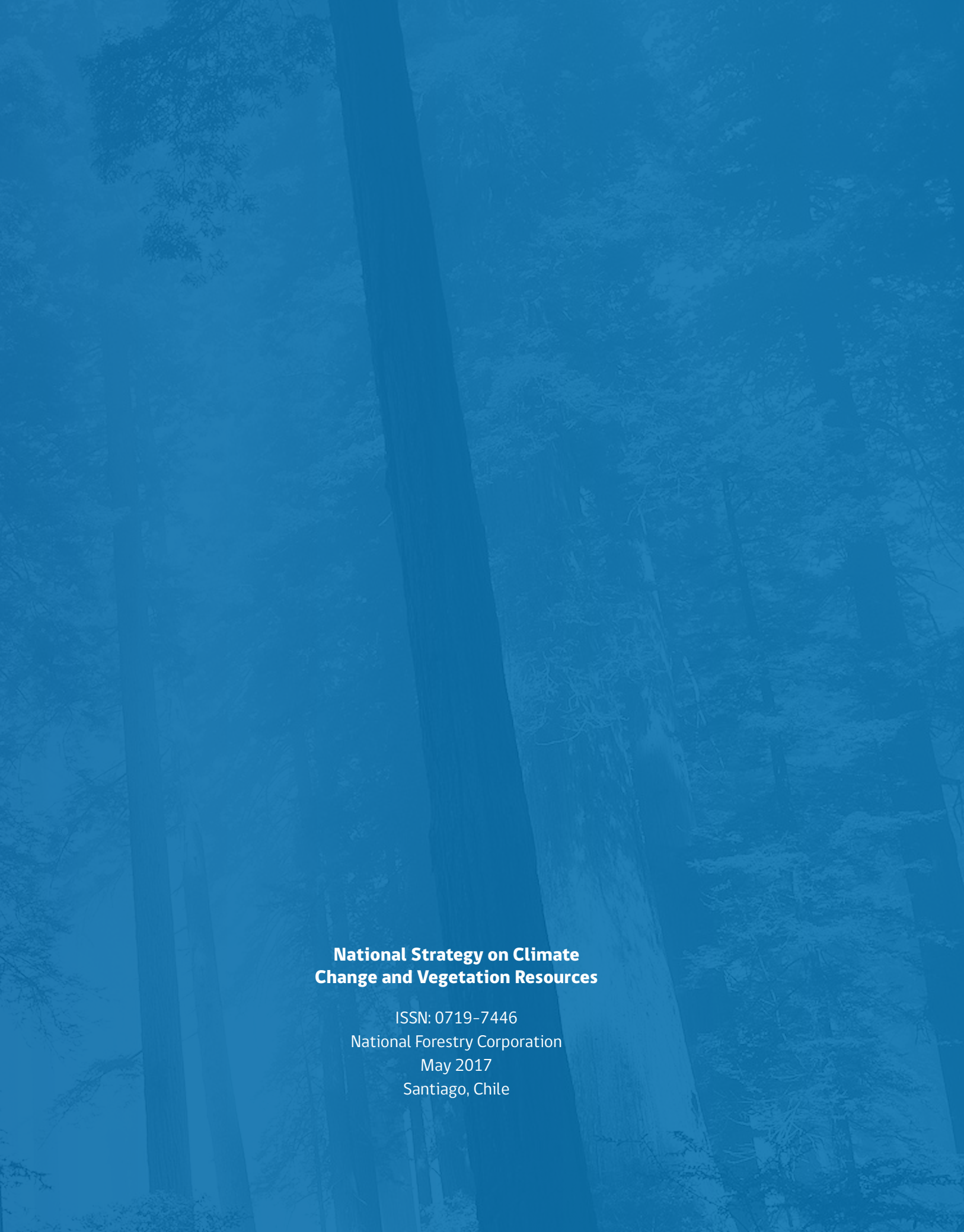
Regions between El Maule and Los Lagos

Climate Change and Environmental Services Unit (UCCSA)
Forest Development and Promotion Management Department (GEDEFF)
National Forestry Corporation (CONAF)
Chilean Ministry of Agriculture

ENCCRV

ESTRATEGIA NACIONAL DE CAMBIO CLIMÁTICO Y RECURSOS VEGETACIONALES



National Strategy on Climate Change and Vegetation Resources

ISSN: 0719-7446
National Forestry Corporation
May 2017
Santiago, Chile

Chile's Subnational Forest Reference Emission Levels/Forest Reference Levels

Regions between El Maule and Los Lagos

Authors

Javier Cano, Angelo Sartori, Osvaldo Quintanilla, Jaeel Moraga, Renato Cifuentes.

Climate Change and Environmental Services Unit (UCCSA). Forest Development and Promotion Management Department (GEDEFF). National Forestry Corporation (CONAF).

Acknowledgements

The National Forestry Corporation (CONAF) and its Climate Change and Environmental Services Unit (UCCSA) would like to thank the Forest Carbon Partnership Facility (FCPF) and particularly The Carbon Fund (CF) for its financial contribution in supporting the implementation of this study through an international public tender held by The World Bank, with the technical support of the team of consultants comprised by Winrock International, Universidad Austral de Chile (UACh) and the Chilean Ministry of Agriculture's Forestry Institute (INFOR). Likewise, we would like to thank the United Nation's UN-REDD Program composed of the Food and Agriculture Organization (FAO), the United Nation's Development Program (UNDP), and the United Nation's Environment Program (UNEP).

According to the physicist and mathematician Lord William Thomson Kelvin (1824-1907), *"What is not defined cannot be measured. If you cannot measure it, you cannot improve it. What is not improved is always degraded"*. This quote -after 100 years of the author's death- concisely accounts for the production process, generation of outcomes and objectives of the Forest Reference Emission Levels/ Forest Reference Levels (FREL/FRL) for the REDD+ policies approach within the framework of Chile's National Strategy on Climate Change and Vegetation Resources (ENCCRV).

Table of Contents

1. Context

In December, 2013, in the 19th Conference of the Parties (CoP) of the United Nations Framework Convention on Climate Change (UNFCCC), the Warsaw Framework for REDD+ was created, which establishes the general guidelines and standard procedures for preparation and implementation in developing countries of policy approaches that promote positive incentives for conducting the following activities (Figure 1):

Reducing carbon emissions associated to:

- Deforestation
- Forest degradation

Increasing CO_2 removals through:

- Increase of forest carbon stocks
- Forest conservation
- Sustainable management of forests

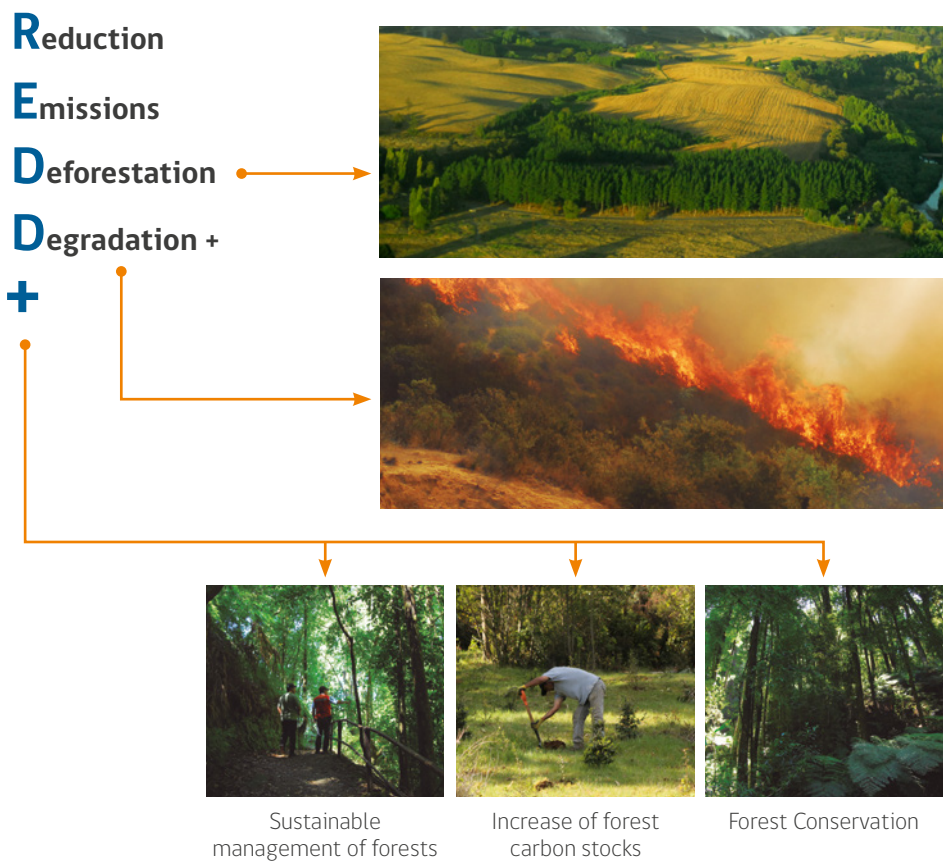


Figure 1. The aim of REDD+ is to develop policy approaches that promote positive incentives for carbon emission reductions (ER) associated to deforestation and forest degradation, along with increasing CO_2 removals through the increase of forest carbon stocks, forest conservation and the sustainable management of forests.

Within the guidelines established for the development of REDD+, a mandatory element is the formulation of a FREL/FRL which must characterize the emissions and removals for each activity during a recent historic period and project them into the future, with the final aim of serving as a base for estimating the performance of the implementation of the measures defined by each country for addressing the causes of deforestation, forest degradation and issues that interfere in the increase of forest carbon removals.

There are a number of good practice guides and methodological guidances –primarily those developed by the Intergovernmental Panel on Climate Change (IPCC)– that deliver a general methodological framework for accounting forest carbon emissions and removals, but not particularly for building the FREL/FRL. This process must be implemented considering each country's political, social and economic specificities, technical capacities, availability of information and variability of forest ecosystems.

Until 2016, 15 countries had submitted their FREL/FRL to the Secretariat of the UNFCCC, with significant gaps, primarily between the REDD+ activities in Figure 2.

In general terms –among the countries that have submitted their FREL/FRL–, the following is stated:

- All countries, with the exception of Malaysia, included the activity of deforestation.
- Chile, Congo, Guiana, Indonesia and Vietnam included the activity of forest degradation.
- Chile, Costa Rica, Ethiopia and Vietnam included the activity of increase of forest carbon stocks.
- Chile and Vietnam included the activity of forest conservation.
- Only Malaysia included the activity of sustainable forest management.

Figure 2. Countries, REDD+ Activities included and year of consignment of the FREL/FRL before the UNFCCC.

In 2017, Cambodia, Ivory Coast, Ghana, Honduras, Madagascar, Nepal, Papua New Guinea, Sri Lanka, Tanzania and Uganda submitted their respective FREL/FRLs to the UNFCCC Secretariat, adding to the expansion of Brazil's FREL/FRL with regard to the Cerrado Forest biome (Figure 3). On the other hand, in Latin America, countries such as Argentina, Bolivia, Uruguay or Venezuela have not yet submitted their FREL/FRLs before the Secretariat.

