



Ministerio del
Medio
Ambiente

Gobierno de Chile

Executive Summary 2016



Chile's Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change



Tercera
Comunicación
Nacional
sobre
Cambio
Climático



www.theGEF.org

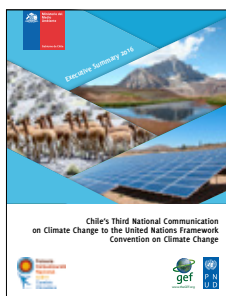




Chile's Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change

Executive Summary 2016





Executive Summary

Chile's Third National Communication On Climate Change
To the United Nations Framework Convention on Climate Change

Project Implementation:

Ministry of Environment (2011-2016)

General Coordinators of the Projects:

Fernando Farias (2013-2016)

Andrea Rudnick (2011-2013)

Technical Coordinator:

Maritza Jadrijevic

Executive Coordinators:

Johanna Arriagada (2015-2016)

Angela Reinoso (2013-2015)

Chapter Coordinators:

Peter Muck, Sergio González, Paulo Cornejo, Jenny Mager,
Maritza Jadrijevic, Johanna Arriagada,
Gladys Santis y Felipe Osses

Proofreading:

Pilar de Aguirre, Andrea Palet

Design and layout:

Duplika Ltda.

Printed in Maval Ltda.

ISBN:

978-956-7204-56-4

“Regarding maps they should be taken only referentially”

Index

PROLOGUE	5
EXECUTIVE SUMMARY	7
1 NATIONAL CIRCUMSTANCES	8
1.1. Geographic Profile and Social Development	8
1.2. Economic Profile	8
1.3. National Institutional Framework related to climate change	12
2 CHILE'S NATIONAL INVENTORY OF GREENHOUSE GASES, SERIES 1990-2013	16
2.1. Introduction	16
2.2. Institutional arrangements and preparation of Chile's NGHGI	16
2.3. Trends in Chile's greenhouse gas emissions	17
3 VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE OF THE COUNTRY	20
3.1. General background and national policies	20
3.2. Climate change trends observed and national projections	20
3.3. Sectors vulnerable to climate change	23
3.4. Climate Change Adaptation	32
4 MITIGATION OF GREENHOUSE GASES EMISSION	35
4.1. Mitigation in Chile	35
4.2. Sectorial mitigation actions	37
4.3. Other mitigation actions	42
4.4. Chile's Nationally Appropriate Mitigation Actions (NAMA)	42
4.5. Measurement, report and verification of mitigation actions	44
4.6. Cross supporting actions for a low carbon economy	44
5 OTHER SIGNIFICANT INFORMATION TO ACHIEVE THE CONVENTION'S OBJECTIVE	45
5.1. Technological transfer on climate change	45
5.2. Systematic Observation of climate variability and climate change	47
5.3. Climate change research programs	48
5.4. Education, formation and public sensitization on climate change	51
5.5. Encouragement of national and local capacities on climate change	53
5.6. Inclusion of climate change in other management instruments	53
6 NEEDS AND SUPPORT RECEIVED REGARDING CLIMATE CHANGE	54
6.1. Financing needs, gaps and barriers, capacity building and technical assistance	54
6.2. International support to climate action	55
6.3. National support for climate action	57
BIBLIOGRAPHY	58



Preface

The term between 2011 and 2016 covered by this Third National Communication on Climate Change, by which the Chilean Government presents to the United Nations and to the world its performance regarding this matter has been particularly fruitful in terms of progress in our country.

We already have climate change adaptation plans in different areas of our economy which are being implemented, as well as a national adaptation plan to climate change which reflects the country's general guidelines to be followed in terms of adaptation. The fact of Chile having this set of plans has allowed the different ministries organizing to work systematically and jointly to improve the country's climate adaptation. Currently Chile has also a Forestry Policy 2015-2035 and a new Energy Policy (Energy 2050), both published this year in which climate change is a part of their design: through both policies we shall have powerful elements to move on in these sectors, with a greater incidence on our current inventory of greenhouse gases emissions and removals, in an attempt to design and implement effective mitigation options and encouraging a gradual transition towards an economy significantly lower in carbon by 2050. The detail of all these elements and their consequences is contained in this document and proves the importance given by our country to jointly face the challenges imposed by climate change. Our goal is that Chile has "climatechanged" sectorial public policies, permanently integrating the climate agenda within the ministries' actions.



Also, during this term and under the recent Paris Agreement, our country was able to coordinate the preparation and approval at the highest ministry level of its Intended Nationally Determined Contribution which explains the country's purposes and tasks in terms of mitigation, adaptation, climate capacity building, technology and climate financing. Agreeing to the preparation of this document meant being able to discuss a new relation framework for climate change actions inside our country, as well as Chile's participation in a joint work with the rest of the countries adhering to this worldwide agreement.

Although we have made progresses in the climate action area for our country, climate variations have also been noted even strongly during this term, making it evident for Chile, its Government and its people that climate change arrived to stay within our borders, and that it is urgent to take care of its effects on our geography and economy. Consequently, we believe that an effective climate action shall be permanent, as well as the messages we convey to citizens. Climate change is a common issue, but it may also be a common opportunity for our countries.

With financial support granted by the Global Environment Facility (GEF) and the permanent collaboration by the United Nations Development Program (UNDP), the Climate Change Department of the Ministry of the Environment was able to coordinate the preparation of this compilation document. Its contents explain and value the significant work performed by professionals of different ministries, scientific, technical and social entities of the country towards a common purpose of revealing our climate information. We convey to all of them our sincere gratefulness for their valuable contributions.

There is a long way to go in our country's road to sustainability. The year 2016 finds us on that road. We have it clear that even if the challenge is huge, the opportunity is even greater to leave a better Chile for the future generations.

Pablo Badenier Martínez
Minister of the Environment of Chile
Santiago, Chile, November, 2016.

Executive Summary

Chile's Third Communication was prepared according to the requirements of the United Nations Framework Convention on Climate Change (UNFCCC). It contains Chile's progress in the implementation of the Convention goals and principles, mainly during the term 2010 to 2016, taking into account that the country presented its First Communication in 2000 and the Second in 2011. In accordance to the guidelines recommended by the Convention for the preparation of this type of documents, we present the national circumstances (chapter 1); results of the national inventory of greenhouse gases emissions and removals (chapter 2); main progress in the country's vulnerability and adaptation to climate change (chapter 3); mitigation of greenhouse gases (chapter 4), any other information relevant to the achievement of the Convention's Objective (chapter 5) and finally, we describe some obstacles, gaps as well as financial, technical and capability needs identified for the country during the process of preparation of this communication (chapter 6).

To prepare this communication we relied on the main financial support by the Global Environment Facility, which was implemented through the office of the United Nations Development Program and the Chilean Government.



PN Torres del Paine. CONAF

1 National Circumstances

1.1. Geographic Profile and Social Development

Chile is a tri-continental country which territory extends along the southwest portion of South America, including Easter Island in Oceania as well as part of Antarctica to the south. The national territory also includes the Archipelago of Juan Fernandez, the islands of San Felix, San Ambrosio, Salas y Gomez, as well as the 200-mile Exclusive Economic Zone (EEZ) with its corresponding continental shelf. Chile limits to the north with Peru, to the east with Bolivia and Argentina, to the south with the South Pole and to the west with the Pacific Ocean that laps its coast in an extent greater than 8,000 km.

Chile has a total area of 2,006,096 km², without considering the maritime territory (territorial sea, EEZ and continental shelf), which is distributed in 755,915 km² corresponding to South America, 1,250,000 km² to Antarctica and 181 km² to Oceania.

Chile has a multiplicity of climates mainly caused by its latitude and height, which originate four macro bioclimates: tropical, Mediterranean, temperate and antiboreal (Figure 1), with 127 terrestrial ecosystems distributed among them and 96 marine ecosystems along the Chilean coast.

Chile is a unitary republic which political-administrative framework is structured in three territorial levels of governance: administrative regions (15), provinces (54) and municipalities (346), with a total population (2002 census) of 15,668,271 individuals and an estimated population for 2020 of 18,896,684 individuals. The population is not evenly distributed in the national territory, but it is strongly concentrated in the central zone, in the Metropolitan Region of Santiago.

Nine indigenous ethnic groups are acknowledged in Chile, mostly mapuche (84%), representing approximately 8.7% of total population

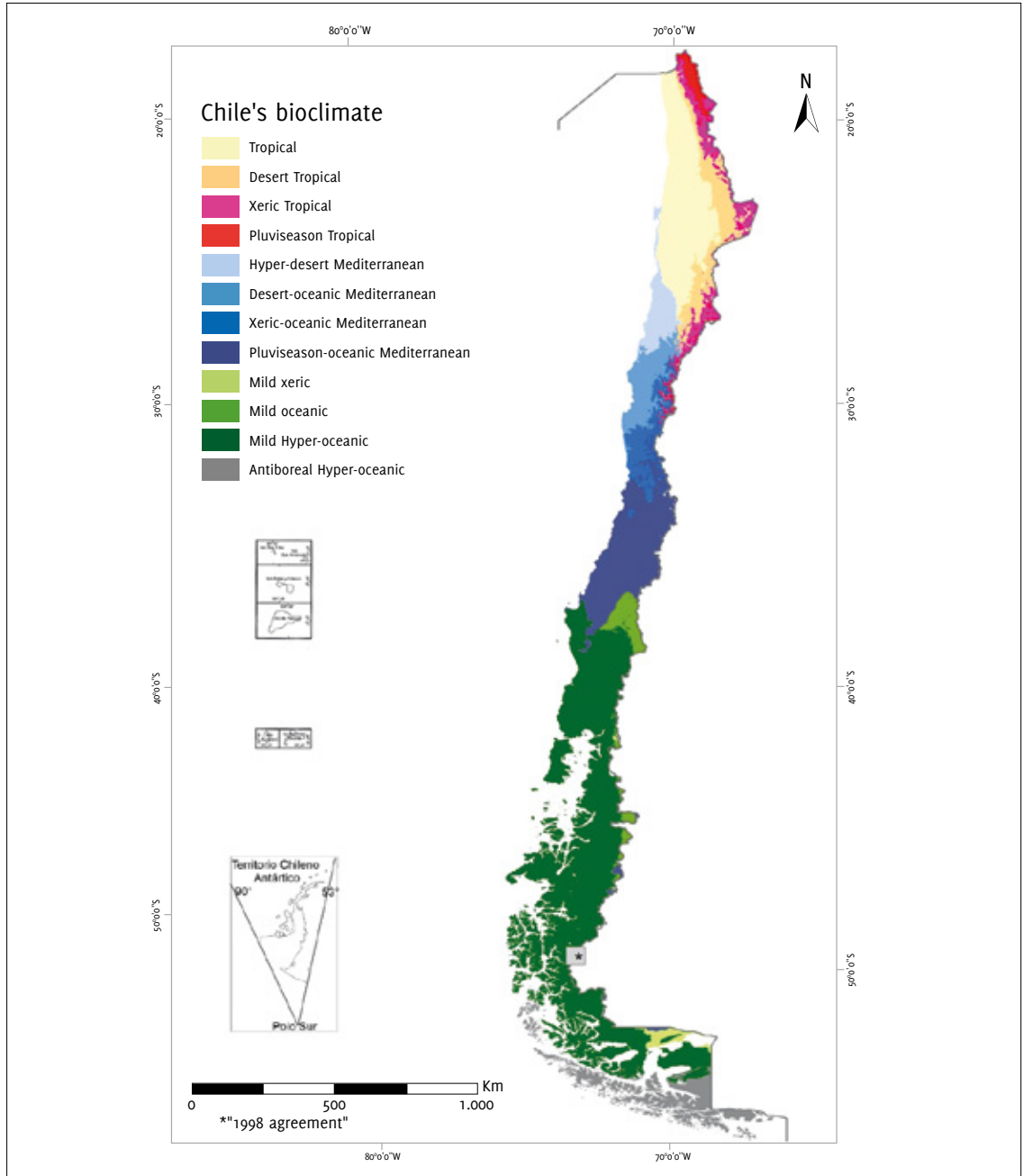
1.2. Economic Profile

Chile support an open-market economy to a large extent, the country's economic growth is ruled by the mining activity, with exports in 2014 corresponding to 54.2% of the total exported by the country (DIRECON, 2015).

During the last twenty years Chile has experienced a fast economic growth, led by commodities exports. The GDP has tripled between 1990 and 2015, and its annual inflation rate is lower than 5% (Figure 2). Although the Chilean economy is based on the extraction of natural resources and primary goods, the addition of financial and personal services represents the GDP highest percentage (37.7%), followed by the manufacturing and mining industries (in total, 33.1%).

Table 1 summarizes the main geographic and social economic indicators in Chile.

Figure 1: Macro bioclimates of Chile



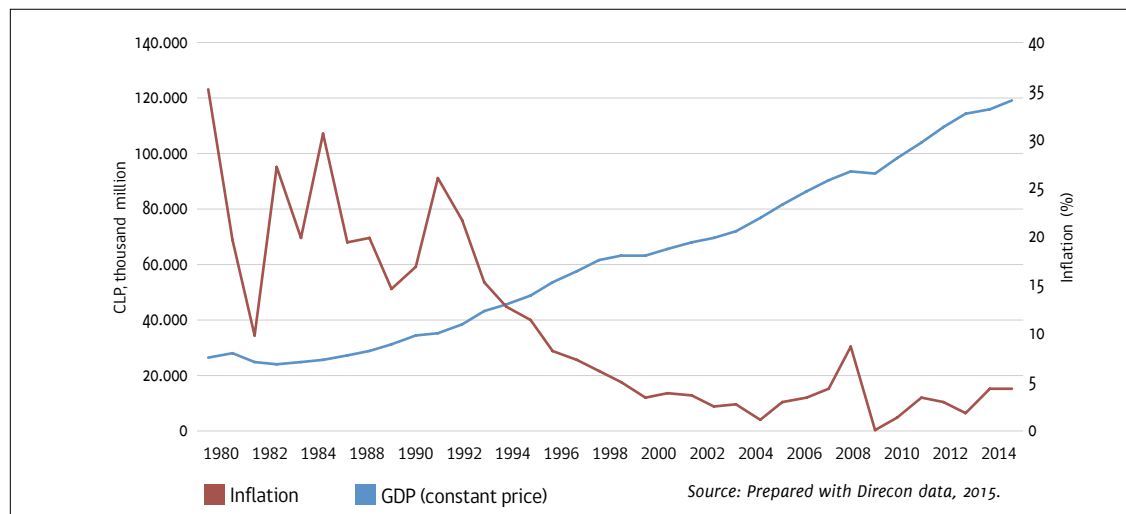
Source: Luebert and Pliscoff (2006), (maritime boundaries, according to DIFROL)

Table 1: Summary of Chile's main geographic and social economic indicators

Information		Source
Geography and population		
Area:		
Total area	2,006,096 km ²	Military Geographical Institute (IGM)
South America area	755,915 km ²	
Oceania area (Easter Island)	181 km ²	
Use of land:		
Agricultural use areas	4.4%	National Forestry Corporation (CONAF) ¹
Native Forests	18.9%	
Forestry Plantations and mixed forests	4.2%	
Grassland and Scrub	27.1%	
Urban and industrial areas	0.5%	
Areas without vegetation	32.5%	Ministry of the Environment (MMA)
Protected marine areas	45,111.4 thousand ha	
National System of Protected Wild Areas (SNASPE)	14,630.5 thousand ha	
Population:		
Population year 2010	17,066,172 individuals	National Statistics Institute (INE)
Male year 2010	8,447,879 individuals	
Female year 2010	8,618,263 individuals	
Population year 2016 (estimate)	18,191,884 individuals	
Male year 2016 (estimate)	9,003,254 individuals	
Female year 2016 (estimate)	9,188,630 individuals	
Population year 2020 (estimate)	18,896,684 individuals	
Population year 2050 (estimate)	20,204,779 individuals	Ministry of Social Development (MIDESO)
Rural population year 2015	12.7%	
Indigenous Population year 2013	1,565,915 individuals	
Mapuche Population year 2013	1,321,717 individuals	
Aimara Population year 2013	120,621 individuals	
Migrant Population year 2013	354,581 individuals	
Social Development:		
Life Expectations year 2015	79.1 años	National Statistics Institute (INE)
Infant Mortality year 2013 (per each thousand born infants)	7.0	UNICEF
Literacy Rate year 2012	98.9%	Superintendency of Sanitation Services (SISS)
Urban Population connected to sewerage system year 2014	96.7%	
Urban Population connected to potable water supply year 2014	99.9%	
Sewage treated at treatment plants year 2014	99.9%	
Human Development Index year 2014	0.832	United Nations Development Program (PNUD)
Population in extreme poverty year 2015	3.5%	Ministry of Social Development (MIDESO)
Population in poverty year 2015	11.7%	
Difference between richest 10% and poorest 10% year 2015	27.2	
Gini coefficient year 2015	0.482 / 0.495	
Economic Activity:		
GDP 2015	USD 240,215.7 million	World Bank
GDP per capita year 2015	USD 22,316	
Estimated GDP growth as of 2016	1.9% annual	
Estimated GDP growth as of 2018	2.3% annual	
Commodities Exports year 2015	43.7% total exports	
Goods and services Exports year 2015	30.1% PIB	

¹ Regarding South America and Oceania area

Information		Source
Geography and population		
Economic Activity:		
Trade Balance year 2014	USD 3,515 million	DIRECON
Mining Exports year 2014	54.2% total exports	
Forestry and agriculture Exports year 2014	7.6% total exports	
Industrial Exports year 2014	38.2% total exports	
Energy:		
Non-renewable sources in electric matrix year 2015	55.9%	National Energy Commission (CNE)
Electricity production capacity year 2015	20,375 MW	Ministry of Energy (MINENERGIA)
Hydroelectricity in the electric matrix year 2015	34%	
NCRE year 2015	11.48%	
Projected NCRE year 2050	60%	
National electric coverage year 2015	99.0%	
Rural electric coverage	96.1%	
Agriculture and Forestry:		
Forestry and agriculture Exports year 2013	USD 15,505 million	Office of Agricultural Studies and Policies (ODEPA)
Forestry and agriculture Exports year 2014	USD 16,042 million	
Forestry and agriculture Exports year 2015	USD 14,691 million	
Arable area year 2015	3.3 million ha	National Forestry Corporation (CONAF)
Area under irrigation year 2015	1.1 million ha	
Forestry area year 2016	17.5 million ha	
Native forest area year 2016	14.3 million ha	
Forest plantations area year 2016	3 million ha	
Planted area year 2014	4,500 ha	
Replanted area	94,000 ha	
Number of workers year 2010	685.5 thousand individuals	National Statistics Institute (INE)
Number of workers year 2014	703.6 thousand individuals	
Aquaculture and Fishing:		
Aquaculture centers crop year 2014	1,214.44 thousand	Fishing and Aquaculture National Service (SERNAPESCA)
non-industrial fishing year 2014	1,507.21 thousand t	
Industrial fishing year 2014	1,029.69 thousand	
Fish production year 2014	74.5%	
Mollusk production year 2014	12.3%	
Algae production year 2014	11.5%	
Number of workers year 2010	61.6 thousand individuals	National Statistics Institute (INE)
Number of workers year 2014	43.9 thousand individuals	
Mining:		
Iron Extraction year 2015	9,427.6 thousand fine metric t	National Statistics Institute (INE)
Copper Extraction year 2015	5,478.0 thousand fine metric t	
Sodium chloride production year 2015	10,553.4 t	
Calcium carbonate production	6,849.5 t	
Sulfur compounds production	4,629.7 t	
Transportation:		
Private transportation fleet year 2015	4,063,153 units	National Statistics Institute (INE)
Public transportation fleet year 2015	188,552 units	
Cargo transportation fleet year 2015	216,745 units	
Residues:		
Solid waste arranged in final disposal sites year 2010	5,935.7 thousand t	Ministry of the Environment (MMA)
Solid waste arranged in final disposal sites year 2014	6,866.2 thousand t	Ministry of the Environment (MMA)
Sewage treated with activated muds year 2014	59.0%	Sanitary Services Superintendence (SISS)
Sewage treated with treatment ponds year 2014	19.8%	
Sewage conducted through underground emissaries year 2014	11.7%	

Figure 2. National GDP at constant prices and inflation, as a Consumer Price Index (IPC)

1.3. National Institutional Framework related to climate change

Since the climate change issue entered the international public agenda, Chile has maintained a proactive attitude towards climate change which has prevailed through time and through the different Governmental administrations.

The national institutional framework in charge of climate change in Chile brings together almost the entire Governmental system. Consequently the issue is not dealt with at a single ministry or public entity, although it is apparent that some institutions have a greater relative weight in the policies, strategies and actions definition, as well as in their execution. The country has a dual public institutional framework, in the sense that entities with specific responsibilities participate in the issue together with crossed instances for decision making and action coordination among different ministries.



PW Torres del Paine, Chiarif Tala.

The main Governmental bodies that are a part of the national institutional framework related to climate change are:

- The Council of Ministers for Sustainability (CMS), which is the top climate governing body,
- The Ministry of Environment (MMA), with the technical focal point regarding the climate change issue, as established by the legal regulations in force, through the Climate Change Department (DCC) based at the Air Quality and Climate Change Division,
- The Ministry of Foreign Affairs, which role is the focal point before the UNFCCC and any other multi or bi-lateral international instance related to the climate change issue; its action in this area is carried out through the Environment and Oceanic Affairs Directorate (DIMA),
- Coordination among ministries corresponding to the Inter-ministries technical team on Climate Change (ETICC), and
- Climate Units belonging to the different ministries which have assumed direct actions.

Currently the main instruments are:

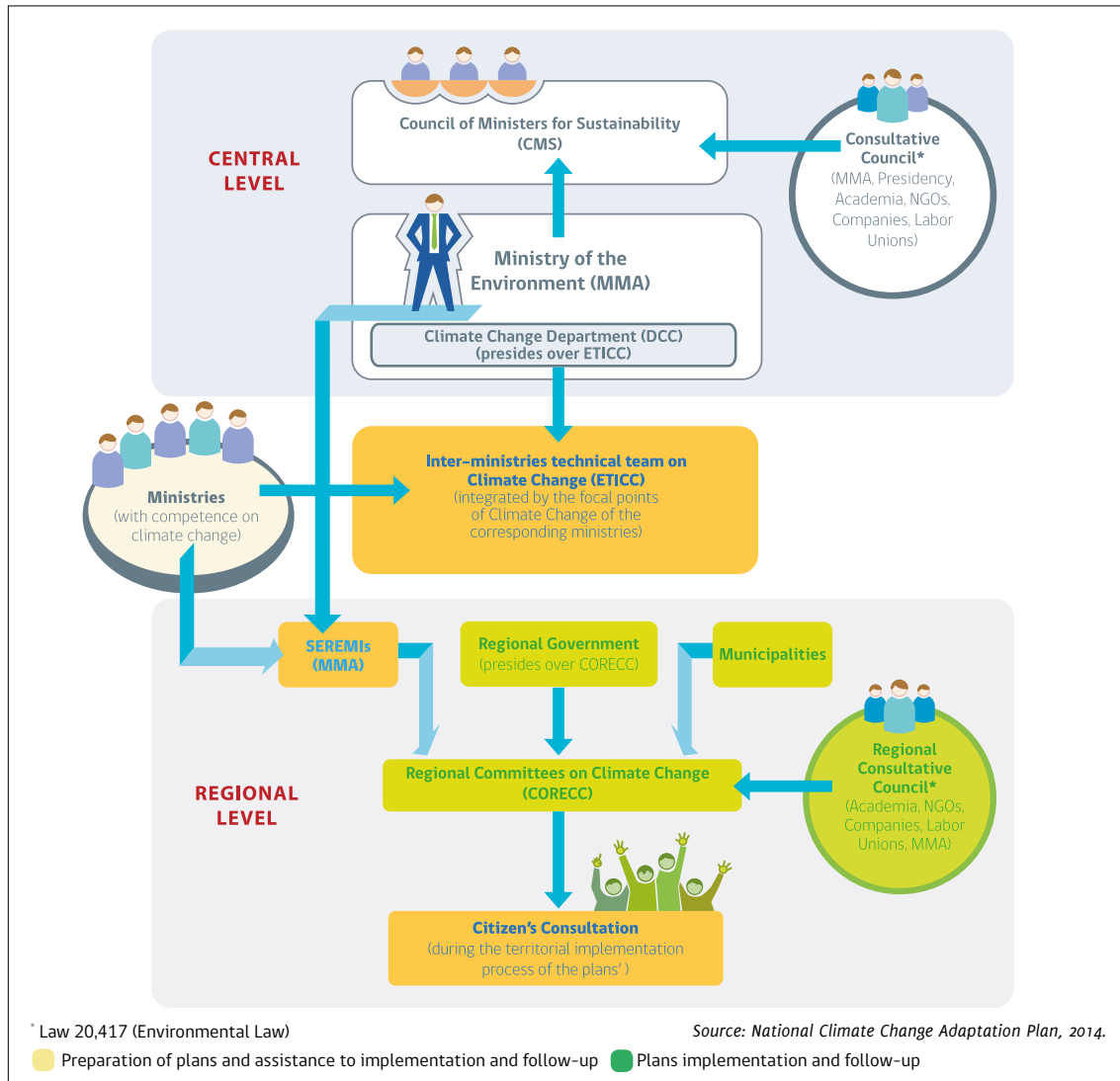
- National Action Plan on Climate Change (PANCC) 2017-2022. Its purpose is to establish a public policy instrument integrating and orienting all actions referred to climate change (public consultation, 2016).
- Law 20,698. This law enacted in 2013, establishes that by 2025 20% of the energy produced in Chile will be originated by renewable sources.
- Early Mitigation Actions. Chile adopted a series of mitigation actions beyond the commitments established at the Convention for the Non-Annex I countries, among the main early mitigation actions is the Energy Program and Law 20,257 of NCREs encouragement.
- Climate Change Adaptation. At present Chile has the “National Climate Change Adaptation Plan”, which includes all sectorial plans and was approved on December 1, 2014 by the Sustainability Ministers Council (CMS), and the following sectorial plans:
 - The Adaptation Plan of the Forestry and Agriculture Sectors, approved in 2013 by the CMS, currently under implementation,
 - The Climate Change Adaptation Plan in Biodiversity, approved in 2014 by the CMS, currently under implementation, and
 - The Climate Change Adaptation Plan for Fishing and Agriculture, approved in 2015 by the CMS, also currently under implementation.



² Law 20,417 establishes that “the Ministry will be in charge of looking after the compliance with the environmental international conventions in which Chile participates, and acting as administrative, scientific or technical counterpart of such conventions, without prejudice of the Ministry of Foreign Affairs powers”.

The National Climate Change Adaptation Plan and the PANCC 2017-2022 have a governance operational structure for the public sector. The cross-cutting handling of Climate Change issues is conducted by the Climate Change Inter-ministries Technical Team (ETICC), created in 2015 and coordinated by the DCC. ETICC members are the ministry focal points on climate change appointed by their corresponding institutions. At sub-national level, the issue was implemented through the Climate Change Regional Committees (CORECC), headed by the Regional Government, with the participation of the Ministry Regional Secretaries (Seremis), municipalities and the representatives of the Regional Consultative Councils (Figure 3).