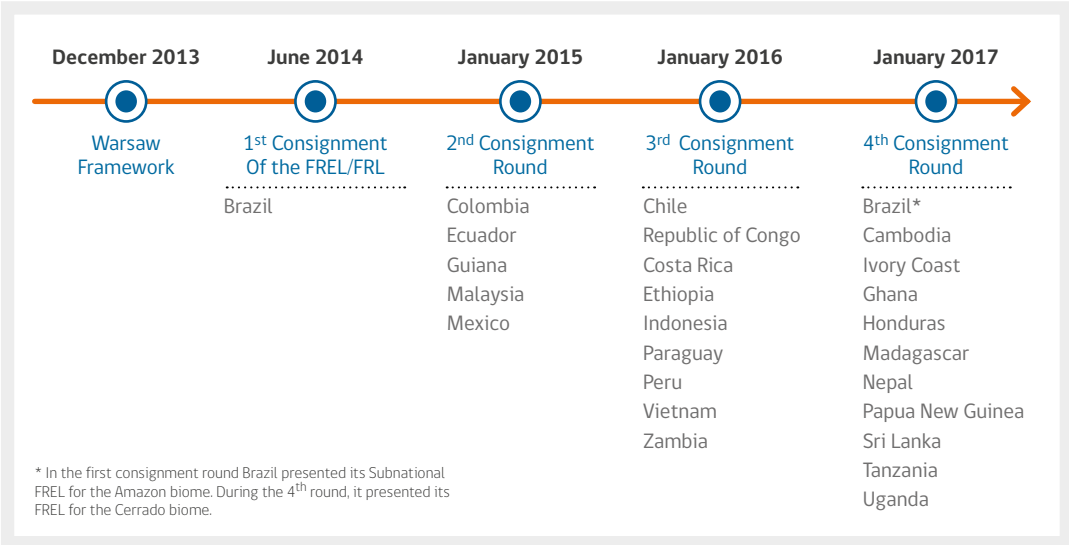


Figure 3. Timeline of reference level consignment before the UNFCCC.

The FREL/FRL submitted by Chile includes information related to the emissions from deforestation and forest degradation, in addition to the removals from the increase in forest carbon stocks and forest conservation, which account for four of the five REDD+ activities, with Chile and Vietnam being the first countries in progressing towards this level of completeness.

This milestone is of great relevance, thus showing the technical capacities developed and the level of progress in the historical information generated by the country, but it is also the true and fair view of the national circumstances and the relevance of Chile's forest sector.

It is also noted that in most tropical countries, deforestation is the largest issue for forests, while for Chile, forest degradation causes larger emissions of Greenhouse Gases (GHG) into the atmosphere, as shown by several studies conducted by CONAF, INFOR, Global Forest Watch, Program on Forests (PROFOR), among others, including the results obtained from Chile's Subnational FREL/FRL, with forest fires and the unsustainable use of vegetation resources being the main causes of these emissions. In the last 20 years, the country's actions have caused a substantial reduction of the annual deforestation rate, with reductions from 20,000 hectares annually in 1990 to 7,000 hectares in 20151 (Figure 4).

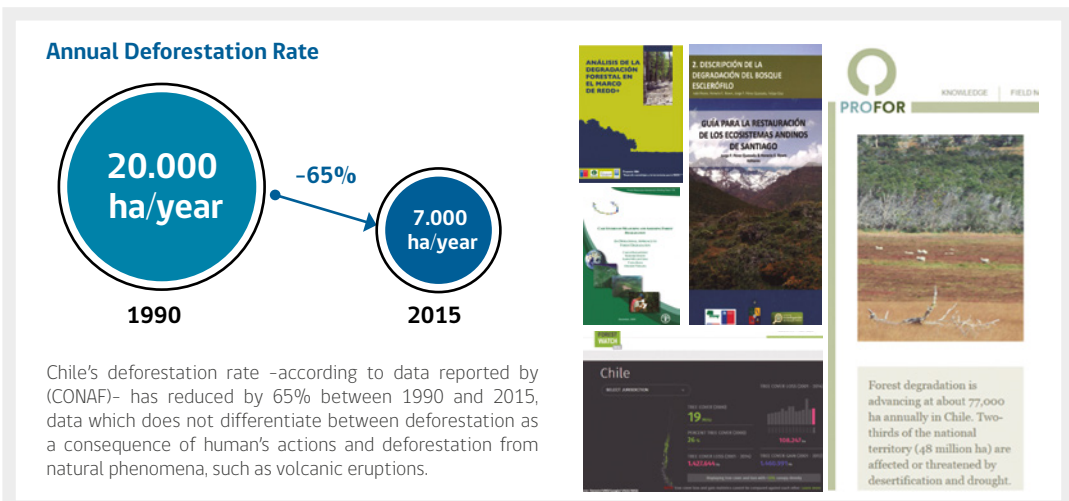


Figure 4. Relevance of forest degradation in Chile.

[1] http://portal.mma.gob.cl/la-deforestacion-del-bosque-nativo-se-ha-reducido-al-minimo-en-chile/

2. Work Team

Chile, just like the rest of the countries which to date have created and published their respective FREL/FRLs, has been supported by international cooperation for the creation of technical capacities that allow the formulation of this mandatory element within the framework of REDD+. Nevertheless, the lack of prior experience of developed and developing countries, international agencies, non-government entities, research centers, the academy and companies has resulted in this being a "learning by doing" process. This process goes beyond the development of technical capacity-building for forest monitoring, since it implies deep knowledge of national circumstances and capacities, institutional arrangements, regulatory frameworks and accounting standards to be applied, inter-relationships between national requirements such as the National Inventory of Greenhouse Gases (INGEI) and the FREL/FRL and international requirements, such as multilateral or bilateral voluntary instances in subjects related to forests and climate change.

CONAF through UCCSA, GEDEFF and the Forest Ecosystems Monitoring Department, part of the Forest Supervision and Environmental Assessment Management Department (GEF) were responsible for the formulation of Chile's Subnational FREL/FRL.

This also included the financial and technical support from the World Bank through the FCPF and the UN-REDD Program comprised by FAO, the UNDP, and the UNEP. In the technical field, the nonprofit organization Winrock International based in Washington, D. C, United States, the INFOR and Universidad Austral de Chile (UACh) collaborated and formed a consortium that allowed them to have a high level of expertise in the development of international reports, generation of inputs for estimating emissions, monitoring land use and land use change, and characterization of Chile's native vegetation.

It is worth noting that CONAF and INFOR, under the coordination of the Department of Agricultural Policy Studies (ODEPA) -all of which are part of the Ministry of Agriculture- generate base information and collaborate as part of the technical team, in the formulation of the INGEI in the Forestry and Other Land Use Sectors, which has allowed to maintain a high level of consistency between the INGEI and the FREL/FRLs.

Climate Change and Environmental Services Unit (UCCSA)

CONAF's **UCCSA** is the National Focal Point of REDD+ before the UNFCCC. This department is responsible for generating preparation elements, implementing and monitoring results and sharing of benefits generated within the framework of the 2017-2025 ENCCRV, including the subject of REDD+ .

Forest Ecosystems' Monitoring Department

CONAF's **Forest Ecosystem Monitoring Department** is responsible for the application of Article No.4 of Law No. 20,283 on Native Forest Recovery and Forest Promotion, which implies the cartographic maintenance and update of the Forest Cadaster, along with the public provision of generated information. It likewise leads the implementation of the National Inventory of Wood Energy and Forest Carbon.

The **World Bank** is an international entity that supports CONAF in several projects that are implemented with international funds within the framework of the design and implementation of the ENCCRV.

The **UN-REDD Program** -created with the joint collaboration of FAO, the UNDP and UNEP- supports countries in the design and implementation of REDD+ through capacity-building techniques, knowledge exchange and assistance in the development of methods and data generation.

Winrock International is an organization based in the United States, specializing in social, agricultural and environmental development. The organization has worked in REDD+ with countries such as Colombia, Peru, Guiana, Guatemala, Costa Rica, Ghana, Liberia, Democratic Republic of the Congo, Mozambique, Cambodia, Vietnam, Laos, Papua New Guinea, Indonesia, Malaysia, Bangladesh, among others.

The **INFOR's** mission is the creation and transfer of scientific and technological knowledge in the forest area. Is responsible for providing data through the Continuous Forest Inventory, and has developed methodologies for estimating forest degradation.

The **UACh** is one of the leading academic institutions in Native Forest Studies. It has participated since the 90's in the formulation of the Forest Cadaster and its updates, and has developed a great number of allometric functions for native species.

3. Definition of Forest

Returning to the initial quote by Lord Kelvin, it is important that prior to delving into sources of information, methods, and results, we define the parameters that we want to measure, starting with the definition of forest, followed by the REDD+ activities and sub-activities included in the FREL/FRLs.

The national definition of forest for REDD+ -as well as the related activities- was defined through a process coordinated by CONAF, with the participation of national and international experts who continuously contributed and commented on the original definitions' proposal and all of its subsequent versions. The resulting definitions underwent a final discussion and validation in the "Second International Workshop for the creation of Forest Reference Emission Levels - Forest Reference Levels and MRV Analysis, the Chilean Context"[2], held with the participation of experts from CONAF, INFOR, UACh, Universidad Mayor, Winrock International, the National Forest Commission of Mexico (CONAFOR)[3] and the World Bank. During the workshop, the last modifications were made and the final definitions were agreed, based on two fundamental principles:

Operational Capacity, using parameters that allow the appropriate measurements of information sources and existing methodologies.

Respect and consideration for the opinions of the majority gathered in the participatory process at a national level conducted for formulating and validating the ENCCRV.

After a thorough analysis, the concept of native forest established in Law No. 20,283 on Native Forest Recovery and Forest Promotion was adopted for the REDD+ approach in Chile, stating: ""a forest is formed by native species resulting from natural generation, natural regeneration or under canopy plantations

[2] More information at:
http://www.enccrv-chile.cl/index.php/descargas/nivel-de-referencia/51-anexo-acta-taller-nr/file
http://www.enccrv-chile.cl/index.php/descargas/nivel-de-referencia/53-Anexo-Definiciones-actividades-REDD/file
[3] Within the framework of the project funded by the Chile-Mexico Fund.

with the same species that exist in the original area of allocation, which may have unintended presence of randomly-allocated exotic species".

As previously mentioned, the definitions of forests and REDD+ approach activities are of operational guidance, which is why in this case we considered forests **those lands determined by the Forest Cadaster as native or mixed forests**, classification categories that adjust to the legal definition applied.

In line with the goals sought through the implementation of the action measures of the ENCCRV, and by respecting the issues raised in the participatory process of formulation and validation of this initiative, the FREL/FRLs did not consider in their accounting the carbon fluxes produced in forest plantations, which -in the national context- are mainly associated to planted forests of exotic species with a purely productive industrial aim.

4. REDD+ Activities

The REDD+ approach activities -referring to the human actions **related to forests that produce emissions or removals of GHGs**- are defined based on processes that may occur within the forest and around it. Some activities are related to forest dynamics that may be identified in a relatively simple manner, mainly those that cause changes in the use of land, such as deforestation. However, there are forest dynamics which do not result in immediate changes in the use of land, but do produce variations in the forests' conditions and capacities for providing goods and services, such as forest degradation or the recovery of degraded forests. There is a high level of difficulty in estimating carbon variations caused by such dynamics. Therefore, it is important to analyze the parameters, methods and sources of information available and to associate these parameters to the REDD+ approach activities.

Starting with the concept of **forests**, it is possible to identify a series of critical transformations:

- It can be converted to other land uses, such as grasslands, scrublands, agricultural lands or urban and industrial areas.
- It can convert from forest[4] to plantation, process known as substitution.

Similarly, these processes or conversions may occur in a reverse manner:

- Grasslands, scrublands and agricultural lands may convert to forests.
- Plantations may convert to native forests.

In addition, since they are constantly-changing formations, forests are subject to natural and other processes linked to human activities, which cause:

- Reduction of their capacity for providing goods and services.
- Increase of their capacity for providing goods and service.

Finally, the use of the forests and the legislation that governs them defines specific forest aims according to their special characteristics and conditions, such as:

- Forests intended for conservation.
- Forests intended for production.