Figure 3. Operating structure for the implementation of the climate change national policy





Archivo MMA.

1.3.1. Environmental Performance Review of Chile by the OECD 2016

In July, 2016 Chile received the results of its Second Environmental Performance Review by the OECD. After the first assessment carried out in 2005, on this occasion 54 recommendations were received.

Regarding climate change, the OECD acknowledges the existence and effectiveness of the inter-ministries coordination instances. However, since the implementation of measures and actions greatly relies on the voluntary participation by the ministries and in their capabilities, it recommends Chile “to strengthen and formalize the institutional basis of the policy on climate change with the purpose of establishing well defined implementation responsibilities, according to Chile’ situation and international commitments”.

The OECD also identified the need to adopt and implement national policies on climate change, in order to overcome the shortcomings detected as regards the existence of initiatives with a positive impact on climate change. The increase of energy efficiency or the expansion of energy generation based on renewable energies are not under a common articulatory framework and do not always explain their relation with climate change. Consequently, the OECD recommends “adopting and implementing a set of national policies on climate change in order to materialize the contribution foreseen, determined at a national level for 2030; applying the mitigation actions appropriate for each country, or alternative measures to ensure compliance with the target as established for 2020”.



2 Chile's National Greenhouse Gas Inventory, 1990-2013

Key points

- In 2013, Chile's total GHG emissions (excluding *FOLU*) amounted to 109,908.8 Gg CO₂ eq, an increase of 113.4% since 1990 and of 19.3% since 2010. The main GHG emitted by Chile was CO₂ (78.4%), followed by CH₄ (10.7%), N₂O (10.0%), and fluorinated gases (0.9%).
- The *Energy* sector is the largest GHG emitter in Chile (77.4%), mainly due to the consumption of coal and diesel for electricity generation and consumption of diesel in road transport.
- The *Agriculture, Forestry, and other land uses (AFOLU)* sector is the only sector that consistently removes CO₂ in the country, and remains as a sink for the entire time series. Net removals from the sector amounted to -26,119.2 Gg CO₂ eq mainly due to the increase in biomass in forest plantations and second-growth natural forest.
- In 2013, Chile's balance of GHG emissions and removals (including *FOLU*) amounted to 70,054.4 Gg CO₂ eq.

2.1. Introduction

This is the Fourth National Greenhouse Gas Inventory (NGHGI) submitted by Chile to UNFCCC in fulfillment of Article 4, paragraph 1(a) and Article 12, paragraph 1(a) of the UNFCCC and decision 1/CP.16 of the 16th Conference of the Parties (Cancun, 2010).

Chile's NGHGI is compiled according to *2006 IPCC Guidelines for national greenhouse gas inventories*, covering the entire national territory and including emissions and removals of carbon dioxide (CO₂) and emission of methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆) in a series of time from 1990 to 2013.

2.2. Institutional arrangements and preparation of Chile's NGHGI

Since 2012, the area of GHG Inventories of the Ministry of the Environment's Department of Climate Change (DCC) designed, implemented, and has maintained the National Greenhouse Gas Inventory System of Chile (SNICHILE), which contains the institutional, legal, and procedural steps for the biennial update of Chile's NGHGI, thus ensuring the sustainability of the preparation of GHG inventories in the country, the consistency of GHG flows reported, and the quality of the results. SNICHILE's ongoing work is divided into five lines of action:

- Operation of SNICHILE
- Updating of Chile's NGHGI
- Quality assurance and quality control system
- Capacity building
- Archiving and dissemination.

SNICHILE's work plan is organized in a two-year cycle of activities. During the first year the Sectorial Technical Teams update the Sectorial Greenhouse Gas Inventories (SGHGI), while in the second year the Coordinating Technical Team compiles the SGHGIs and develops the cross-cutting issues of Chile's NGHGI.

The preparation of the Fourth Chile's NGHGI began during the first half of 2015 and concluded in mid-2016. The Energy's SGHGI was updated by the Ministry of Energy's Foresight and Energy Policy Division; the IPPU's SGHGI was updated by the MMA's DCC; the AFOLU's SGHGI was updated by the Ministry of Agriculture through the Office of Agrarian Studies and Policies (ODEPA), the National Forestry Corporation (CONAF), the Forest Institute (INFOR), and the Agricultural Research Institute (INIA); the Waste's SGHGI was jointly updated by the Ministry of Environment's Waste and Environmental Risk Office and its DCC. Once the updating process was completed, the SGHGIs were compiled by the MMA's DCC for the preparation of Chile's NGHGI and the respective National Greenhouse Gas Inventory Report (NIR), which goes through a review process at the national and international levels.



Archivo MMA.

In conclusion, Chile's NGHGI is the result of the collective and continuous efforts of the Ministries of Agriculture, Energy, and Environment, which have worked in coordination under the framework of SNICHILE. This work has strengthened the preparation of Chile's NGHGI by adding expert knowledge from the various sectorial ministries involved.

2.3. Trends in Chile's greenhouse gas emissions

In 2013, the balance of GHG³ emissions and removals in Chile amounted to 70,054.4 Gg CO₂ eq, while total GHG emissions⁴ in the country amounted to 109,908.8 Gg CO₂ eq, an increase of 113.4% since 1990 and of 19.3% since 2010 (Table 2). The key drivers of this trend in the GHG balance were the *Energy* and the *AFOLU* sectors. The values observed that fall outside of the trend (Figure 4) are primarily the consequence of forest fires accounted for in the *AFOLU* sector.

In 2013, the total GHG emissions were dominated by CO₂, accounting for 78.4%, followed by CH₄ (10.7%) and N₂O (10.0%). Fluorinated gases collectively accounted for 0.9% of total GHG emissions in the country.

³ In this report, the terms "balance of GHG emissions and removals" or "GHG balance" refer to the sum of emissions and removals of greenhouse gases, expressed in carbon equivalent (CO₂ eq). This term includes the entire AFOLU sector.

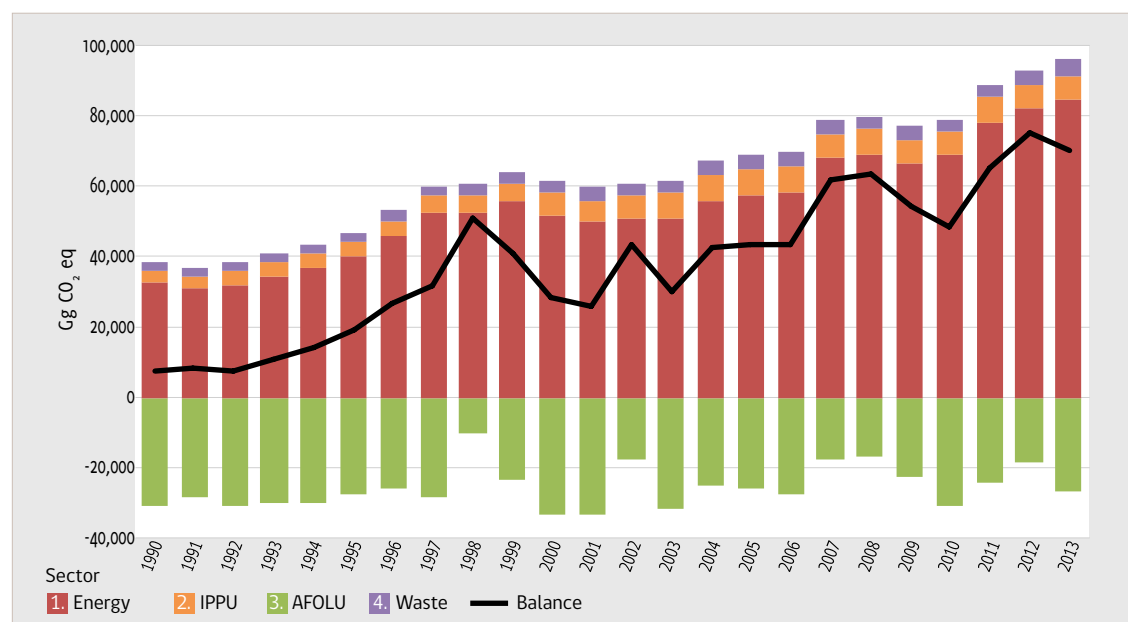
⁴ In this report, the term "total GHG emissions" refers to the sum of national GHG emissions only, expressed in carbon dioxide equivalent (CO₂ eq). This term excludes sources of emissions and sinks from forestry and other land uses (FOLU) of the AFOLU sector, but includes greenhouse gas emissions from Agriculture.

Table 2. Chile's NGHGI: GHG emissions and removals (Gg CO₂ eq) by sector, 1990-2013

Sector	1990	2000	2010	2011	2012	2013
1. Energy	33,219.5	52,122.9	69,423.7	78,527.0	82,076.6	85,075.4
2. IPPU	3,127.5	6,449.6	6,008.1	6,868.3	7,214.9	6,619.4
3. AFOLU	-30,866.3	-32,819.2	-30,514.4	-24,339.9	-18,410.7	-26,119.2
Agriculture	12,633.5	13,580.7	12,879.8	12,741.7	13,285.0	13,735.2
FOLU	-43,499.8	-46,399.9	-43,394.2	-37,081.6	-31,695.8	-39,854.4
4. Waste	2,526.1	3,348.3	3,802.6	3,939.8	4,019.2	4,478.8
Balance (with FOLU)	8,006.8	29,101.5	48,719.9	64,995.1	74,899.9	70,054.4
Total (without FOLU)	51,506.6	75,501.4	92,114.2	102,076.7	106,595.6	109,908.8

Source: MMA's Coordinating Technical Team

IPPU= Industrial processes and product use; AFOLU= Agriculture, forestry and other land use; FOLU= Forestry and other land use

Figure 4. Chile's NGHGI: GHG emissions and removals (Gg CO₂ eq) by sector, 1990-2013

Source: MMA's Coordinating Technical Team

IPPU= Industrial processes and product use; AFOLU= Agriculture, forestry and other land use; FOLU= Forestry and other land use

The *Energy* sector is the leading GHG emitter in Chile, accounting for 77.4% of total GHG emissions in 2013. That year, GHG emissions from the sector amounted to 85,075.4 Gg CO₂ eq, an increase of 156.1% since 1990 and of 22.5% since 2010. In general, this is mainly due to the increase in energy consumption in the country, including the consumption of coal and natural gas for electricity generation and consumption of liquid fuels, mostly diesel and gasoline, for road transportation. With regard to subcategories, the *Energy Industries* (mainly *Main activity electricity and heat production*) is the leading source of GHG emissions within the sector, with 45.3% share in 2013, followed by 28.9% from *Transport* (mainly road transportation), 16.8% from *Manufacturing industries and construction*, and 8.0% derives from *Other sectors* (mainly *Residential*). The *Oil and natural gas* subcategory accounted for 0.9%, while *Solid fuel* accounted for 0.1%.



Central termoeléctrica, Archivo MMA.

The *IPPU* sector accounted for 6.0% of total GHG emissions in 2013. In the same year, GHG emissions from the sector amounted to 6,619.4 Gg CO₂ eq, an increase of 111.7% since 1990 and of 10.2% since 2010. Overall, this is mainly due to the sharp increase in production of iron and steel, lime, nitric acid, and cement. With regard to categories, 37.7% of GHG emissions from the sector correspond to the *Mineral industry*, followed by 23.9% from the *Metal industry*, 21.2% from the *Chemical industry*, 10.4% from *Product use as substitutes for ozone depleting substances*, 4.7% from *Other product manufacture and use*, and, finally, 2.1% from *Non-energy products from fuels and solvent use*.

The *AFOLU* sector is the only sector that consistently removes CO₂ in the country, making it the most relevant due to its mitigation potential. In 2013, the GHG balance from the sector amounted to -26,119.2 Gg CO₂ eq, reducing its sink condition by 15.4% since 1990 and by 14.4% since 2010. Overall, this is because the *Land* category decreased their removals, while GHG emissions from categories associated with agricultural activities (*Livestock* and *Aggregate sources and non-CO₂ emissions sources on land*) have remained stable during the 1990-2013 series. Regarding emissions and removals of greenhouse gases in absolute terms by category, 73.8% correspond to *Land*, followed by 15.5% from *Aggregate sources and non-CO₂ emissions sources on land* and, finally, 10.6% correspond to *Livestock*.

The *Waste* sector accounted for 4.1% of total GHG emissions in 2013. In the same year, GHG emissions from the sector amounted to 4,478.8 Gg CO₂ eq, an increase of 77.3% since 1990 and of 17.8% since 2010. In general, the key driver is the sustained increase in solid waste generation and its final disposal in landfills. With regard to categories, 72.0% of GHG emissions from the sector correspond to *Solid waste disposal*, followed by 26.7% from *Wastewater treatment and discharge*, 1.3% from *Biological treatment of solid waste* and, finally, 0.01% from *Incineration and open burning of waste*.

In accordance with the requirements of the UNFCCC and the 2006 IPCC Guidelines, GHG emissions generated by the consumption of fossil fuel in international air and maritime transport and CO₂ emissions from biomass burned for energy purposes were quantified and reported as *memo items*, but were excluded from the balance of GHG emissions and removals in the country.

3 Vulnerability and adaptation to climate change of the country

3.1. General background and national policies

Chile is a country vulnerable to climate change, since it complies with seven of the nine vulnerability characteristics as defined in the UNFCCC.

Chapter 3 presents the country's vulnerability conditions to the adverse effects of climate change and the adaptation actions being adopted with the purpose of taking into account Chile's needs and concerns on this matter. The adaptation strategy is carried out through nine sectorial plans and it is coordinated following to the operational structure described in the National Climate Change Adaptation Plan of 2014 and the Climate Change National Action Plan 2017-2022.



San Javier, Macarena Mella.