The tools, information sources and methodologies that allow estimating the dynamics to which these resources are exposed were identified by considering this framework, generating an initial stratification between those conversions that cause changes in the use of land and those processes that occur in permanent forests. Subsequently, we identified the sources of information that allow identifying the regulatory frameworks which regulate forest interventions. As a result of this exercise, the following definitions were established for the activities within the REDD+ approach.

[4] Consistent with the definition of forest adopted for the REDD+ approach, this document shall consider "forest" as the definition of "native forest" in Law No. 20,283

Deforestation

GHG Emissions due to the conversion of forest areas into other land uses in a permanent manner.

Considerations:

1. The conversion of forest use to plantation is not considered deforestation

2. An area temporarily devoid of forest is not considered deforested as long a natural or assisted regeneration activity is planned, reported and documented.

Forest Degradation

GHG Emissions from the reduction of a forest's carbon content, induced by human activity with an intensity that recommends the cessation of the productive forestry activity, but whose level does not imply land-use change.

Considerations:

1. Additionally, all changes from forest use to forest plantation are considered forest degradation. Although a forest plantation may have a larger content or absorption capacity of GHG, the substitution process considers the emissions from vegetation removal to be incurred for the establishment of a plantation, which is added to the previously mentioned causes.

2. The emissions produced by biomass burning in forest fires are considered part of the forest degradation emissions.

Increase in Forest Carbon Stocks

GHG Removals from an increase in forest carbon content in lands converted from other uses to forests, in addition to the increase of carbon content from the recovery of degraded forests.

Considerations:

1. Increases in areas converted from forests to forest plantations are not considered an increase of forest carbon stocks, since they are included in the definition of forest degradation, as described above.

2. All conversions in the use of forest plantation to forest, process known as restitution, are considered an increase of forest carbon stocks. This is how the consistency with the concept of substitution applied to forest degradation is maintained. Considering the fact that restitution is a process that happens after plantation harvesting, it should be noted that carbon content prior to the restitution is zero.

Forest Conservation

Net accounting of emissions from forest degradation and removals due to the increase of forest stocks in forest areas subject to formal Conservation processes.

Considerations:

1. Forests subject to formal conservation processes are those corresponding to Preservation Forest Types such as the Chilean wine palm, the Alerce and the Araucaria. Forest areas that are part of the National System of State-Protected Wilderness Areas (SNASPE) are also included, along with those registered as Private Protected areas with forest Conservation nature (APP).

Sustainable Management of Forests

Net accounting of emissions from forest degradation and removals due to the increase of forest stocks in forest areas subject to formal management processes.

Considerations:

1. Formal management processes are those activities performed under instruments managed by CONAF: management plans and standards.

Currently it is not possible to spatially delimit the native forest areas subject to forest management through the previously stipulated formal processes with an official cartography. Within the framework of strengthening of the base technical background for implementing the ENCCRV, we are developing inputs that will enable to establish forest carbon fluxes associated to this activity. Meanwhile, the variations in stock management are integrated in the estimations of emissions from forest degradation and removals from the increase of forest carbon stocks, as appropriate.

5. Extension of the FREL/FRL

CONAF, according to the conditions of national-level information and as established by the UNFCCC, has decided to focus its efforts in the generation of FREL/FRLs under a sub-national scale, prioritizing the South-Central zone of Chile, area with a high concentration and the greatest diversity of forests in the country with a strong anthropic pressure that affects its condition permanently due to activities that cause deforestation and forest degradation.

The area covered by the subnational FREL/FRL includes five of the fifteen administrative regions that divide Chile, from the El Maule to the Los Lagos Regions, including both of them (Figure 5). The temperate forest is present in these regions, with a great potential for the reduction of emissions and increase of GHG removals related to forests, and the capacity for producing non-carbon environmental benefits, such as water balance improvement, soil conservation and biodiversity maintenance, among several other positive impacts in communities which directly depend on these ecosystems.

The extension of these five regions covers a surface of 16,522,077 hectares, which account for 22% of Chile's continental area and contain 5,853,387 hectares of forests, accounting for 41% of the total of this type of vegetation in a the country. Eleven (11) out of the 12 forest types defined by law at a national level are depicted in the subnational area of the FREL/FRL.

The expansion of the FREL/FRL is contemplated -at a national level- once improvements have been made in the national base information, along with the optimization of the methods to be used. For this purpose, we are currently planning and implementing studies in order to present the national-level FREL/FRLs in 2018.

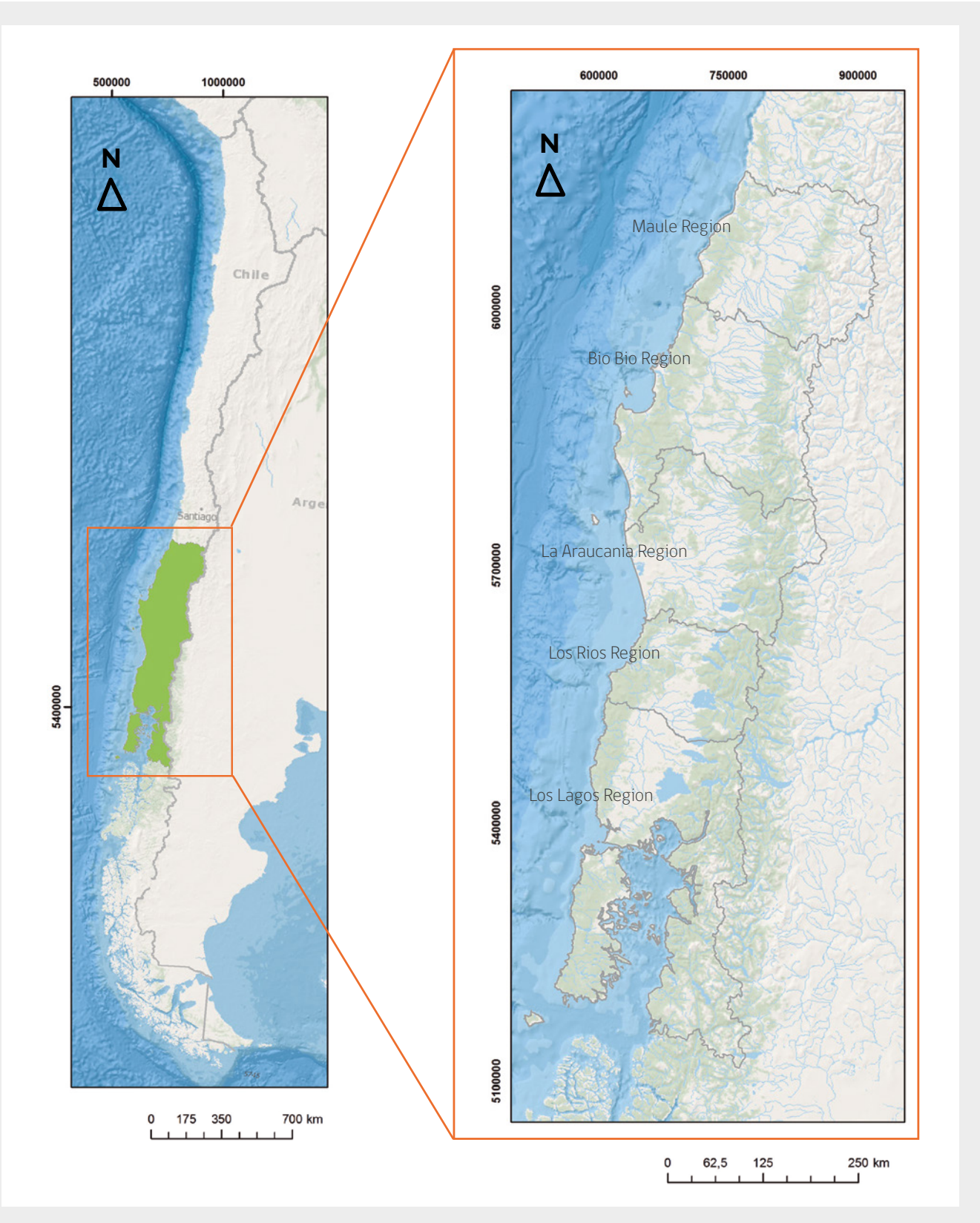


Figure 5. Area covered by Chile's subnational FREL/FRL.

6. Sources of Information

Considering the definition of forest and activities of the REDD+ approach, we have identified the necessary information for the formulation of the FREL/FRL, composed of the following elements:

- Areas of land- use types and of land-use change.
- Carbon contents and their variations.

These two elements are generated through two basic official inputs, respectively.

- Forest Cadaster of land-use and vegetation, headed by CONAF.
- Continuous Forest Inventory, headed by INFOR.

The **Forest Cadaster** of land use and vegetation generates the official national information with regard to land-use and land-use change. Since 1997, with the publication of the results of several land use areas, regional level updates have been created, which have allowed identifying the area of standing forests, the area of forests substituted by forest plantations, and the area of other land uses converted to forests.

The **Continuous Forest Inventory** includes the measurement of dasometric parameters in permanent plots of land allocated between the Regions of Coquimbo and Magallanes, with periodic re-measurements. The first cycle of the Inventory was developed between 2001 and 2010, including the base measurement and the first re-measurement. Currently the inventory runs in 4-year cycles, conducting re-measurements of 25% of the plots each year, and a projection of the remaining 75%. The outcomes provide volumes of above-ground biomass, below-ground biomass and necromass.

For the formulation of the FREL/FRLs, in addition to the two sources indicated, other sources were used, highlighting the databases used in the development of Chile's INGEI. The latter contributed complementary data, both developed by national researchers and default data provided by the IPCC for the estimation of carbon contents by type of land use, annual average increase by forest type and other elements that enabled the transformations necessary for converting the primary data into tons of carbon dioxide equivalent (tCO2eq), unit used to report the forest GHG emissions and removals to the UNFCCC.

Additionally, we integrated data of areas affected by forest fires, Landsat 5 and 7 satellite images, calculation tools and geographic information technologies, such as Google Earth Engine, and Collect Earth.

7. Method

The FREL/FRL considers emissions from different **carbon pools** or reservoirs during a **historical reference period** through the estimation of **activity data** or areas of change and **emission factors**, or GHG flow by unit area, reporting the results together with their associated level of **uncertainty**.

Carbon pools

The IPCC considers five carbon pools in forest structure:

> **Above-ground biomass:** it includes carbon accumulated in the trunk, branches, twigs and vegetation leaves.

> **Below-ground biomass:** it includes carbon accumulated in the roots.

> **Dead Organic Matter (DOM) or Necromass:** it includes carbon accumulated in standing dead biomass and coarse wastes.

> **Leaf-litter:** it is dead biomass composed of leaves and small-sized fragments of wood.

> **Soil Organic Carbon:** it is organic matter incorporated and accumulated in the first 30 centimeters of soil.

The following pools have been considered in the subnational FREL/FRL, according to the activity.

> **Above-ground and below-ground Biomass:** for all activities.

> **Necromass:** in activities of deforestation, forest degradation and forest conservation. The increase in forest carbon stocks is not included in the activity because there is no information regarding the necromass accumulation rate in areas converted into forest lands.

> **Leaf-litter:** it is not considered due to the absence of data for the reference period.

> **Soil-organic carbon:** it is not included due to the absence of official georeferenced information that allows estimating the relation between the activities and soil-organic carbon. Despite the existence of global values that could be used, soil carbon content is considered to depend largely on local conditions, particularly in terms of the type of vegetation cover, climate and soil, as well as the management factors to which it is exposed.

Reference period

The reference period corresponds to the temporary range in which forest carbon emissions and removals are estimated for their future projection. The reference period used for the estimation of Chile's Subnational FREL/FRL was determined based on indicators and criteria established by international entities linked to the REDD+ approach, such as the Methodological Framework of the FCPF[5], additionally considering the availability of necessary information for the construction of the FREL/FRL and the different methodologies applied for estimating emissions and removals of the different activities and sub-activities.