3.2. Climate change trends observed and national projections

3.2.1. Atmospheric conditions observed

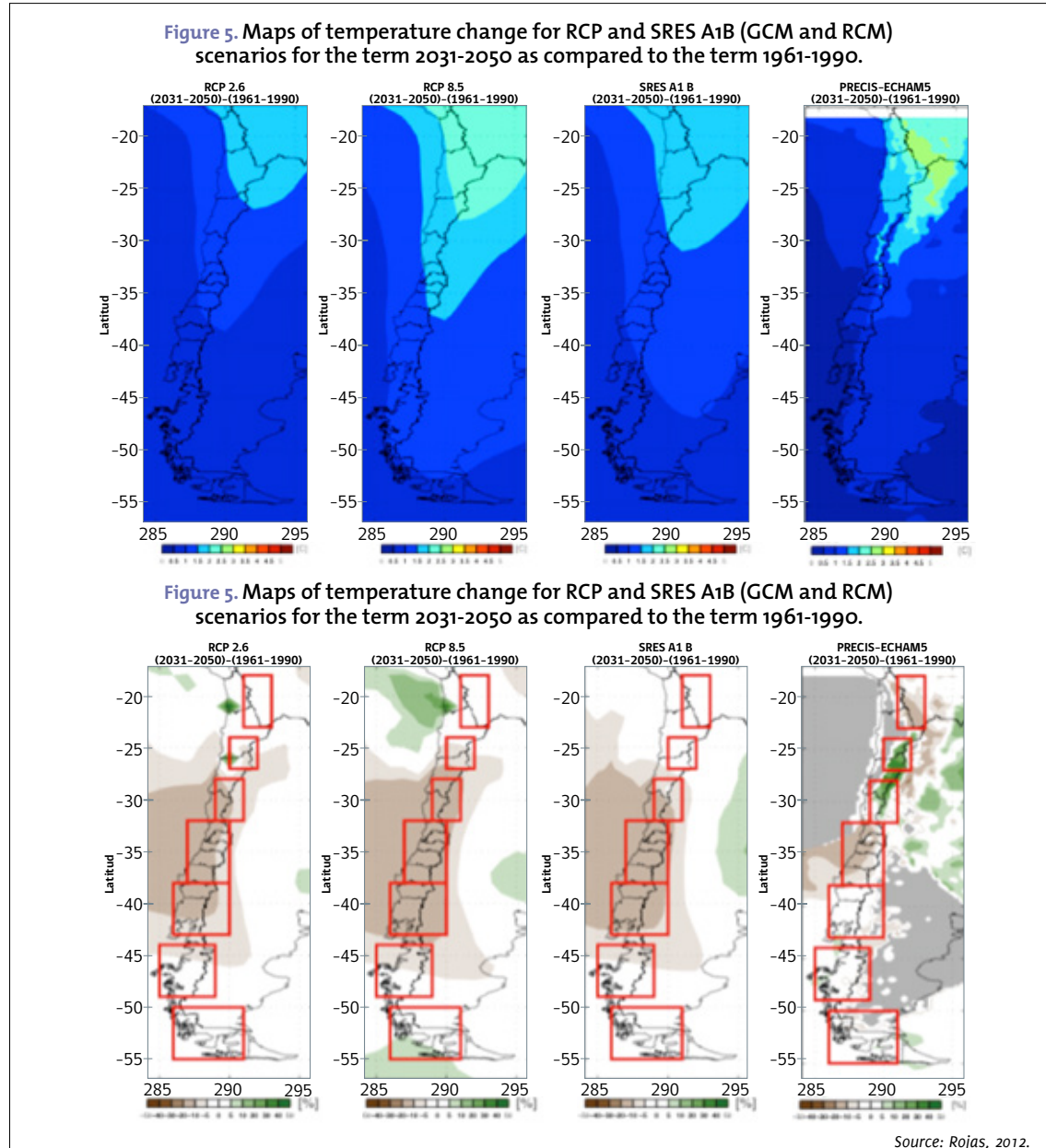
The trends observed in the average temperatures in Chile until 2010 show a cooling pattern at the coast and inland warming (central valley) and at the Andes as a main trend. The coastal cooling coincides with the cooling pattern of the superficial temperatures of the Pacific ocean given the decadal oscillation of the Pacific (PDO) (Vuille et al. 2015).

In the XX and XXI centuries the rainfall trends vary depending on the region and term considered. During the XX century rainfall in the Northern zone (18°-30° South) shows a significant inter-decadal variability associated to PDO. In the case of the Central zone (30°-35° South), rainfall shows inter-decades variations associated to PDO, while in the Southern zone (37°-43° South) there has been a decreasing trend during the term analyzed (1979-2014). During the term 2010-2015 the Central-South zone of the country (from Coquimbo to Araucanía) recorded a rainfall deficit close to 30% (Boisier et al. 2016).

3.2.2. Temperature and rainfall projections

For the preparation of the IPCC Fifth Report, AR5, new GHG emission and concentration scenarios were developed called "Representative Concentration Pathways" (RCP). Using them, the fifth phase simulations of the inter-comparison project of climate change projections simulations were generated (Coupled Modeling Inter-Comparison Project 5, CMIP5).

Figure 5 shows the temperature projections for the term 2031-2050, for the two extreme scenarios RCP2.6, RCP8.5, CMIP3-SRES A1B and the regional simulation PRECIS-ECHAM5 for the A1B emissions scenario. The warming pattern is similar in all cases: greater warming at the high plateau level and lower at the southern region. The regional model, given its greater space resolution projects a greater warming in the Andean zone.



In the case of rainfall, the trends of Figure 6 show that the term 2031-2050 would be dryer as compared to the historical mean, and a decrease between 5% and 15% is foreseen for the zone comprised between the basins of rivers Copiapó and Aysén. Such projections would increase towards the Southern zone of the country, specifically between the basin of Biobío river and the Southern limit of Los Lagos region.

3.2.3. Climate variability and extreme events

Chile climate is strongly influenced by three climate forcings: El Niño Southern Oscillation (ENSO), PDO and the Antarctic oscillation (AAO). ENSO has been described as one of the factors explaining the climate variability observed in central Chile. In that area, ENSO's occurrence is associated to location and high pressure centers intensity alterations by which the frontal systems enter the territory, establishing in general terms that during the warm or Niño phase the possibility of rainfall is higher than normal (Caviedes and Waylen, 1998). On the contrary, a decreasing trend has been noted in the rainfall amounts every time a significant decrease of the sea superficial temperature is recorded (La Niña phase) (Larkin and Harrison, 2002). Climate forcing has a significant impact on the frequency and intensity of hydro meteorological phenomena, such as a “megadrought” (Garreaud et al. 2015) that lasted from 2010 to 2015.



3.2.4. Cryosphere and sea conditions

Cryosphere

Recent studies indicate that climate variability factors (ENSO, PDO) considerably affect snow accumulation and mountain flow regimes. Historical changes in temperatures have altered the flow of lower elevation rivers, which suggests a possible development of a future threshold effect which could burst if the temperature increase noted during the last decades continues (Cortés et al. 2011; Masiokas et al. 2008; McPhee et al. 2014).

Other large components of cryosphere are glaciers. Recent evidence shows a backwards trend in most of glaciers in Chile. The difficulty to produce a projection of such trends into a predictive model lies in the fact that the relative influence of temperature variations and rainfall over its evolution has not been established (Bown et al. 2008; Casassa et al. 1998; Masiokas et al. 2009, 2016; Mernild et al., 2015; Pellicciotti et al., 2014; Rivera et al., 2002, 2006).

Sea

In Chile the sea level relative variation (NMM) as compared to the marine soil is conditioned by the seismic activity in the subduction zone between the Nazca plate and the South American plate. An analysis from

the records of up to sixty years of mareographs from the SHOA national network (Contreras-López et al., 2012) indicates that the NMM change rates differ significantly along the country. The place with the greatest increase in NMM is Easter Island, with 3.2 mm/year. Forecasts of one of the climate change conservative scenarios for 2100 show NMM increases between 0.2 and 0.3 m for different latitudes in Chile, values which coincide with the increase rates estimated by Cepal (2011) and the IPCC report (Magrin et al., 2014). Using numerical models, Albrecht and Shaffer (2016) project NMM increases at the Chile coast of 34 to 52 cm for the RCP4.5 scenario, and of 46 to 74 cm for the RCP8.5 scenario at the end of the XXI century.

The increase of atmospheric CO₂ emissions is inducing changes to the chemistry of sea water, decreasing its pH, lowering the availability of carbonate ions and reducing the calcium carbonate status. This phenomenon, known as ocean acidification occurs at a faster pace at the polar and sub-polar regions, such as Antarctica. The average pH of the surface water has been reduced by approximately 0.1 units since the industrial revolution and future reductions are expected of up to 0.3 units for year 2100 (IPCC, 2013).



Los Ríos. Archivo MMA.

3.3. Sectors vulnerable to climate change

From a vulnerability perspective, it is expected that the country is significantly impacted by climate change associated phenomena. The most relevant sectors in Chile that are vulnerable to climate change are water resources, biodiversity, farming, fishing and aquaculture, energy, cities, health, infrastructure, tourism and coastal areas.

3.3.1. Water Resources

The water resources sector is fundamental because it has a direct and indirect influence on the characteristics or productivity other sectors. The changes expected for the water sector may affect the different water safety features, either because they decrease the amount of water available for different productive uses, to sustain valuable means of life or ecosystems, or because they increase negative effects in terms of water quality or occurrence of extreme events such as disasters of hydro meteorological origin. Given their effects on water safety, hydric resources are directly connected to a series of sectors and systems. Significant progress has been made in Chile since the Second National Communication (2CN) in the study of such connections and in the analysis of indirect impacts mediated by changes in hydrological conditions. Currently there are 37 basins or sub-basins under analysis from a hydrological perspective, applying simulation models of SRES or RCP type climatic scenarios.

One of the most important basins in Chile is that of river Maipo, located at central Chile with a population of about seven million individuals concentrated in Santiago city. According to the different scenarios assessed by MAPA project, these effects could dramatically reduce the water volumes stored at El Yeso dam, the main source of water for the supply of potable water of Santiago city. A worsening of the irrigation water supply conditions is also expected due to an increase in water demand and a decrease of its offer during the irrigation season.

In spite of all the progress related to information of the effects on climate by the observed and projected changes, the need to generate more precise models allowing for future modeling should be noted, for example to identify the effects of the temperature increase on snow sublimation in the northern zone of the country, or to understand the influence of rocky glaciers on the rivers runoff regime.

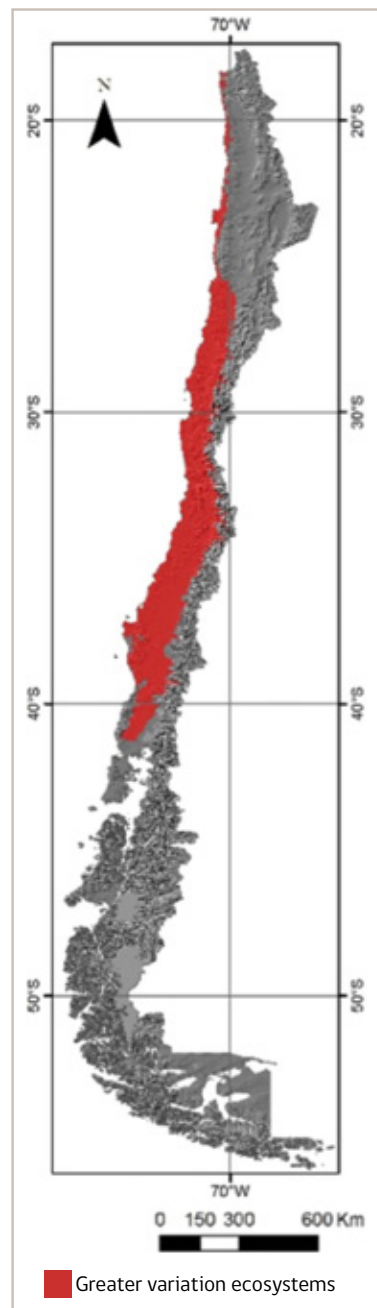
3.3.2. Biodiversity

Since the 2CN Biodiversity vulnerability studies have been updated both for species and ecosystems. The main results show a longitudinal variation of desert formations towards Andean vegetation and a latitudinal advance towards the south of the desert scrub formations and Mediterranean sclerophyll forests.

The update of ecosystems analysis presented by Marquet et al., (2010) maintains the latitudinal change pattern of ecosystems, concentrating the highest space variability at the Mediterranean zone of central Chile and the interior North zone of the high-temperature area (Araucanía Regions, de Los Ríos y Los Lagos), which corresponds to areas dominated by scrub and sclerophyll forests, thorn forests and deciduous forests (Figure 7).

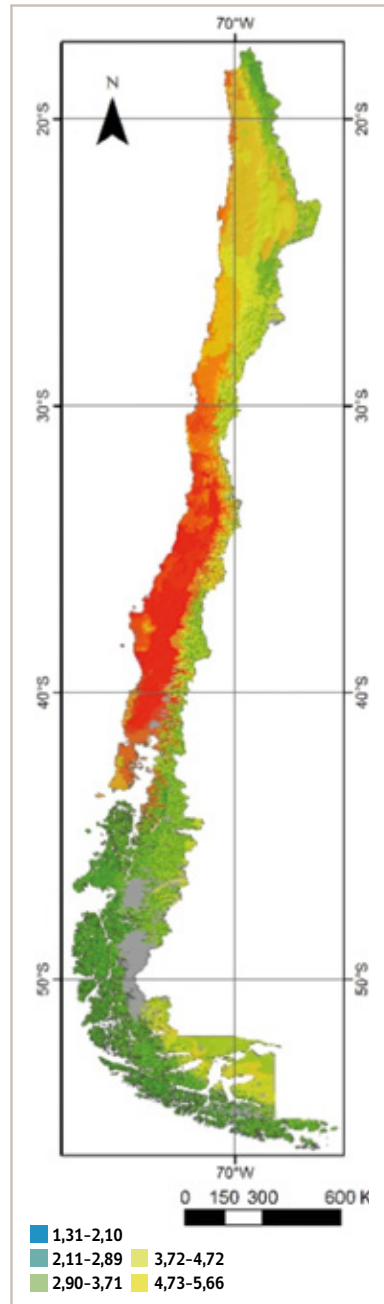
A vulnerability index was calculated applying the “bioclimate stress” concept to the 127 terrestrial ecosystems and including different types of anthropogenic pressures (Santibáñez et al., 2013). The index showed a trend to an increased vulnerability towards the central zone both for a greater anthropic presence as well as for the expected results of bioclimate stress. The floors with greater values for this index are within the deciduous, thorn and sclerophyll forest formations (Figure 8). The study also concludes that faced to the new climate scenarios, vegetation floors tend to reduce and fragment around their present area instead of displacing.