It is worth noting that in the initial versions of the Subnational FREL/FRL reported by Chile to the UNFCCC and the FCPF, there was a significant heterogeneity in the dates of the information used; therefore, there was no clear definition of the reference period. With the aim of remedying this deficiency, based on the comments and suggestions of the review teams of both instances and the effort and experience of the technical team in charge, we harmonized the data sources used and applied interpolation techniques that allowed reducing the heterogeneity of the reference periods.

Considering the availability of information and the applied methodologies, we determined two differentiated reference periods.

- **2001-2013 Period**, for activities or sub-activities linked to **land-use or sub-use change**: deforestation, degradation from substitution, increase in forest area and restitution. In this case, and considering that the main source of information is CONAF's Cadaster -which is created in different dates for each Region- an interpolation was conducted, according to the available data as per Table 1.

- **2001-2010 Period,** for activities or sub-activities which occur in **permanent forests**: degradation in permanent forests, recovery of degraded forests and forest conservation. Emissions of Methane (CH_4) and Nitrous Oxide (N_2O)- which are generated with combustion during forest fires- are also included.

[5] Framework which establishes the criteria and indicators to be complied by the countries participating in this pilot multilateral REDD+ instance (https://www.forestcarbonpartnership.org/guidelines-and-templates).

Information Dates of Land-use Change Activity Data							
Region	Date of Map 1	Date of Map 2	Date of Map 3	Initial year of Reference Period	Final year of Reference Period	Initial Year of Interpolation (b1)	Final Year of Interpolation (b2)
Maule	1997	2009	2016	2001	2013	4	3
Biobio	1997	2008	2014			4	1
La Araucania	1997	2007	2013			4	0
Los Rios	1997	2006	2013			4	0
Northern Los Lagos	1997	2006	2013			4	0
Southern Los Lagos	1997	Sin información	2013			4	0

Table 1. Historical Information of Forest Cadaster used in activities and sub-activities linked to land-use changes.

Estimation Methodology for Land-use changes

The **Activity Data** or areas subject to land-use conversions were calculated using -as a basic input- CONAF's Forest Cadaster.

The area of forests converted to other land uses was estimated (agricultural land, pastureland and/or settlements, and forest plantations), in addition to conversions of other land uses to forests. This section includes emissions and removals from deforestation, substitution, restitution and increase of forest area, according to the definitions above.

Each cover generated within the framework of the Forest Cadaster includes the associated land-use, according to the categories specified in the Forest Cadaster Manual 6, which were reassigned to different land-uses. According to the estimation of land-use and change, the affected areas were established for each activity of the REDD+ approach, as specified in Table 2.

Forest Cadaster Land-use	Initial Use	Final Use	Sub-activity	REDD+ Activity
Adult Native Forest	Forest	Plantations	Substitution	Degradation
Mixed Forest		Other land uses	Deforestation	Deforestation
Plantations	Plantations	Plantations	N/A	N/A
		Other land uses	N/A	N/A
		Native Forest	Restitution	Increase of forest carbon stocks
Industrial and urban areas	Other land uses	Native Forest	Increase of forest area	Increase of forest carbon stocks
Agricultural land				
Scrublands and Grasslands				
Wetlands		Plantations	N/A	N/A
Areas devoid of vegetation				
Snow and glaciers		Other land uses	N/A	N/A
Bodies of water				

Table 2. Land-uses registered by the Forest Cadaster, reallocation of categories and definition of REDD+ activities and sub-activities.

[6] Forest Cadaster Manual http://www.enccrv-chile.cl/index.php/descargas/nivel-de-referencia/63-Anexo-Manual-Catastro-1995/file

In order to establish the unit emission by type of land-use change or **Emission Factors** linked to emissions from deforestation and the sub-activity of degradation from substitution, we used the data from above-ground biomass stocks and native forest necromass by Region, according to the Continuous Forest Inventory (Table 3). For the case of below-ground biomass, the root: shoot ratio (0.29) developed by Gayoso (2002) was used.

Region	Biomass (t ms ha^{-1})	Necromass (t ms ha^{-1})	Total (t ms ha^{-1})
Maule	103,4	4,6	108,0
Biobio	192,9	10,0	202,9
La Araucania	334,8	46,9	381,7
Los Rios	422,6	117,4	540,0
Los Lagos	348,1	69,4	417,5

Table 3. Forest Biomass Stocks in tons of dry matter by hectare, by region, disaggregated by each one of the carbon reservoirs included in the analysis.

In order to establish the unit removal by type of change or **Removal Factor** linked to the **restitution and increment of the forest area**, the annual average growth of biomass per hectare data was used for each forest type (Table 4) from the Continuous Forest Inventory, with the exception of the "Araucaria" Forest Type, whose source is a study on the Araucaria (Araucaria Araucana) in the South of Chile (Mujica, 2003).

Type of forest	Secondary Forest	Adult
	(m^3 ha^{-1} $año^{-1}$)	
Alerce	0,45	0,45
Cipres de Las Guaitecas	3,9	3,9
Araucaria	4,6	4,6
Cipres de La Cordillera	4,7	3,9
Lenga	6,0	5,2
Coihue de Magallanes	6,1	4,6
Roble Hualo	4,6	3,0
Roble-Rauli-Coihue	6,1	5,0
Coihue-Rauli-Tepa	5,1	4,0
Sclerophyllous	2,2	1,9
Siempreverde	5,8	3,2

Table 4. Average annual increase (in cubic meters) per hectare and year, by forest type.

The estimations of carbon stocks for the category "Other land uses" must also be considered after the events of land-use change, assuming the national study estimates, and research from other countries with similar characteristics or default values of the IPCC (Table 5). In the case of plantations, it was indicated that carbon stocks directly after substitution account for cero.

Land use	Biomass (t ms ha^{-1})[7]	Necromass (t ms ha^{-1})	Source
Settlements	2	0	INGEI (2014)
Agricultural Land	10	2	INGEI (2014)
Grasslands	4,73	8,13	Gayoso (2006)
Scrublands-Grasslands	9,04	14,99	Gayoso (2006)
Scrublands	9,04	14,99	Gayoso (2006)
Arborescent scrub	21,78	35,25	Gayoso (2006)
Scrubland with succulent plants	9,04	14,99	Gayoso (2006)
Succulent plants	4,73	8,13	Assumption, same as Grasslands.
Scrubland plantation	9,04	14,99	Gayoso (2006)
Plantations	0	0	Decision made by technical team responsible for creating FREL/FRLs.
Arborescent scrub	21,78	35,25	Gayoso (2006)
Scrubland with succulent plants	0	0	Assumption
Succulent plants	0	0	Assumption
Scrubland plantation	0	0	Assumption
Plantations	0	0	Assumption

Table 5. Forest biomass stocks, in tons of dry matter per hectare, per carbon reservoirs included in the analysis for Other Land-uses.

Based on the **Activity Data** (Figure 6) and **Emission/Removal Factors**, the total emissions and removals are estimated by applying the IPCC's standard equations (2006)[8].

[7] Biomass and necromass units in [t ms ha-1] correspond to tonnes of dry matter per hectare.
[8] All of the methodological details are found in "Chile's Subnational FREL/FRL" at: http://www.enccrv-chile.cl/descargas/publicaciones/35-nivel-de-referencia-de-emisiones-forestales/file

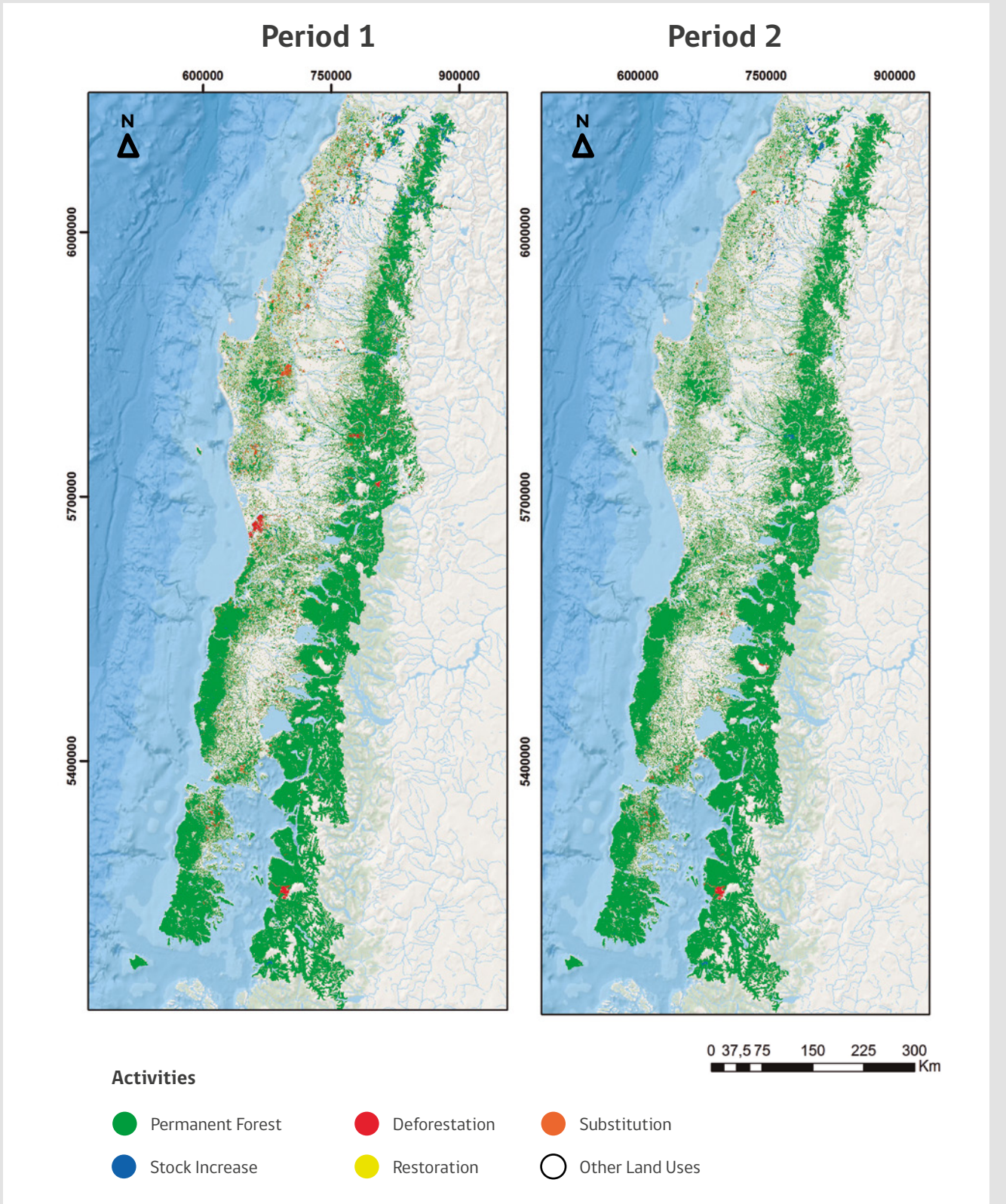


Figure 6. Map of activity data linked to land-use changes for the area covered by Chile's Subnational FREL/FRL.

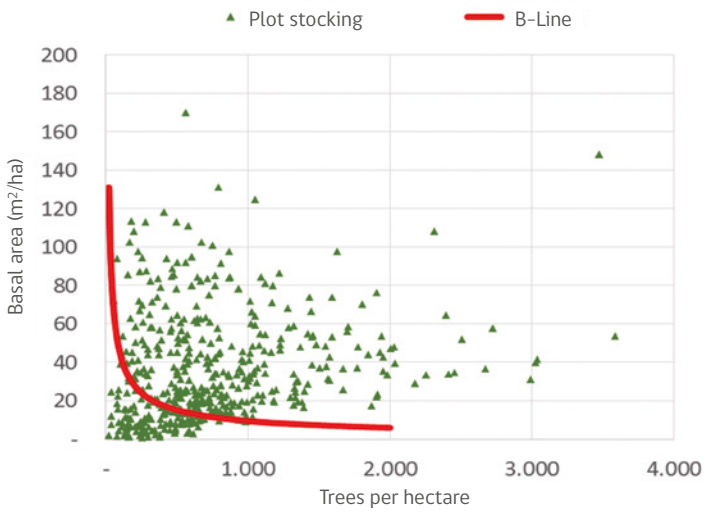
Estimation methodology in Permanent Forest

In order to estimate the **Activity Data** or area affected by degradation in permanent forests, recovery of degraded forests, and conservation of forests, we used the *Stocking Management Charts* originally developed by Gingrich (1967) and applied in Chile by Gezan et al. (2007), Bahamondez *et al.* (2009 and 2016) and Müller-Using et al. (2013). This methodology determines the silvicultural conditions of the forest for the optimal use of the site, maximum stock volume and minimum density for the recovery of the optimal stand density. The system uses the data of number of trees per hectare, basal area and quadratic mean diameter obtained in Continuous Forest Inventory plots for estimating carbon stocks for different dates coincident with its field measurements.

The Continuous Forest Inventory plot data is depicted in the density diagram, or *stocking* chart, based on the number of trees, basal area per hectare and quadratic mean diameter.

The density chart considers several thresholds for different types of forests, along with its status at the time of measurement, distinguishing between degraded and non-degraded plots (Bahamondez, 2009). With regard to the methodology applied to the FREL/FRL, the optimal density threshold, known as line B, will allow rating the degradation status in permanent forests and the recovery of degraded forests.

The B-Line represents the empirical limit where trees can develop and fully occupy the capacity of the site with no competition (Gingrich, 1967). The delimitation of this threshold was established through expert field work and is specific for each type of forest (INFOR, 2012). The line B is considered to be the threshold of a forest's natural resilience; therefore, activities of productive use are not recommended in forests rated below this line (Figure 7)[9].



At the time of formulation of the FREL/FRL, we had only validated and published the density chart associated with the forest type Roble-Rauli-Coihue (Oak-Rauli-Coihue) (Ro-Ra-Co). Currently, density chats are being developed for other forest types, which will be validated in the near future and will allow reducing the level of uncertainty of the FREL/FRL.

Figure 7. Density graph and B-line. Based on data generated by site measurements of the Continuous Forest Inventory used in the FREL/FRL.

[9] More information on the density chart parameters at: http://www.enccrv-chile.cl/index.php/descargas/nivel-de-referencia/52-anexo-datos-inventario-continuo/file

The density chart is a tool that allows describing forest status in a static moment. However, the activities and sub-activities to be analyzed in the FREL/FRL are processes that will be developed over time. Therefore, in order to determine the plots that are subject to degradation or recovery processes, we analyze the density chart displacements, caused by the variation of the basal area and number of trees per hectare between two measurements (Figure 8, Table 6).

- The plots moving towards the diagram's origin axis, crossing or maintaining below the B-line, are considered degradation plots.
- The plots moving away from the diagram's origin axis, crossing or maintaining below the B-line, are considered plots of recovery of degraded forests.
- Plots that move over the B-line, regardless of the direction, are not considered within the FREL/FRL, since variations are considered to be a natural effect and the plots are within the resilience threshold.

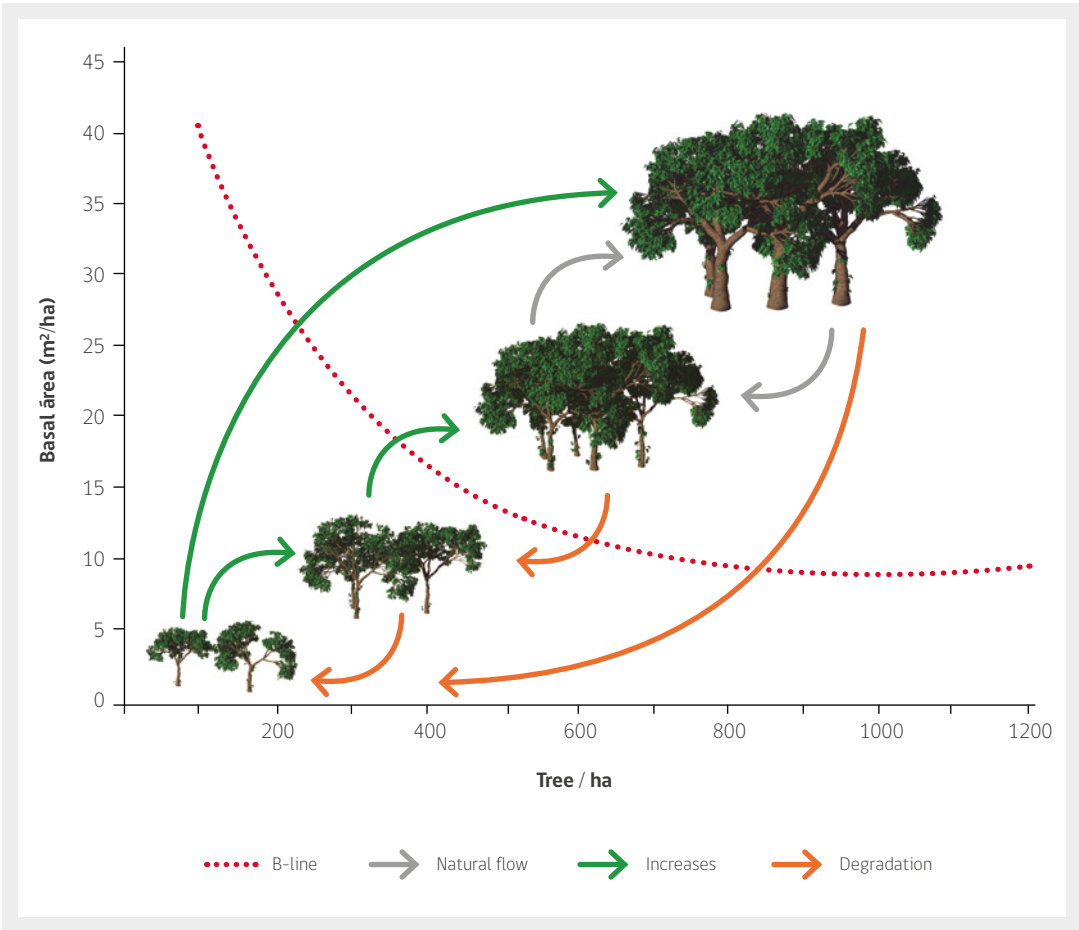


Figure 8. Example of carbon fluxes that account for increases (green arrow), degradation (orange arrow), and natural flux (grey arrow).

Location Change in the Density Chart	CO_2 Flux	Corresponding Activity
Above B in 2001 and below B in 2010	Emission	Degradation
Reductions below B in 2001 and below B in 2010	Emission	Degradation
Increases below B in 2001 and below B in 2010	CO_2 Removals	Increase of forest carbon stocks
Below B in 2001 and above B in 2010	CO_2 Removals	Increase of forest carbon stocks
Above B in 2001 and above B in 2010	N/A	Not accounted

Table 6. Possible changes in density chart between the two time periods. REDD+ activities that are accounted for.

The density chart records the dasometric information of plots gathered during field work, allowing to generate estimations for these plots, but lacking spatially explicit information which covers the total area of study.

In order to obtain spatially explicit information that allows estimating the areas subject to each of the previously described activities, a supervised classification approach is applied for nonparametric extrapolation to the k-nearest neighbor (K-nn), modified according to Tomppo (1991). This method is widely applied in the analysis of forest inventories and allows for the simultaneous extrapolation of status variables in sample plots, such as the basal area and the number of trees per hectare.

This methodology is applied for the permanent forest area, and stratification is subsequently performed for identifying the conservation areas (Figure 9). In order to differentiate conservation areas, the most recent maps of each Region's Forest Cadaster are used for identifying the total surface of Alerce and Araucaria Forest Types , which are primarily composed of these species under legal protection and are therefore, conservation areas. The spatial data of the National System of State-Protected Wilderness Areas (SNASPE) is also extracted from the Forest Cadaster. These are used for identifying the areas of public-protected areas. Regional data on areas of private-protected areas is obtained from Private-Protected Areas.

Moreover, from a *rasterized* digital cartography of the forest cover, the pixels affected by forest degradation and those in process of recovery of degraded forests -both from inside and outside of the conservation areas- are identified, estimating the carbon flux from pixel to pixel. For this purpose, a function of biomass volume based on the estimated basal area, expansion factors and conversion factors is used for each pixel, subsequently converting the vegetation cartography into carbon stocks[10], through the K-nn interpolation.

For accounting for GHG emissions other than carbon dioxide (NON-CO_2) from forest biomass burning, we used the tabular data with information on the area affected by forest fires in Chile's 2015 INGEI Annexes. The original data source is the historical forest statistics from CONAF and Companies from 1985 to 2012. The reported data includes total annual areas of forest fires in each region between 1971 and 2012. However, in the FREL/FRL, only data from 2001 to 2010 was included in order to maintain consistency with the permanent forest reference period.

[10] The methodological details are found in "Chile's Subnational FREL/FRL", document available at: http://www.enccrv-chile.cl/descargas/publicaciones/35-nivel-de-referencia-de-emisiones-forestales/file