Figure 7. Ecosystems with a greater space variability as a consequence of climate change.



Source: Pliscoff, unpublished data.

Figure 8. Ecosystems vulnerability index (vegetation floors) for 2050 scenario.



Source: Santibáñez et al., 2013.

To analyze impact on species, the most used approximation corresponds to the species distribution models or niche models (Guisan and Zimmermann, 2000). This methodology is used in the Marquet et al., study (2010), which allows characterizing the current distribution of one species and project it in future scenarios by means of climate variables and known presences. As a result of the ecologic niche modeling, the response to climate change of the analyzed species shows for the term 2070-2100 that, in general and even though decreases dominate in the species distribution area of limited dispersion, the number of extinguished species is reduced. It has been noted that the response is highly dependent on the species dispersion capacity.

In the modeled term (end of the century), over half the studied species could expand their distribution range, while considering that most of species not able to disperse show decreases in their projected distribution area. Such results are consistent with the changes expected for native arboreal species of the Mediterranean region of Chile reported in Bambach et al., (2013).

3.3.3. forestry, Agriculture and livestock

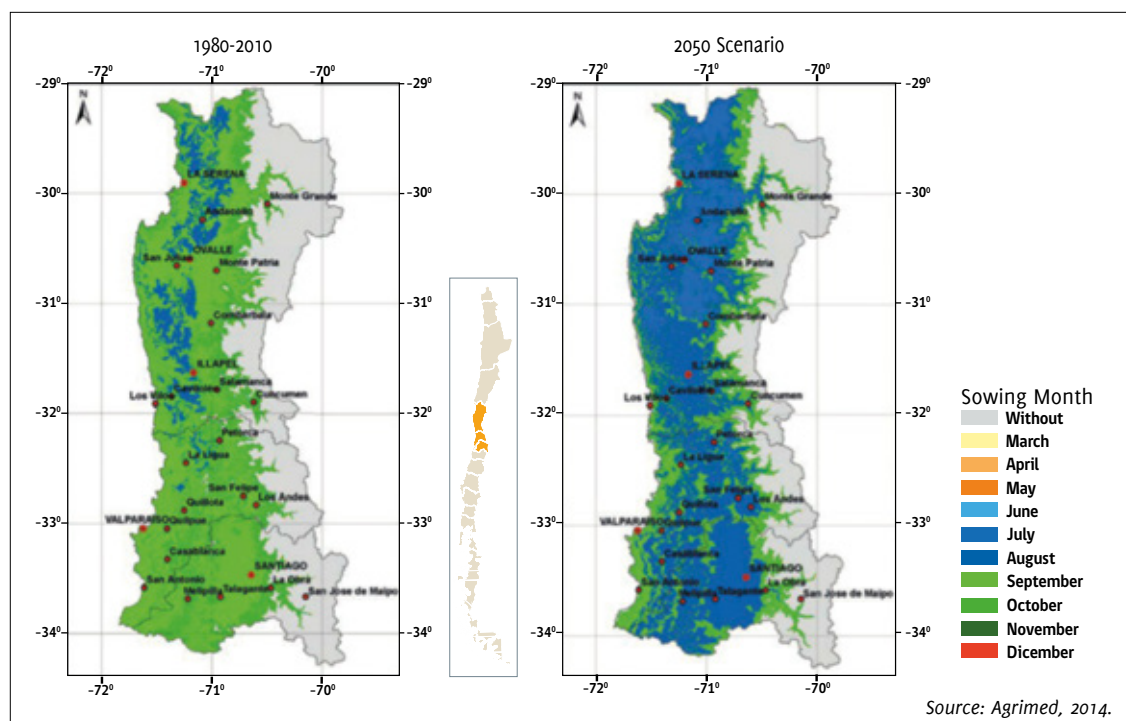
It is estimated that this is one of the most vulnerable sectors to climate change phenomena. The livestock and forestry industries are a significant source of employment, with a relevant share in the country's gross domestic product (GDP) of the country. The 2CN showed a detailed analysis of the potential impacts of climate change on the Agriculture sector. Most of the country's agricultural regions (Atacama to Los Lagos) would experience aridization as a consequence of rainfall decline which will continue during the XXI century (Agrimed, 2008). One of the main conclusions of such study indicates a displacement of the current agroclimate zones to the south, particularly referring to fruit cultives and forestry (Agrimed, 2008).

Impact on agricultural productivity projections have been updated for some crops, taking into account the new RCP climate scenarios. For example, according to estimates based on RCP 8.5 scenario for corn, around 2050 the production potential would considerably expand towards southerner latitudes as compared to the current extension, a displacement mainly explained by temperature increase in such latitudes. Notwithstanding, in the northern part of the current production zone decreases in the productive potential are foreseen of about 10% and 20%. Irrigation requirements would decrease between 10% and 30%

as a consequence of earlier crops which would allow a greater use of winter rainfall. Regarding crops seasonality, in the central-north zone of the country the optimal sowing time would be advanced to winter months given temperature increases. At the valley zone of the Metropolitan region advances would be to August, while at the colder zones of Andean foothills crops would continue during the spring (Figure 9).

In general, conclusions derived from the studies presented at the Second National Communication continue being valid. Such results are consistent with evidences which did not find considerable differences in the main climate variables among modeling derived from SRES and RCP scenarios for Chile zone.

Figure 9. Changes in the optimal sowing time between baseline (1980-2010) and 2050 scenario (RCP 8.5);



3.3.4. Fishing and aquaculture

Fishing activities at the central-south zone of Chile are the most important in the country, since they concentrate around 45% of domestic production. This zone productivity is determined by the Humboldt Current system (SCH), one of the most productive in the world both for its primary production (Daneri et al., 2000; Fossing et al., 1995) as well as fishing production (Bakun and Broad, 2003). The SCH occupies the central-south of Chile (~ 42° S) until the north of Peru (~ 4°-5° S). The most significant forcing within the context of climate change for SCH would be:

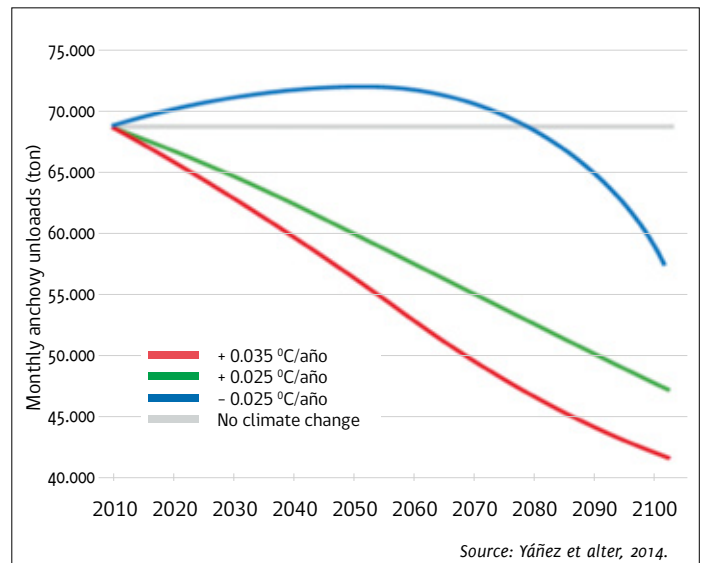
- changes in the concentration of environmental oxygen in the water column and in the sediments
- variations in the space-temporary intensity and dynamics of coastal upwellings
- changes in the sea temperature
- changes in ENSO frequency and intensity
- changes in circulation (marine currents)
- modification to the space-temporary dynamics of mesoscale physical structures (such as filaments, meanders, swirls, jets)
- increased sea level
- change in sweet water contribution to the coastal ecosystem

The potential impact of climate change on Chilean fishing and aquaculture are mainly focused on the effects of inter-annual variability associated to ENSO and PDO events. The importance of such variability is related to different space-temporary scales with effect on abundance, survival to the first stages of life, recruiting and changes in species distribution.

In Chile at least 11 fish and mollusk resources show different levels of vulnerability to climate change: anchovy (*Engraulis ringens*), common sardine (*Strangomera bentincki*), horse mackerel (*Trachurus murphyi*), hake (*Merluccius gayi*), species of sand eel conger eel, crabs, Juan Fernández lobster (*Jasus frontalis*), clam (*Mesodesma donacium*), large oyster (*Argopecten purpuratus*), abalone (*Concholepas concholepas*) and sea urchin (*Loxechinus albus*).

Studies on the impact of future changes in the sea mean surface temperature (TSM) project an increase in the anchovy catches in the north of Chile in case TSM decreases by 0.02 °C a year, and remarkable decreases if TSM increases by 0.034 °C a year or by 0.025 °C a year (Figure 10) (Yáñez et al. 2014).

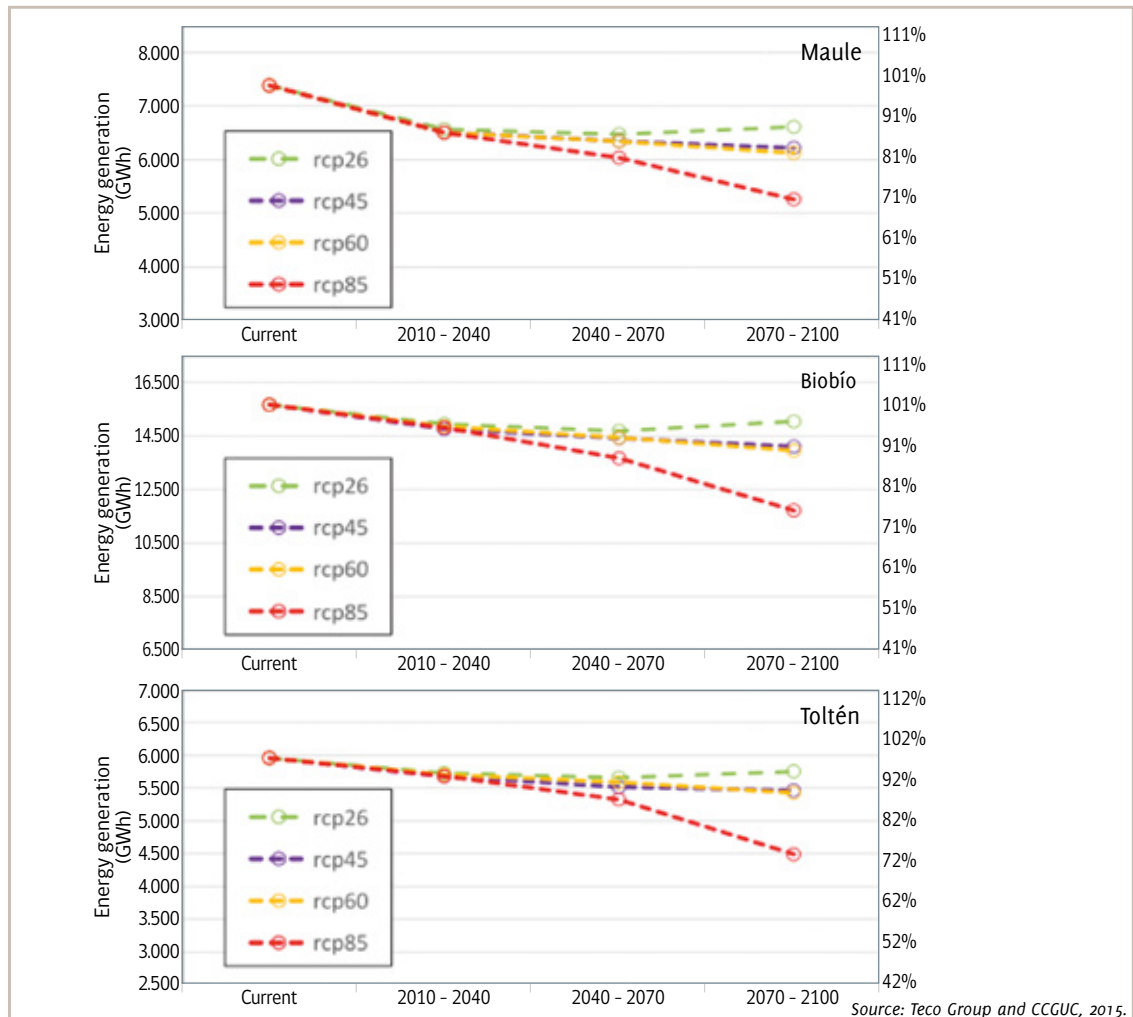
Figure 10. Monthly projection of anchovy catches in the northern zone of Chile, considering four climate change scenarios. Source: Yáñez et al. 2014.



3.3.5. Energy

In terms of energy supply, a series of connections with climate conditions may be found, particularly in the case of renewable generation sources. The most evident is the case of hydroelectric generation, which directly depends on the availability of hydric resources. In Chile, a little less than 50% the electricity supply of the SIC (from Taltal to the South) comes from hydroelectric generation and, in general, the growth plans of such offer consider this source as a significant strategic axis. The latter coincides with recent studies (TECO Group and CCGUC, 2015) which show there is still a significant generation potential for the basins in the south of Chile (basins at the south of river Maipo). Figure 10 shows the possible impacts of climate change on the electric energy generation at three of the most important basins in the country.

Figure 11. Estimate of climate change impact on the electricity generation capacity associated to future projects at Maule, Biobío and Toltén basins.



3.3.6. Infrastructure

Infrastructure services and works are the support to a wide range of social and productive sectors. Consequently they enable economic development and social wellbeing, the population's health and quality of life. In Chile infrastructure vulnerability to climate change has started being characterized by means of studies describing the potential impacts on hydric resources (as a resource and as a threat) and implications of such impacts. Furthermore, recently the Ministry of Social Development has started developing a Methodology for the Identification and Assessment of Disaster Hazards in Public Investment Projects. This effort requires a better description of the physical processes and vulnerability, and of exposure conditions that trigger a disaster. The need to also incorporate climate change has been detected in this process. It is worth mentioning that such progress has also led to define methodologies to assess climate change impact on infrastructure, in order to have new design and adaptation practices. A relevant document is the "Methodological Approach to assess climate change adaptation at the MOP public infrastructure" (CCG-UC, 2012), which defines a methodology to incorporate climate change to works planning, design and operation.

According to research conducted, impacts associated to climate change would affect drainage, fluvial works, bridges, ports infrastructure as well as coastal infrastructure.

3.3.7. Cities

The "Urban Adaptation to climate change" Study (MMA, 2014) considered urban vulnerability to variability and climate change of Chile's regional capitals and analyzed how such climate threats are considered by the territorial planning instruments. The five main threats, of a total of fourteen identified in this study are, in order of occurrence: floods, mudslides and downpours, landslips, droughts and temperature increase.

One of this study's conclusions is that national institutions show limitations in deploying climate change agendas at their national territories. A lack of involvement by local governments is apparent, which increases vulnerability conditions in some cities along the national territory.

In a MINVU study (2016) carried out within the framework of the UNDP project "Implementation of the Urban Development National Policy", the impact hazard of climate events is estimated per regional capital and it is illustrated by means of a climate origin threats index, and a social vulnerability index based on poverty, as established by CASEN survey. The threats index is composed by events occurred and their occurrence probability according to geographic location, including the possibility of sea level rise for the nine coastal regional capitals.

The study "Preparation of a digital basis of Chile's climate as per district: baseline (1980-2010) and projection to 2050" (MMA, 2016b) provides information on climate change as of 2050 according to the RCP8.5 scenario for 336 Chilean districts.

Table 3 shows a synthesis of two studies (MMA, 2016, 2016b) for the fifteen Chilean regional capitals. Rainfall absolute changes of less than 5 mm/year have been considered as "0".

Table 3. Synthesis of climate event impact hazards and temperature and rainfall changes as of 2050 according to RCP 8.5 scenario for the fifteen regional capitals of Chile.

City	Impact hazard	Potential threat due to sea level rise	Temperature changes to 2050				Rainfall changes to 2050	
			Summer	Summer	Winter	Winter	(mm)	(%)
			(°C)	(%)	(°C)	(%)		
Arica	0,72	yes	2,2	11	2,5	17	0	0
Iquique	0,62	yes	2,1	10	2,4	16	0	0
Antofagasta	0,63	yes	2,1	10	2,2	16	0	0
Copiapó	0,57	not applicable	2,2	11	2,2	21	0	0
La Serena	0,76	yes	1,9	11	1,8	17	-10	-13
Valparaíso	0,89	yes	1,9	11	1,6	15	-68	-17
Santiago	0,64	not applicable	2,7	14	1,7	19	-51	-15
Rancagua	0,63	not applicable	2,2	11	1,7	19	-82	-15
Talca	0,66	not applicable	2,1	11	1,5	18	-132	-16
Concepción	0,85	yes	1,7	10	1,3	14	-150	-15
Temuco	0,69	not applicable	1,9	12	1,2	16	-192	-15
Valdivia	0,48	yes	1,6	10	1,1	14	-231	-13
Puerto Montt	0,75	yes	1,7	12	1,2	18	-229	-12
Coyhaique	0,41	not applicable	1,6	15	1,5	79	-85	-7
Punta Arenas	0,61	yes	0,9	11	1,5	94	92	4

3.3.8. Health

During the last five years the Health sector has generated significant information regarding the sector vulnerability to climate change impacts, as well as the possible effects such changes may have on the population. This has led to the definition of strategies and specific measures allowing the population and the country's institutions to adapt to these new conditions.

In general, the relationship between climate change impacts and their effects on human health is complex and multidimensional, hence it is difficult to isolate particular causes so as it is necessary to learn their interactions to identify where to concentrate efforts (GreenLab, 2012).

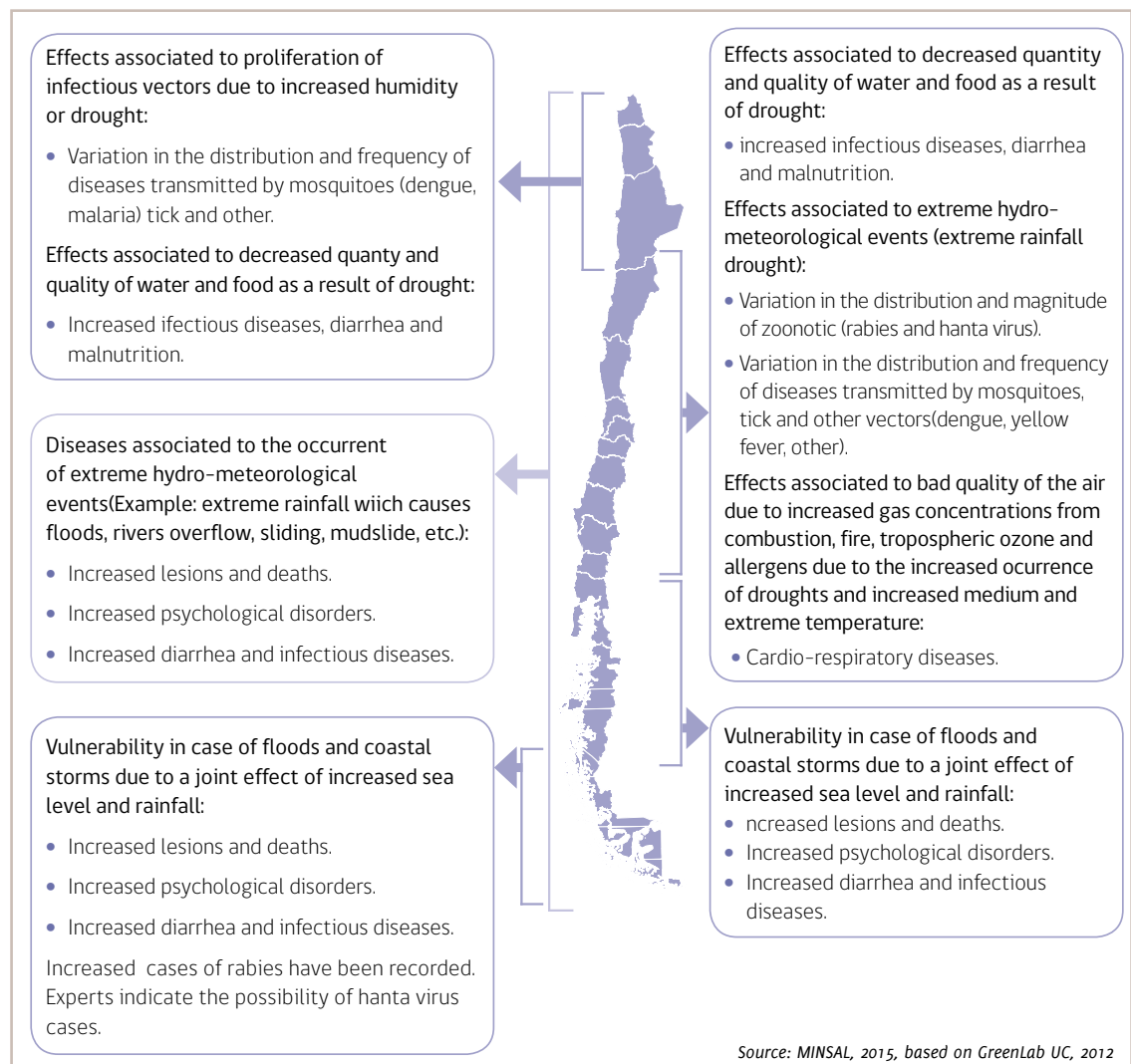
The study "Identification of impacts, vulnerability assessment of the health sector to climate change and adaptation proposals" (GreenLab UC, 2012) projects the impacts on health for the country in accordance with climate modeling scenarios SRES developed by CEPAL (2009), and with the literature and international experience on the issue. The results of this study were one of the main inputs for the preparation of the first version for the Climate Change National Adaptation Plan for Health in Chile.

According to such study, the impacts on health, either nationwide or local, may be classified according to their scope. The national scope impacts are those expected as a consequence of extreme hydro-meteorological events, among them those associated to ENSO phenomenon. Such events may cause an increase of infectious and diarrhea diseases; diseases associated to water consumption and contaminated

food; morbidity variation as a result of temperature changes, as well as damages and death for the direct effect of such phenomena, all of which may have an impact on vulnerable groups of the population, as well as on individuals performing outdoors activities periodically at zones of intense solar radiation (GreenLab UC, 2012).

Local impacts are expected at the northern zone (between Arica y Parinacota Region and the Andean sector of Antofagasta), at the central zone (between Atacama Region and de Los Lagos Region), at the southern zone (between Chacao channel and Aysén Region) and at the austral zone (the entire Magallanes Region) (MINSAL, 2015).

Figure 12. Synthesis of possible climate change impacts on health.



3.3.9. Tourism

Climate is an essential resource for tourism, especially for touristic segments such as seaside, nature and winter sports. Climate changes and weather patterns at touristic destinations may significantly affect tourists comfort and their travel decisions, and have direct effects on tourism marketing, demand, visitors flow and consequently on the communities offering services and activities.

According to the World Tourism Organization, in 2014 Chile was the seventh destination for foreign tourists within America and the third country with the largest reception of international tourists in South America, behind Brazil and Argentina. Currently, the domestic touristic industry has acquired a greater relevance; as a matter of fact, it contributed with 3.23% of GDP in 2010 (SERNATUR, 2014) and in 2015 Chile received about four million visitors.

Among Chile's main touristic attractions are its wide coast and sea, river and lake shores; the Andes mountains, with their ski stations, their hills and volcanoes; islands and islets, among them Easter Island and Chiloé; as well as other natural sceneries integrated by natural reserves, nature sanctuaries, national parks, natural monuments, RAMSAR sites and biosphere reserves.

In spite of all these possible connections between climate change and the tourism sector, to date there are no studies at a national level that explicitly study the potential impacts or tourism vulnerability to climate change phenomenon.

3.4. Climate Change Adaptation

The Chilean strategy regarding climate change adaptation is defined in the National Adaptation Plan to Climate Change of 2014 and in the National Action Plan on Climate Change 2017-2022, of 2016. Both plans, approved by the CMS, approach the adaptation to climate change through sector plans and a series of cross-cutting and inter-sector measures.

According to the country's commitments undertaken through its INDC of 2015, in 2018 Chile shall have Adaptation Plans to Climate Change for the Farming, Biodiversity, Fishing and Aquaculture, Health, Infrastructure, Cities, Water Resources, Energy and Tourism sectors, which will be updated every five years.

According to the Report of the National Adaptation Plan to Climate Change (MMA, 2016c), 70% of its activities are in their implementation phase and 4% are finished.

The four sector plans available (Farming, Biodiversity, Fishing and aquaculture, and Health) are in a ongoing implementation phase enabled by the financial support of the Global Environment Facility (GEF) and the adaptation fund of United Nations Framework Convention on Climate Change. Such plans approach their corresponding sector adaptation through a series of measures described as "action files", ordered according to strategic lines, specific goals or action axes.

Forestry, Agricultures and Livestock Plan (MMA, 2013)

This plan comprises 21 action files ordered as per 5 strategic lines: i) improving agricultural competitiveness; ii) encouraging research and innovation; iii) promoting economic, social and

environmental sustainability; iv) transparency and access to markets, and v) modernizing the Ministry of Agriculture (MINAGRI) and its services.

They are all under execution, with an average progress of 70.7%. The Minagri is working on the 2018 update of this plan, with this update, the second cycle of sector plans, as undertaken in the Chilean INDC will be initiated.

Within the context of implementation of this plan there are two projects: i) “Enhancing resilience to climate change of the small agriculture in the Chilean region of O’Higgins”, financed by the adaptation fund of United Nations Framework Convention on Climate Change for a total amount of US\$9,960,000, and ii) the project “Technical Cooperation for measurement of carbon footprint and handling of plagues and diseases of untraditional export products adapted to hydric shortage conditions”, financed by the Chile Mexico Fund for a total amount of US\$261,087.

Biodiversity Plan (MMA, 2014a)

This plan comprises 50 action files ordered according to 4 specific purposes: i) biodiversity research and capacity building in management, information and environmental awareness at a national, regional and local level; ii) promotion of sustainable productive practices for adaptation to climate change in biodiversity and maintenance of the ecosystem services; iii) consideration of biodiversity objectives in the urban territorial planning instruments, in the regional territorial ordering plans (PROT) or other, as adaptation mechanism to climate change; iv) strengthening of the National System of Governmental Protected Areas and implementation of adaptation to climate change measures in the ecosystems and species, in environments both terrestrial and marine, coastal, of continental water and oceanic islands, both at rural and urban and outskirts sites.