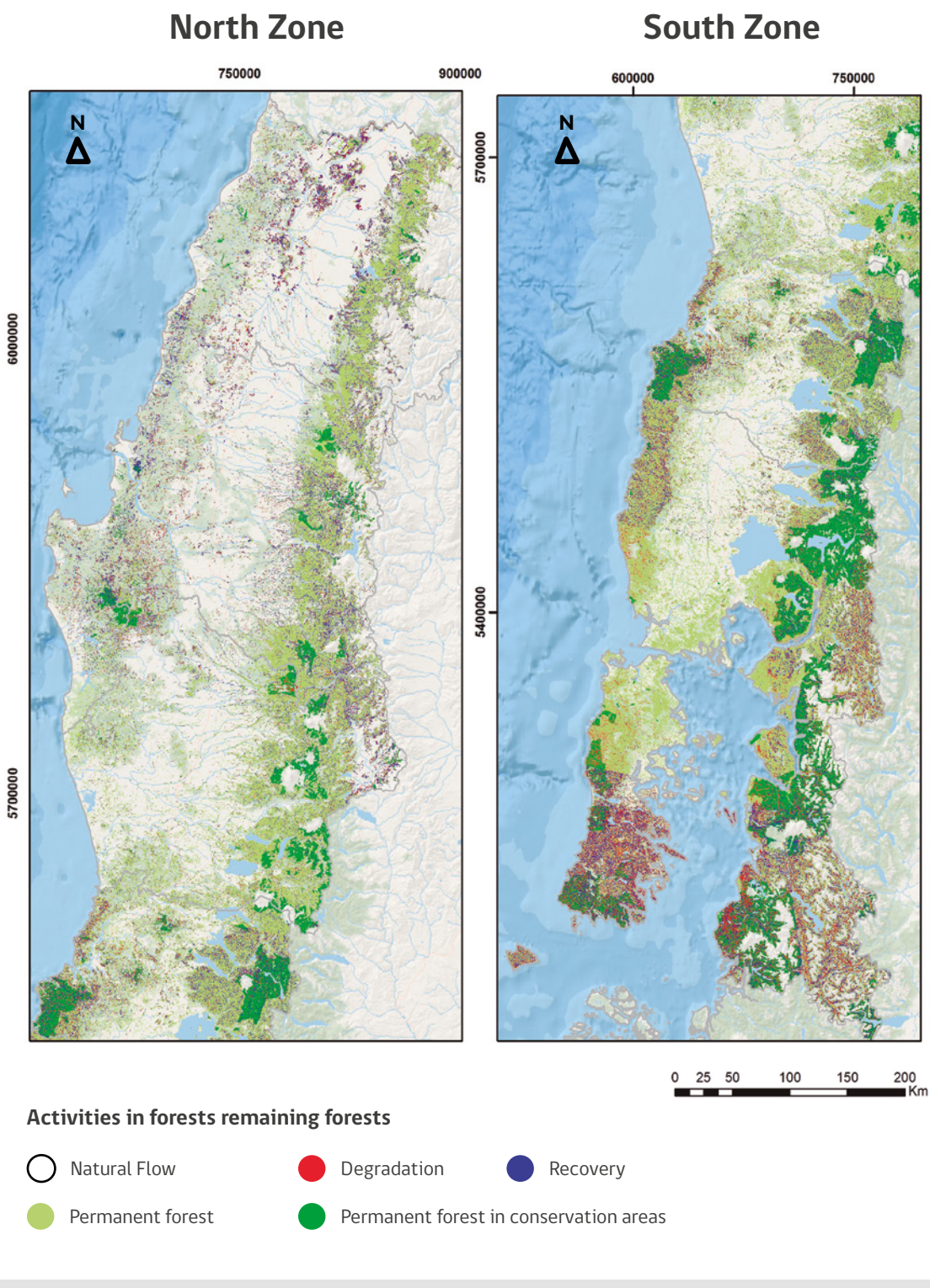


Figure 9. Activity data map in standing forests for the area covered by Chile's Subnational FREL/FRL.

Uncertainty Analysis

Uncertainty is an essential element in the FREL/FRL due to the fact that, just like all estimates, it differs from the actual underlying value; therefore it is necessary to find the error. Some causes of uncertainty are relatively easy to characterize for their inclusion in the quantification of uncertainty, such as the sampling errors, instrument accuracy, and statistical variance of the models. Other causes, such as bias, are more complex and their resolution is more difficult.

The official review processes of the UNFCCC and the FCPF agree in identifying the lack of depth in the performed uncertainty analysis as a weakness in the first versions of Chile's Subnational FREL/FRLs. The latter is a common circumstance in all countries' reports and is enhanced by the use of historical information, designed for other effects, and which -in many cases- does not contain the original databases. For this reason, the technical team conducted a substantial improvement of the report, creating new and more detailed information on the topic of uncertainty estimation.

In the uncertainty analysis, all potential **sources of error** were included, and the **accuracy** of the used information was estimated, in order to subsequently perform an **error propagation** analysis, therefore obtaining the final value of uncertainty.

Within the **sources of error** linked to **Activity Data**, we carried out an accuracy analysis of the maps of land-use and sub-use change from the Forest Cadaster based on the methodology defined in Olofsson *et al.*, (2014), validating the types of land-use and sub-use change with the tool Collect Earth , through the analysis of over 4,500 polygons accounting for an area larger than 90,000 hectares.

In addition, for activities in permanent forests, we included the radiometric and geometric performance error of the satellite images used, the error in degraded pixels mapping, with more 600 control points, and the error reported forest fire area.

With regard to the sources of error linked to carbon contents or **Emission Factors**, we considered uncertainty from field measurement errors, volumetric function errors for estimating biomass, uncertainty of the expansion factor of native forests, the basic density of native species, native forest root: shoot ratio, necromass estimation and estimation of biomass from other land-uses.

The total uncertainty of FREL/FRLs was estimated applying the error propagating methods described by the IPCC (2006):

Propagation of errors without weighting

Used when the parameters are directly multiplied for estimating the final result. For example, for the estimation of emissions from deforestation, we directly multiply the forest loss by the emission factor resulting from this land-use change and soil cover.

Weighted Error propagation

Used when the parameters are added to estimate the final result. For example, forest carbon increase removals resulting from the direct sum of increases from conversion from non-forest to forest, and increases in forests remaining forests.

8. Results

The results obtained in building Chile's Subnational FREL/FRLs indicate that the average emissions from deforestation -at a national level- account for around 3.5 million tCO_2eq annually, and from forest degradation in standing forests of around 5.0 million tCO_2eq annually (Table 7).

Removals are mainly generated by the recovery of degraded forests, which reach an average higher than 9.0 million of tCO_2eq annually. Meanwhile, restitution and the increase of forest areas account for removals lower than 0.2 and 0.8 million tCO_2eq annually, respectively. In the conservation areas, the net flux accounts for an average of removals of around 2.5 million tCO_2eq annually (Table 8).

Region	Activity							
	Deforestation		Substitution		Degradation in permanent forests		Forest fires	
	Deforested Area (ha year^{-1})	Emissions (tCO_2eq year^{-1})	Área Degradada (ha year^{-1})	Emisiones (tCO_2eq year^{-1})	Área Degradada (ha)	Emisiones (tCO_2eq year^{-1})	Área Degradada (ha year^{-1})	Emisiones (tCO_2eq year^{-1})
Maule	872	84.983	3.170	434.685	53.666	169.708	599	4.582
Biobio	1.416	396.645	4.570	978.618	62.399	213.428	1.237	17.843
La Araucania	1.630	1.059.067	2.525	1.413.313	34.183	435.415	2.116	58.616
Los Rios	751	644.696	920	774.622	42.905	592.373	151	6.085
Los Lagos Sur	585	401.230	459	181.556	268.078	3.551.324	782	23.977
Los Lagos Norte	1.216	866.265	277	293.246				
Total	**6.470**	**3.452.886**	**11.921**	**4.076.040**	**461.231**	**4.962.248**	**4.884**	**111.103**

Table 7. Area and emissions by region and sub-activity for the area covered by Chile's Subnational FREL/FRL.

Region	Activity							
	Increase of forest area		Restitution		Recovery of Degraded forests		Conservation	
	Area (ha year^{-1})	Emissions (tCO_2eq year^{-1})	Area (ha year^{-1})	Emissions (tCO_2eq year^{-1})	Degraded Area (ha)	Emissions (tCO_2eq year^{-1})	Conservation area (ha)	Emissions (tCO_2eq year^{-1})
Maule	6.949	-344.834	934	-46.346	34.903	-790.982	17.803	-14.780
Biobio	2.763	-132.910	1.452	-69.860	417.846	-1.079.374	97.255	-72.359
La Araucania	2.530	-158.175	499	-31.156	118.176	-1.328.564	164.340	-334.741
Los Rios	690	-40.371	222	-12.985	17.468	-1.968.685	225.862	-710.081
Los Lagos Sur	615	-33.806	83	-4.548	89.276	-3.953.636	930.671	-1.298.478
Los Lagos Norte	283	-15.782	0	0				
Total	**13.830**	**-725.878**	**3.190**	**-164.895**	**461.231**	**-9.121.241**	**1.435.931**	**-2.430.439**

Table 8. Area and removals by region and sub-activity for the area covered by Chile's Subnational FREL/FRL.

The estimation of the total emissions and removals reflect that most forest carbon emissions in the area of study are linked to degradation, with more than 9 million tCO_2eq annually. Removals from forest carbon stock increases and conservation account for somewhere around the total emissions (Table 9) The FREL/FRL was projected as the average of historical emissions and removals to 2025 (Figure 10).

Region	Activity ($tCO_2eq\ year^{-1}$)			
	Deforestation	Degradation	Increases	Conservation
Maule	84.982	608.976	-1.182.162	-14.780
Biobio	396.645	1.209.890	-1.282.143	-72.359
La Araucania	1.059.067	1.907.344	-1.517.894	-334.741
Los Rios	644.696	1.373.080	-2.022.041	-710.081
Los Lagos	1.267.494	4.050.103	-4.007.772	-1.298.478
Total	**3.452.884**	**9.149.392**	**-10.012.012**	**-2.430.439**

Table 9. Average historical emissions and removals by activity and region for the area covered by Chile's Subnational FREL/FRL.

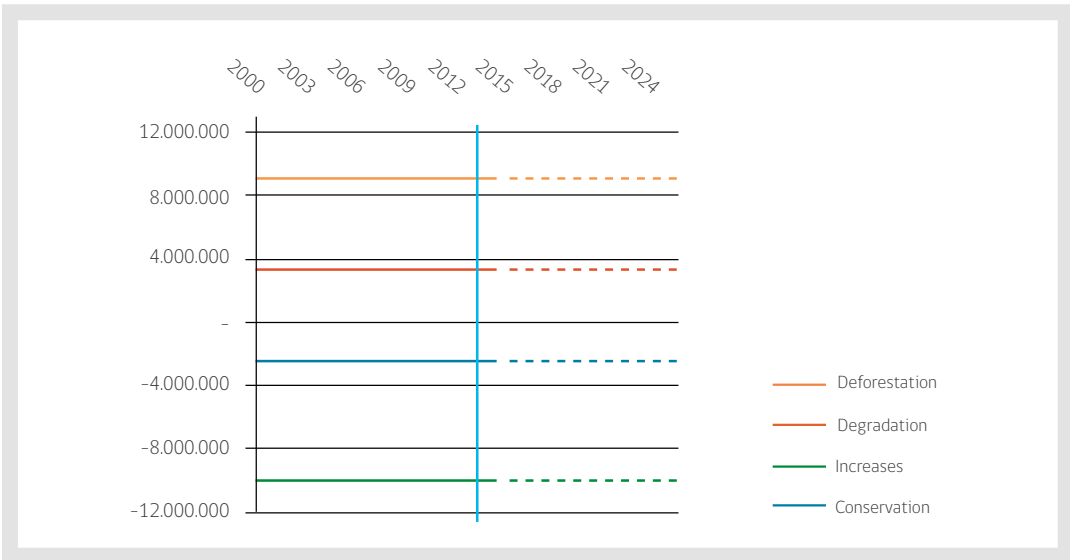


Figure 10. Chile's Subnational Forest Reference Emission Levels/Forest Reference Levels (RL: Reference Level).

The total uncertainty is the error propagation of the uncertainties of the sub-activities above. Error propagation was weighted according to the absolute emissions/removals of each activity, resulting in a total uncertainty of 33.3% (Table 10).

Sub-activity	Parameter	Uncertainty (%)	Weighting (Absolute Value)
Deforestation	$U_{Deforestation}$	17,93%	3.452.885,1
Degradation from substitution	$U_{Deg\_Sustitución}$	15,60%	4.076.040,0
Degradation from forest fires	$U_{Deg\_Incendios}$	27,37%	222.206,9
Degradation in standing forests	$U_{Deg\_Extracción}$	82,39%	4.962.248,1
Increases from non-forest to forest	$U_{Aumentos\_NB-B}$	23,37%	890.772,9
Increases in standing forest	$U_{Aumentos\_B-B}$	82,39%	9.121.239,4
Conservation	$U_{Conservacion}$	64,76%	5.003.601,3
Total uncertainty	**U_{TOTAL}**	**33,29%**	

Table 10. Uncertainty from estimation of emissions associated to each propagated activity and uncertainty.

As can be seen in Figure 11, the emissions and removals reported in Chile's Subnational FREL/FRL are well below those of countries with more extensive forest areas, such as the amazon forests of Brazil, Peru or Colombia, or the tropical forests in Africa, Asia and Oceania. However, and as shown by the mega forest-fires during the summer period of 2017, Chile is one of the countries with the most vulnerability to climate change due to its geography, climate and the high level of endemism of native species that compose its flora. Therefore, the reduction of emissions and increase of removals from the implementation of the action measures of the ENCCRV do not only contribute to global climate change mitigation, but also gain great relevance in promoting the generation and maintaining other environmental and social benefits, such as biodiversity, water production or the enhancement of economic and social conditions of farmers and rural populations.

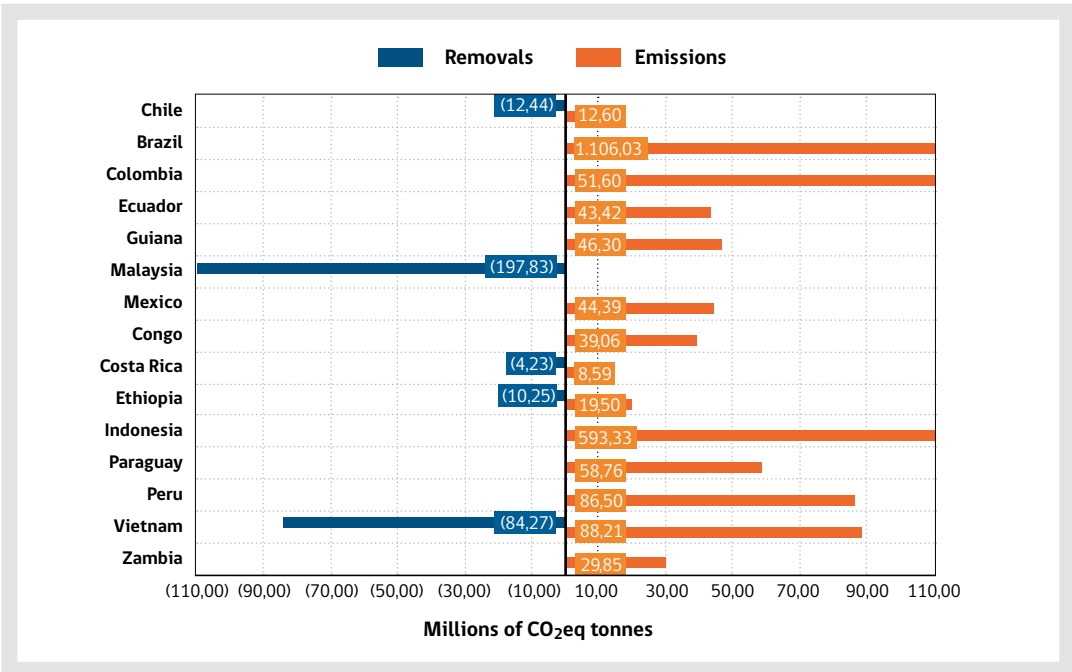


Figure 11. Emissions and removals reported by each country in their respective FREL/FRL.

9. Analysis and Technical Assessment Process

Chile's Subnational FREL/FRL was formulated with the aim of answering the requirements established in two different instances:

- The Warsaw Framework for REDD+, established through decisions 9/CoP19 to 15/CoP19 of the UNFCCC in Warsaw, November 2013.
- The FCPF Carbon Fund Methodological Framework, agreed to by the Participants Committee on December, 2013.

Each one of the above instances establishes its own analysis, assessment or technical review processes.

Technical Assessment Process of the UNFCCC Reference Levels

In January, 2016, Chile recorded its Subnational FREL/FRL before the UNFCCC Secretariat, therefore initiating the Technical Assessment Process established by the Convention. The Assessment Team (AT), coordinated by the Convention Secretariat, was composed of Walter Oyhantcabal (Uruguay) and Inge Jonckheere (Belgium), freelance international experts from the Land-use, land use-change and forestry sector (LULUCF) belonging to the UNFCCC Expert Panel, the observer Kamal Djemouai (Argelia), member of the Consultative Group of Experts on National Communications from the Parties not included in Annex I to the Convention.

In March, 2016, the Technical Assessment Session was held in Bonn, Germany, instance whose aim is a deep analysis that allows for the search for additional clarifications needed by the countries. During the session, the AT communicated with two of Chile's Technical Teams, which helped with clarifying the country's decisions based on national circumstances, deepening the applied methodologies, the available sources of information and the proposed reference periods.

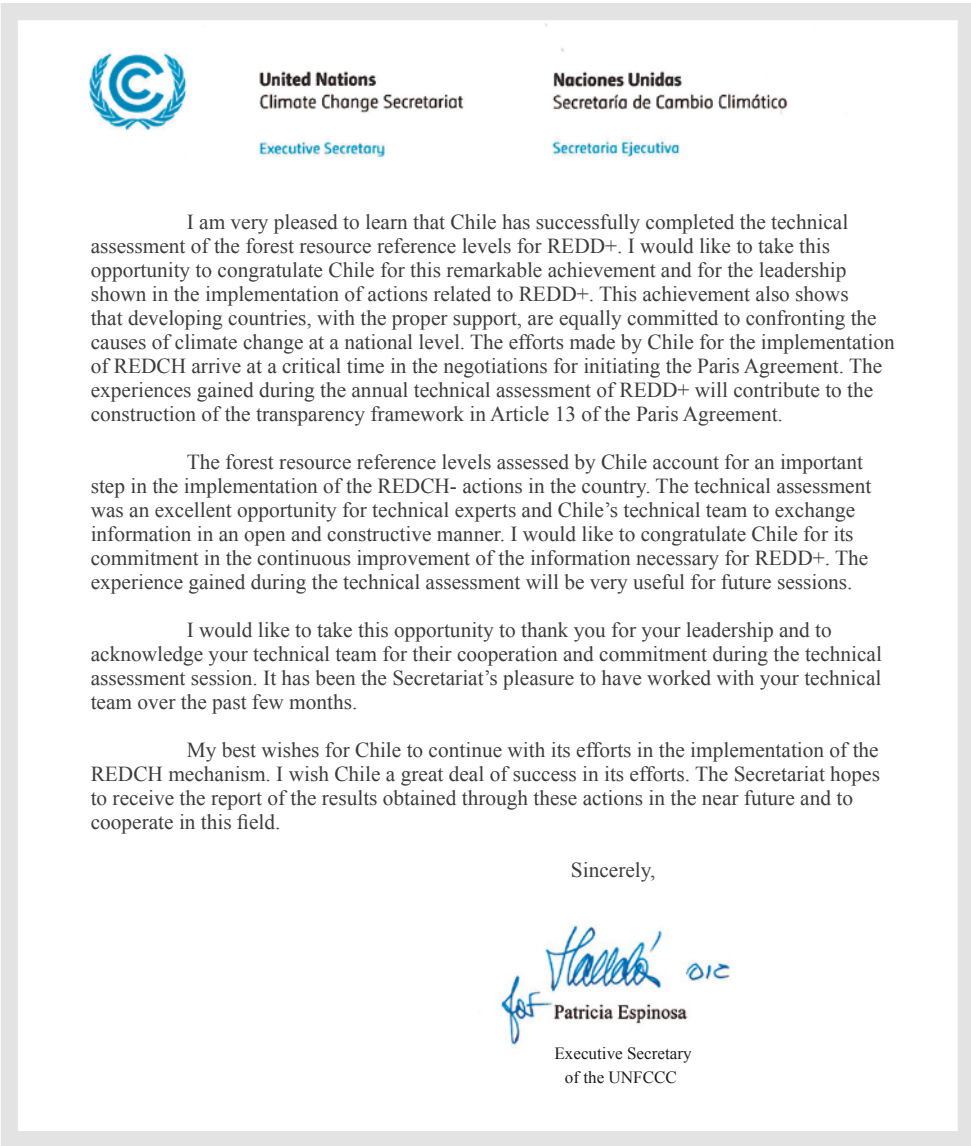
After Chile's submission of additional information and a new and direct communication between the parties, -in June, 2016- the AT made a series of recommendations to Chile, primarily focused on the integration of methodological protocols with the goal of obtaining more transparency, deepening the uncertainty analysis and standardizing the analysis periods. These guidelines were aimed at reducing the variability of information derived from the heterogeneity of the Forest Cadaster measurement and monitoring periods in the regions included in the area of analysis.

Chile addressed all of these recommendations, reviewing the document in detail in order to include the methodological protocols, deepening the uncertainty

analysis and standardizing -through the application of IPCC-recommended methods- the reference periods; and incorporating a specific chapter of "Capacity-building Needs". These modifications meant that Chile had to generate a new consignment in August, 2016.

The modified FREL/FRL was analyzed by the AT, thus generating the final technical assessment report which -after being reviewed and accepted by Chile- was published together with the Modified FREL/FRL in UNFCCC's REDD+ web platform, on February, 2016[13].

Chile satisfactorily overcame the Technical Assessment Process of the UNFCCC after a period of more than one year of incorporation and development of improvements in the presented work. This was a fundamental milestone as demonstrated in the congratulations and acknowledgment letter sent by the Executive Secretary of the UNFCCC, Mrs. Patricia Espinoza (Figure 12).



United Nations
Climate Change Secretariat

Executive Secretary

Naciones Unidas
Secretaría de Cambio Climático

Secretaria Ejecutiva

I am very pleased to learn that Chile has successfully completed the technical assessment of the forest resource reference levels for REDD+. I would like to take this opportunity to congratulate Chile for this remarkable achievement and for the leadership shown in the implementation of actions related to REDD+. This achievement also shows that developing countries, with the proper support, are equally committed to confronting the causes of climate change at a national level. The efforts made by Chile for the implementation of REDCH arrive at a critical time in the negotiations for initiating the Paris Agreement. The experiences gained during the annual technical assessment of REDD+ will contribute to the construction of the transparency framework in Article 13 of the Paris Agreement.

The forest resource reference levels assessed by Chile account for an important step in the implementation of the REDCH- actions in the country. The technical assessment was an excellent opportunity for technical experts and Chile's technical team to exchange information in an open and constructive manner. I would like to congratulate Chile for its commitment in the continuous improvement of the information necessary for REDD+. The experience gained during the technical assessment will be very useful for future sessions.

I would like to take this opportunity to thank you for your leadership and to acknowledge your technical team for their cooperation and commitment during the technical assessment session. It has been the Secretariat's pleasure to have worked with your technical team over the past few months.

My best wishes for Chile to continue with its efforts in the implementation of the REDCH mechanism. I wish Chile a great deal of success in its efforts. The Secretariat hopes to receive the report of the results obtained through these actions in the near future and to cooperate in this field.

Sincerely,

for Patricia Espinosa

Executive Secretary
of the UNFCCC

Figure 12. Congratulatory letter from the UNFCCC Executive Secretary for the successful achievement of the FREL/FRL Technical Assessment Process.

[13] Final Report of the Technical Assessment of the FREL/FRL available at: http://unfccc.int/resource/docs/2016/tar/chl.pdf

Review Process of the FCPF Carbon Fund Technical Advisory Panel (TAP)

In a parallel manner to the Convention's Technical Assessment Process, Chile -as a participating country in the FCPF Carbon Fund- formulated and submitted to review its Emissions Reduction Program Document (ERPD)[14], which includes a specific chapter on FREL/FRL. The Technical Review process was conducted by the *Technical Advisory Panel* (TAP), comprised by Ben H.J. de Jong (the Netherlands) and Augustine Inthamoussu (Uruguay), experts in carbon accounting methodologies, Ludovino Lopes (Brazil), expert in legal matters, Angelika Kandzior (Germany) expert in safeguard matters, and Fernando Santibanez (Chile), a local expert. The aim of the TAP analysis is to analyze the level of compliance of the ERPD with the FCPF Methodological Framework, document including a total of 78 criteria or indicators, out of which 43 correspond to the field of carbon accountability.