Of this plan, 37 measures are under implementation, with an average progress status of 37.2%. The most relevant project is “Design of a biodiversity and climate change monitoring network”, financed by the Climate Technology Centre and Network (CTCN) for US\$250,000.

Fishing and Aquaculture Plan (MMA, 2015a)

This plan comprises 29 actions files ordered according to 5 specific objectives: i) promoting implementation of the precautionary and ecosystem approach in fishing and aquaculture as a manner to improve marine ecosystems resilience and the coastal communities that use hydro biological as well as the sector resources in general; ii) developing the necessary research to improve the knowledge on climate change impact and scenarios over ecosystem conditions and services on which fishing and aquaculture are based; iii) disseminating and reporting climate change impacts with the purpose of educating and training users and significant stakeholders on this issues; iv) improving the standardization, political and administrative framework to effective and efficiently approach the



Archivo MMA.

challenges and opportunities of climate change, and v) developing direct adaptation measures aimed to reduce vulnerability and climate change impact on the fishing and aquaculture activities.

Within the framework of this plan implementation the Project “Strengthening climate change adaptation capacity in the Chilean fishing and aquaculture sector”, should be highlighted. The Special Climate Fund of GEF in an amount of US\$2,500,000 provided funding for this project.

Health Plan (MMA, 2016)

This plan comprises 16 action files ordered according to 8 action axes: i) strengthening of institutions, ii) strengthening of human capital, iii) studies, iv) surveillance, v) promotion of health among citizens, vi) response in emergency situations, vii) decreased vulnerability, and viii) health care This plan is subject to approval by the Council of Ministers for Sustainability.



Archivo CONAF.

4 Mitigation of Greenhouse gases emission

Nationally, the actions that contribute to the reduction of GHG emissions have been developed in a sectorial context. The Ministry of Environment, in its role as coordinator of climate change issues in Chile, has gathered information on national policies and initiatives with benefits in GHG mitigation, enhancing this variable as an indicator of the country's efforts to comply with the objectives of the UNFCCC.

4.1. Mitigation in Chile

At COP 15 (2009, Copenhagen) the Minister, President of the National Environment Commission (CONAMA) expressed Chile's voluntary pledge, which affirms that "Chile will take nationally appropriate mitigation actions to achieve a 20% deviation below the "Business as Usual" emissions growth trajectory by 2020, as projected from the year 2007". The statement also specified that "To accomplish this objective, Chile will need a relevant level of international support." This voluntary commitment has led to the development of various mitigation activities in the country focused on reducing GHG emissions.



For the first time the Paris Agreement, adopted in December 2015, involves all parties in a common cause to make ambitious efforts to fight climate change and adapt to its effects and called on countries to make their best efforts in their Intended Nationally Determined Contributions. As part of the preparation of this agreement, Chile developed its Intended Nationally Determined Contributions (INDC).

4.1.1. Chile Intended National Determined Contribution (INDC)

Chile has submitted its INDC to the Secretary of the UNFCCC in September, 2015. The country's commitments are divided into 5 pillars: i) mitigation, ii) adaptation, iii) capacity building and strengthening, iv) development and Technology Development and Transfer, and v) financing.

In the case of the mitigation pillar, Chile has chosen to present its contribution using the format of emissions intensity (tons of CO₂ equivalent per unit of gross domestic product (GDP) in millions of CLP\$ at 2011). Methodologically, it was decided to separate the Land Use, Land-use change, and Forestry (LULUCF) sector from the national commitment to mitigation, due to the high annual variability of sinks and emissions from the sector, and for being less dependent on the trajectory of economic growth.

Chart 1. Chile's national contribution to mitigation**Carbon Intensity Target:**

- a) Chile is committed to reduce its CO₂ emissions per GDP unit by 30% below their 2007 levels by 2030, considering a future economic growth which allows to implement adequate measures to reach this commitment.
- b) In addition, and subject to the grant of international monetary funds, the country is committed to reduce its CO₂ emissions per GDP unit by 2030 until it reaches a 35% to 45% reduction with respect to the 2007 levels, considering, in turn, a future economic growth which allows to implement adequate measures to achieve this commitment.

Specific Contribution from the forestry sector:

- a) Chile has committed to the sustainable development and recovery of 100,000 hectares of forest land, mainly native, which will account for greenhouse gas sequestrations and reductions of an annual equivalent of around 600,000 tons of CO₂ as of 2030. This commitment is subject to the approval of the Native Forest Recovery and Forestry Promotion Law.
- b) Chile has agreed to reforest 100,000 hectares, mostly with native species, which shall represent sequestrations of about 900,000 and 1,200,000 annual equivalent tons of CO₂ as of 2030. This commitment is conditioned to the extension of Decree Law 701 and the approval of a new Forestry Promotion Law.

Within such context, all sectors quantified in the INGEI 1990-2010 have a priority to carry out mitigation actions in Chile.

4.1.2. Assessment of mitigation in Chile

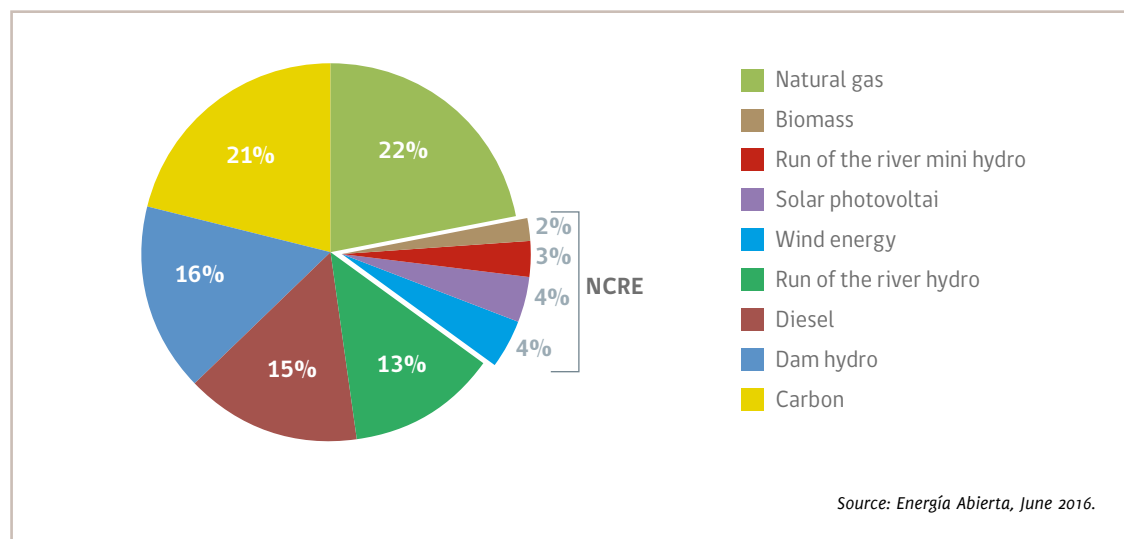
The inventory information provides the context and the grounds to understand the significance of sectorial mitigation actions given that the gradual implementation of such actions shall be reflected on the trend of the country's GHG emissions.

On the other hand, with the purpose of assessing possible mitigation scenarios in the different emission sectors, the MAPS-CHILE Project was developed between 2012 y 2013 which apart from building capacities and involving society in the



Archivo MMA.

Figura 13. Chile's total installed capacity as per source type, 2016.



analysis of mitigation options in Chile, provided the basic elements to prepare the Chile's INDC document as a long term commitment.

4.2. Sectorial mitigation actions

Chile has implemented a series of cross-cutting and sectorial actions, which, although they have been designed with sectorial purposes, due to their characteristics, they have had an impact on GHG emissions in the country.

4.2.1. Energy Sector

This sector is regulated by the Ministry of Energy and its dependent or related organizations, being the private sector responsible for making investments.

On June, 2016 the total installed capacity of the national energy matrix was 20,627 MW. As from 2010 the Chilean electric system must comply with a non-conventional renewable energy (NCRE) injection quota. As of 2005 their installed capacity was 286 MW, while in 2016 it was already 2,720 MW, which represents 13.15% of the total capacity of Chile's electric systems (Figure 13) (CNE, 2016).

The Ministry of Energy, created in 2010, is the public entity responsible for preparing and coordinating plans, policies and standards for the country's energy development thus ensuring Chilean population has an access to energy in a safe manner and at a reasonable price.

During the last six years the Ministry enacted a series of laws and programs which directly or indirectly contribute to reduce GHG emissions:

- In 2011 the Ministry of Internal Affairs and Public Security, and the Ministry of Energy issued the guidelines on application of energy savings measures in the public administration which purpose is to achieve a minimum 5% decrease of electric consumption in the public buildings.
- In 2012 the National Energy Strategy 2012-2030 was launched, which goal is defined as a 12% decrease of the country's projected energy demand to 2020, and which main pillar is energy efficiency.
- In 2013 the Energy Efficiency Action Plan was launched (PAEE 2020), which establishes a series of concrete measures under the influence of the National Energy Structure, with the purpose of achieving the goal of a 12% reduction of the final energy demand projected for 2020.
- In 2013 Law 20,698 (Law 20/25) was enacted, which establishes that NCREs participation in the electric generation matrix in Chile must reach 20% by 2025.
- The Energy Agenda was presented in 2014, and a consultation multi-acting committee was created to prepare the country's Energy Policy.
- In 2015 the consultation multi-acting committee published the "2050 Roadmap: Towards a sustainable and inclusive energy for Chile", which incorporates a series of purposes and goals, such as lifting the existing barriers for NCREs (the commitment is that by 2025, 45% of the electric generation capacity is originated by this type of sources) as well as encouraging the efficient use of energy as energetic resource (the savings goal is 20% in 2025).

Other activities aimed to the Energy Sector GHG reduction is related to the NAMA developed by the Ministry of Energy and the Economic Development Agency of the Chilean Government (CORFO) (see 4.3. Other mitigation actions), in a project which encourages the incorporation of self-sufficient renewable energy systems.



Archivo MMA.

4.2.2. Transportation Sector

According to 2013 INGEI figures, in Chile CO₂ eq emissions of this sector are mainly originated by terrestrial transportation (88.9%), followed by national aviation (4.1%), national navigation (3.6%), other type of transportation (2.8%) and railways (0.6%).

The Ministry of Transportation and Telecommunications (MTT), through its Transportation Undersecretary, is the public entity in charge of generating policies, standards and conditions for the development of transportation systems.

With the purpose of strengthening its planning and development role, in 2012 the Planning and Development Coordination was created which manages the purposes and tasks developed by the Roads and Urban Transportation Program (SECTRA), the Traffic Control Operative Unit (UOCT), the Intelligent Cities Unit (UCI), the Short Term Management Unit (UGCP) and the Infrastructure Projects Management Unit (UGPI).

In 2013, the Transportation National Policy (PNT) was designed to establish an institutional framework to lead sectorial work in the long term, which sets the objectives, principles and instruments allowing for planning and implementing of the transportation systems that will be needed in the future, in order to contribute to the social and economic development of the country.

The following are examples of mitigation progress in the Transportation sector:

- In 2012, the emission standards were updated to reduce motor vehicle contaminants in the entire national territory.
- In 2012, the incorporation of low carbon vehicle technologies was promoted through the Energy Consumption Label on new vehicles, which in 2012 was voluntary and from 2013 it started being applied mandatorily.
- In 2014, the Technological Improvement Project for Buses of the Public Transportation System (Transantiago) was developed to deliver recommendations enabling the fleet renewal process projected for the term 2015-2022. The purposes were mitigating contaminants emission and increasing energy efficiency of the public transportation in Chile.
- The order of the urban public transportation systems was restructured with the purpose of decreasing atmospheric pollution and GHG emission; the fleet was renewed, as well as the plans to improve buses energy management.
- The fleet technological replacement program contributes to air decontamination. Since its start-up, in January 2015, over 2,850 buses have been replaced in the national territory.
- The promotion of modal alternatives encourages the use of non-motorized means in the cities through the creation and maintenance of cycle lanes. In 2013, the Santiago cycle lanes Master Plan was approved, an initiative which contemplates the design and construction of a network of approximately 932 km of cycle lanes for the capital. In 2014, the Cycle Lanes Plan was announced, a national initiative that contemplates the construction of 190 km of high standard cycle lanes which shall extend throughout the fifteen regions of the country.

4.2.3. Use of land, change in the use of land and forestry (UTCUTS)

The UTCUTS sector is formed by emissions and removals originated at forestry, meadows and scrubs soil; agricultural soil; urban soil; wetland and bare soil. The UTCUTS net contribution to GHG emission of the country is negative because its capacity to capture CO₂ exceeds its emissions. Capture sources are mainly native forest renewals, regeneration of managed native forest and forestry plantations, mostly exotic.

The Ministry of Agriculture is the Governmental entity in charge of encouraging, orientating and coordinating this sector activity in the country through the National Forestry Corporation (CONAF), the Farming Investigation Institute (INIA), the Foundation for Agricultural Innovation (FIA), the Institute for Farming Development (INDAP), the Information Center for Natural Resources (CIEN), the Forestry Institute (INFOR), among other. The Ministry contributes to the sector's development by means of regulations and programs aimed to technology transfer, innovation and financial support to small producers, with the purpose of fostering productivity and competitiveness of agricultural, livestock and forestry activities.

By virtue of its contribution capacity to the sector's mitigation, INDC Chile makes a specific contribution to this sector, associated to sustainable management and forest recovery.

One of the key instruments to comply with this forestry goal is the National Strategy for Climate Change and Vegetal Resources (ENCCRV) that CONAF is formulating and implementing, in order to make available a legal, technical, operational and financial platform that regulates and promotes preservation, recovery and rational use of vegetal resources from a rationale that contributes to mitigation and adaptation to climate change, and to the resulting processes of desertification, drought and soil degrading, with an emphasis on the territories of greater social, economic and environmental vulnerability of the country.