After the submission of the first draft of the document on May, 2016 -and during the same year in July- a one-week face-to-face review session was held in Chile, in which the team of experts received additional information and clarifications. After this process was completed in August, 2016, the first TAP Report was made publicly available, where the expert analysis in the field of carbon accounting identified 24 indicators as fulfilled, 10 as non-applicable and 9 as unfulfilled.

The indicators identified as unfulfilled matched those issues identified by the UNFCCC's Technical Assessment Team, particularly in aspects related to the level of uncertainty.

Together with the modification of the FREL/FRL presented to the Convention, the National Technical Team enhanced the document submitted to the FCPF, reducing the unfulfilled indicators to 4 in the analysis conducted the TAP in November, 2016.

On December, 2016, during the Carbon Fund Meeting held in Washington D.C, United States, additional information was provided, and proposals of technical nature were made in order to respond to the observations made to these four (4) yet unfulfilled indicators. The latter were linked to uncertainty estimation issues, successfully accepting the clarifications provided by the national technical team, by the TAP, representatives from developed countries, and other donors and stakeholders from civil society organizations.

This was a key fact for Chile to have **an Approved Resolution[15] with No Conditions from the Carbon Fund Secretariat**, being the first participating developing country in this instance to achieve this milestone, allowing the initiation of negotiations for a potential signing of the Emission Reductions Payment Agreement (ERPA)[16].

"I would like to highlight the great communication, ability and willingness of Chile's technical team for implementing the improvements suggested in the review process".

Ben de Jong, TAP Leader

"I would like to highlight the good work done by the professionals in this area, which is reflected in the consistency, transparency and complexity of the document. In addition, the team not only showed broad knowledge of the subject during the visit to the country, but worked both professionally and promptly for proper observation-gathering. The fluid communication and dedication made the review possible in due time and proper form".

Agustin Inthamoussu, TAP Expert in carbon accounting

[14] The ERPD -along with other documents- provides the information required by the Carbon Fund Participants Committee for deciding if the Emission Reductions Payment Agreement (ERPA) is negotiated or not.

[15] https://www.forestcarbonpartnership.org/sites/fcp/files/2016/Dec/FCPF_CFM15_Resolution_1_Chile%20FINAL.pdf

[16] The ERPA is an agreement for the sale and marketing of an agreed amount of emission reductions generated in the Emission Reductions Program for an established period, which: 1) defines responsibilities, rights and obligations; 2) grants funding to the Emission Reductions Program; and 3) manages and reallocates the risks of the Program.

10. Expansion and Continuous Improvement

Chile's FREL/FRL was formulated under a step-wise or continuous improvement approach, with the aim of incorporating enhancements based on the optimization of the applied methods and the development of more accurate information, as well as the expansion of the FREL/FRL at a national level.

In the face of the activities related to the expansion of the FREL/FRL, the enhancement of technical, institutional, and national capacities are highly relevant, through the generation of a critical mass that can address commitments, both from within CONAF and from other institutions related to natural resource management belonging to the State of Chile, and from the academic field.

The major difficulties experienced in the development of the FREL/FRL have been identified in the area of uncertainty estimation and the lack of cartography for territorial management at a property level. This is why it is important to develop greater capacity-building in training of professionals, integrating experts in forest inventories and forest sampling statistics within the technical team.

The analysis of active satellite technologies, such as RADAR and LIDAR is of particular interest for analyzing carbon fluxes in permanent forests in areas with high probability of cloud cover, mainly in Chile's Southern macro zone, as well as in the analysis of the strong phenological variations in vegetation.

There are a series of areas for technical improvement that are being analyzed and discussed, among which are the following:

- The temporality and scale of the Forest Cadaster updates still exhibit a substantial degree of irregularity; therefore the development of methodologies and tools is fundamental for the systematic update of the Forest Cadaster, in order to estimate activity data linked to land-use changes.

- The use of satellite images is fundamental in applied methodologies; therefore, the automation of pre-processing and analysis activities will allow an optimization of times and costs, in addition to a standardization of the protocols that would significantly increase the transparency and replicability of the results and processes.

- The estimation of forest degradation thresholds in permanent forests was based on the Roble-Rauli-Coihue (Oak-Rauli-Coihue) forest type density chart, reason why it is necessary to develop density charts for the rest of the forest types.

- There are significant information gaps available and specific subnational circumstances linked to the high ecosystem variability of Chile, making it necessary to further explore the analysis of methodologies for the estimation of carbon fluxes in forests permanent in different subnational areas. The Southern macro zone is of particular interest, housing around 50% of Chile's native forests and with geographic and climatic conditions which significantly hinder direct and remote data acquisition.

- The dissemination of results and the practical application of the information generated as a tool for decision-making and the implementation of on-site activities requires the creation of an integrated platform that allows storing, generating semi-automated reports and displaying -both spatially and in databases- the results to different types of users.

- Generation of new information -linked to soil organic carbon fluxes- with the aim of increasing the level of complexity of the FREL/FRL and supporting other reports that Chile must submit to international instances -such as INGEI or Land Degradation Neutrality (LDN) from the UNCCD.

Currently, through broad international support framed within the ENCCRV, a series of works are being developed, focused on reducing the gaps and needs identified in the formulation process of the FREL/FRL.

- A series of initiatives are being developed with the goal of generating biennial national updates of the Cadaster aimed at the identification of appropriate methodologies and tools:

  - Support from a team of professionals assigned to these labors, from CONAF's Forest Ecosystems Monitoring Department, funded through a project with resources from the Global Environment Fund (GEF) named the "Integrated Ecosystem Monitoring and Assessment System (SIMEF).

  - Analysis of the sources of information and development of semi-automated algorithms for processing optical satellite images, both through Google Earth Engine, and systems based on free software, through activities framed within the GEF financing Project, Sustainable Land Management and training programs conducted with FAO Technical Assessment funds.

  - Feasibility analysis for the integration of the tool Collect Earth as one of the elements for increasing the update frequency of the Forest Cadaster at a land-use level with support from FAO.

- With the aim of estimating carbon emissions and/or removals associated to the activity of sustainable management of forests, we are working on the georeferencing of property and stand polygons. With the latter we have implemented management plans between 2001 and 2016 in the regions between El Maule and Los Lagos. This work is being financed with resources from the FCPF and is technically supported by the Center for Environmental Studies EULA from Universidad de Concepción.

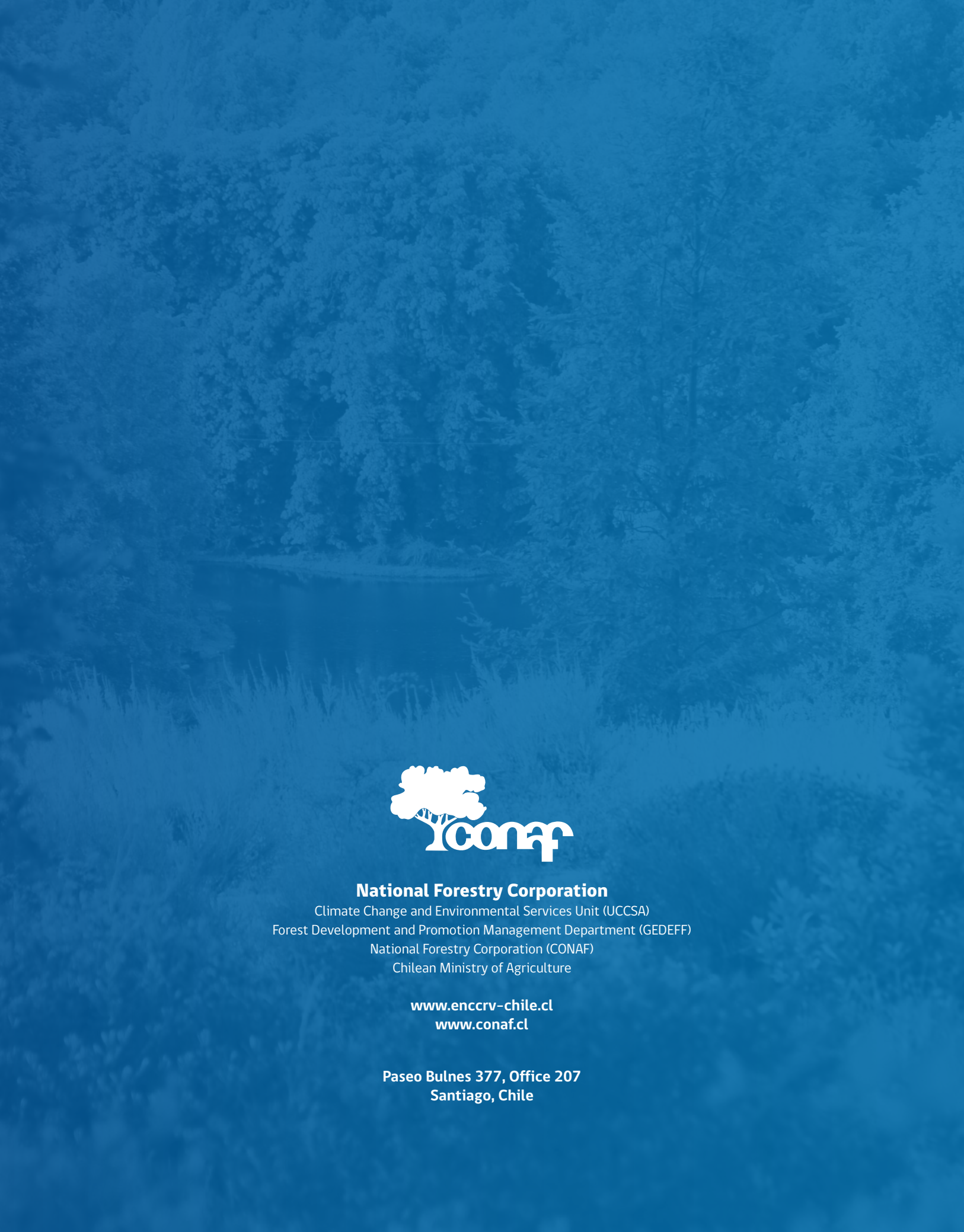
- In the second semester of 2017, the process for the expansion of the FREL/FRL to regions in Chile's Mediterranean macro zone (Region of Valparaiso, Region of O'Higgins and the Metropolitan Region) will be completed. Simultaneously, the gap analysis has been conducted for the regions of the South macro zone, Regions of Aysen and Magallanes, and we are expecting to get the first advances for finalizing the Consignment of the National FREL/FRL during 2018.

- During 2016, the Native Forest Law Research Fund developed the density chart for the Lenga Forest Type, which should be validated in 2017. Subsequently, density charts were developed for Chile's main forest types.

- In parallel, we have conducted the following specific training for CONAF professionals:
  - Training Course on GHG Inventory and Reference Levels. October, 2016, conducted by Aether Espana and the GHG Institute.
  - Google Earth Engine Training. November, 2016, conducted by experts from the University of Gottingen.
  - SEPAL/Google Earth Engine Training. January, 2017, conducted by FAO experts.

- In November, 2016, experience-exchange activities were held with experts from the forest monitoring area of the United States, China, Spain, Mexico, and the UK in the framework of the ForestSAT2016 International Congress, with participation of CONAF's technical team.

- During 2016, CONAF's technical team participated in international activities both face-to-face and online, with the double aim of increasing the technical capacities and disseminating the progress made as a South-South cooperation instrument within the framework of the actions that have been undertaken for implementing the ENCCRV.



National Forestry Corporation
Climate Change and Environmental Services Unit (UCCSA)
Forest Development and Promotion Management Department (GEDEFF)
National Forestry Corporation (CONAF)
Chilean Ministry of Agriculture

www.enccrv-chile.cl
www.conaf.cl

Paseo Bulnes 377, Office 207
Santiago, Chile