The ENCCRV main guidelines are the approach on Reducing Emissions from Deforestation and Forest Degradation (REDD+) and Carbon Existence Increase and Land Degradation Neutrality (LDN). On the other hand, the strategy will be a tool to comply with the Sustainable Development Objectives approved in 2015 by the General Assembly of the United Nations.

4.2.4. Waste Sector

The Waste sector emissions are originated by the final disposal of municipal solid waste; waste water treatment and their corresponding muds; from hospital residues incineration and nitrous oxide emission from human excretions.

The most part of Chile's GHG in this sector are originated by municipal solid waste whose management, regulated by the Sanitary Code, is granted to municipalities through the Municipalities Organic Constitutional Law.



Archivo MMA.



Antártica, Archivo MMA.

Currently, the policy for the integral management of solid waste –a responsibility of the MMA– is being updated. A milestone in this area is Law 20,920, enacted in 2016 which establishes the framework for residues management; producer’s extended responsibility and recycling encouragement, and forces manufacturers and importers of six priority products to recover a percentage of their products once their useful life has ended.

4.2.5. Mining Sector

Chile is the first copper producer in the World. Notwithstanding, the decrease of international demand resulting from the Chinese economy downturn –its main buyer– during the last years has caused a significant decrease in sales prices which has directly affected its contribution to the domestic GDP. In spite of this industry’s contraction, the sector’s energy consumption has continued growing as well as the associated GHG emissions. Direct emissions of the mining sector due to the use of fossil fuels with energy purposes during 2013 (according to Chile’s INGEI) amounted to 5.3 million CO₂ eq tons. According to a COCHILCO analysis, 76% of such emissions are originated by the open pit mine processing given the great use of diesel at the works.

The main institutional arrangement within this sector is the Cooperation Agreement which took effect in July, 2014 between the Ministry of Energy and the Mining Council. Its main purpose is to encourage the efficient use of energy resources through the promotion of energy management, the use of efficient equipment and systems, and the creation of an efficiency culture inside the member companies. Among the activities developed by the companies within the Agreement’s framework are: energy audits to operations; identification of efficiency measures and the definition of a short, medium and long term implementation plan at, apart from maintaining adequate records to assess activities. On the other hand, the Ministry of Energy is in charge of supporting and enabling the development of such activities (Cooperation Agreement between the Ministry of Energy and the Mining Council, 2014).

As regards mitigation of climate change, most of the mining sector progress actions are initiatives made by the private sector.

4.3. Other mitigation actions

In addition to the sector actions, in Chile there are other initiatives to reduce GHG, such as the Clean Production Agreements (APL), sustainable construction and urbanism and particularly, the voluntary actions performed by private companies. Within the private sector, the activities of the Mining, Cement and Steel should be highlighted, with investments in the calculation of their emission both to respond to their companies' needs and to report to international sectorial associations. Also, energy handling and management systems have increased the companies' energy efficiency decreasing GHG emissions. On the other hand, in response to the individual characteristics of each area and to the need of reducing costs and increasing competitiveness, improvements have been incorporated to processes and raw materials have been replaced, among other mitigation initiatives.

4.4. Chile's Nationally Appropriate Mitigation Actions (NAMA)

According to the UNFCCC, the NAMA concept refers to any action that reduces emission related to business as usual emission by 2020. NAMAs are supported and enabled by international funds oriented to technology, financing and capacity building.

In October, 2010 the Climate Change Office (currently DCC) of the MMA started a process to raise NAMA ideas and proposals by the main emitting sectors in Chile, for which international support is sought. With the opening of the NAMA registration prototype and then the official Convention registration (NAMA Registry), Chile has been able to materialize this task and become the first country in the world to register a NAMA with the Convention, in October, 2012.

Six sectorial NAMA are identified in Chile, with different levels of progress and information available (Table 4). Of these, five have been registered with the NAMA Registry. Some have experienced significant changes in their design, which are contained in the Chile' Second Biennial Update Report. NAMA are supplementary to sectorial mitigation actions.



Eolic energy, MMA.

Table 4. Chile's Nationally Appropriate Mitigation Actions (registered with the NAMA Registry)

Name	Description	Sector and Gases	Term	Estimated GHG reduction	Progress
Self-Sufficient Renewable Energies for consumption in Chile (SSREs)	Promoting the incorporation of self-sufficient renewable energies through the creation of adequate financial and technical conditions for this emerging industry first development stages	Energy CO ₂	2015-2021	1,5 MtCO ₂ e.	- €15MM were granted through a NAMA Facility - The Nama Support Project (prior to implementation) is in the planning and detailed preparation stage
Green Zone for Transportation in Santiago	Composed by four specific initiatives (scalable and replicable) to promote low carbon emission transportation means: 1) Promotion of light vehicle fleets with zero and low emission; 2) More efficient buses for public transportation; 3) Promotion of non-motorized vehicles 4) Traffic management	Transportation and Infrastructure CO ₂	2014-2022	1,43 MtCO ₂ e	Component 1: 3 electric operational Taxis. Component 2: 1 electric operational bus. Component 3: Public bicycles system implemented (18 stations); 2 new high standard cycle lanes. Component 4: 3 new semi-pedestrian axes implemented or under implementation; 100 surface cycle supports installed Progress of emission reduction under estimation as of July 2016
Support to the design and implementation of the National Strategy for Climate Change and Vegetal Resources (ENCCRVR)	Technical and financial support for the development of studies and activities oriented to identify and reduce ENCCRVR basic information weaknesses, in addition to enhancing the capacities of ENCCRVR related national and regional teams	Forestry/ LULUCF		Support to the design and implementation of the National Strategy for Climate Change and Vegetal Resources (ENCCRVR)	Technical and financial support for the development of studies and activities oriented to identify and reduce ENCCRVR basic information weaknesses, in addition to enhancing the capacities of ENCCRVR related national and regional teams
Clean Production Agreements (APL) in Chile	The purpose of APLs is implementing clean production through goals and actions in a given term. This is a standard that establishes specific goals and actions to be implemented by a productive sector, mainly based on the best techniques available in the market	Cross	2012-2020	18,4 MtCO ₂ e	- 2015: 17 agreements are signed a total 46 agreements since 2012 - Estimated accrued reduction: 2,224,083 tCO ₂ eq
Program for energy valuation of industrial residues (former National Program for Industrial and Commercial Catalysation of Organic Residues Management in Chile)	The purpose of this NAMA is under redesign to obtain an energy valuation program for industrial residues	Energy, Residues CO ₂ ; CH ₄	To be defined	Reduction potential under estimation	The original design of this NAMA showed implementation difficulties, hence a study is under development with international support to change the design of this NAMA purposes, focusing on the energy benefits of industrial residues treatment. This new design and the estimate of potential reductions are expected during 2016

4.5. Measurement, report and verification of mitigation actions

Measurement, report and verification (MRV) is a term used to describe all measures taken by the countries to collect emission, mitigation and support actions data, gather this information in reports and inventories and submit them for review or analysis (International Partnership on Mitigation and MRV, 2014).

The purpose of MRV in Chile is promoting transparency of GHG mitigation activities through mechanisms allowing the follow up of its objectives. Having MRV systems for individual actions is essential to assess effectiveness, even if Chile reports the implementation of its mitigation actions to the international community through IBAs and international communications, as requested by the UNFCCC.

Since 2011, Chile has worked on independent MRV systems that have acted as management tools for NAMAs. Apart from building capacities in this area through the international support of several projects, such as the preparation in 2014 of the document “Guidelines for a generic MRV framework for NAMAs” (MMA, 2015). It which explains how to measure, report and verify the GHG emission impacts and other semi-impacts of mitigation actions. Although developed for NAMA, it may be used for any type of action that mitigates GHG emission.

In Chile there are MRV systems for NAMAs (for example, NAMA of the forestry sector or self-sufficiency NAMA), for programs (such as voluntary production agreements or programs monitored by ACHEE), for goals (for example, energy efficiency goal monitored by the Ministry of Energy), etc. These systems are (or will be) developed in different computer platforms (Centro de Energía , 2016)

4.6. Cross supporting actions for a low carbon economy

The Low Emission Capacity Building (LECB-Chile) Project, which was started in 2012, is an initiative led by the UNDP in twenty five countries. HuellaChile Project was originated in 2013 at the DCC of the MMA and it is the official initiative of the Chilean Government for the quantification, report and management of corporate GHG emissions of organizations located in the national territory. It is also one of the first official instances promoting the active participation of the private sector in climate change mitigation.

In 2014 the Government enacted the Law on Tax Reform which includes three green taxes for the first time in Chile. The first applies to light vehicles according to their urban performance and emission of NOx.. The second applies to fixed sources, and it taxes SO₂, NO_x and MP emissions to the environment. It is expected that such taxes have significant but indirect co-benefits for GHG reduction. The third green tax is a direct tax on CO₂ emission of US\$5 per ton.

5 Other significant information to achieve the Convention's objective

Chapter 5 of 3CN approaches the country's efforts in technology, research, education and national capacities building, which show that climate change is a part of the national agenda and it is being dealt with by the Chilean society through concrete actions. The measures and activities implemented in the term 2010-2015 are mentioned, and they are related to the efforts reported in the Second National Communication. The analyzed issues, particularly relevant for the country are technological transfer in climate change; systematic observation of climate change; information related to research programs on climate change; education, formation and public sensibilization on climate change, and encouragement of national and local capacities on climate change.



Pinguins, MMA.

5.1. Technological transfer on climate change

The main organizations involved in the coordination of technological transfer mechanisms in Chile are the National Council of Innovation for Competitiveness (CNIC), the Innovation Division of the Ministry of Economy, Encouragement and Tourism, and the National Institute of Industrial Property (INAPI). On the other hand, entities encouraging the implementation of technological transfer actions through the delivery of financing to performing entities are the National Commission for Scientific and Technological Research (CONICYT), CORFO and the Agricultural Innovation Foundation (FIA).

As a result of a permanent work on this issue headed by the CNIC, the Innovation and Competitiveness Agenda 2010-2020 was published in 2010, which highlighted climate change as an issue of national concern and as a scientific research line that should be financed as regards agriculture and fruit growing (CNIC, 2010). In December, 2015 the National Innovation Program 2014-2018 was presented, which includes a diagnosis of the innovation, research and development status and defines the roadmap for 2014-2018.

The most significant Chilean public initiatives in this area between 2010 and 2015 were prepared by the following entities.

Corporación de Fomento de la Producción (CORFO)

CORFO, created in 1939, is the Chilean governmental entity in charge of promoting the national productive activity. It is related to the promotion of environmental technologies, including mitigation and adaptation to climate change.

Between 2012 and 2015, a series of supporting instruments (co-financing) were made available for projects related to climate change mitigation and adaptation, which are divided into competitive development, innovation, investment and financing, entrepreneurship and technological capacities building instruments.

Since 2013, CORFO has promoted the settlement in Chile of international excellence centers devoted to research related to the country's sustainable development, to climate change mitigation and adaptation, to energy generation and access and to energy efficiency. Some of such centers are: Laborelec Chile, Center for Systems Biotechnology and Center for Solar Energy Technologies, both from Fraunhofer Chile Research, Marine Energy Research and Innovation Center (MERIC) and UC Davis Chile.

In addition, a Subsidy to Pre-Investment Studies in NCRE Program was implemented through the Center for Innovation and Encouragement of Sustainable Energies (CIFES), by which 121 studies have been granted with a total projected power of 2,232 MW. Also, CORFO has granted credits for US\$ 137 million during the term 2009-2012 to perform 15 NCRE projects. It also has the Technological Consortia for Innovation program, by which it generates medium and long term scientific-technological research lines which approach sustainability issues related to fruit, wine and aquaculture, as well as the strengthening of genetic improvement programs.

Ministry of Energy

The Ministry of Energy and its related entities, such as the National Energy Commission (CNE) and the Chilean Agency for Energy Efficiency (ACHEE), have been key players in technological transfer, since technology incorporation in this sector may be a great contribution to GHG reduction. Between 2007 and 2011, with the purpose of eliminating information barriers on the availability and quality of the renewable energy resources of our country, the Ministry of Energy prepared and started up public information platforms allowing for characterization in early stages of appropriate sites for the development of NCRE projects, particularly wind energy, solar energy for self-sufficiency, non-consumptive water usage rights, marine energy and forestry bioenergy.

For example, in 2012 the Clean Technology Fund (CTF) granted the Ministry with US\$ 200 million for the implementation of four great projects, with funds delivered by the Inter-American Development Bank (IDB) and the International Finance Corporation (IFC) of the World Bank, as follows:

- Solar Plant Concentration Project
- Large Scale Photovoltaic Program
- Energy Efficiency Program and Renewable Energy for Self-Sufficiency
- Geo-thermal Hazards Mitigation Program

Ministry of Public Works

The MOP Architecture Directorate (DA) has published the following documents on energy efficiency in public construction: Manual for passive design and energy



efficiency in public buildings; Energy Management Manual in Public Buildings and Standardized Terms of Reference on energy efficiency and environmental comfort for design and works biddings of the Architecture Directorate, per geographic zones of the country and type of buildings.

5.2. Systematic Observation of climate variability and climate change

Systematic observation of climate and its variability is carried out in the country through the monitoring of meteorological, atmospheric, oceanographic and terrestrial relevant parameters. Observation programs carried out during the term 2010-2016 were carried out within a national and international context, that is:

5.2.1. National Programs on climate observation

The national programs on climate observation involve meteorological and oceanographic aspects related to different climate zones, and they are particularly addressed to agriculture, marine and aerial navigation and meteorology in general, that is, they are not oriented to the systematic study of climate change.

The corresponding programs involve monitoring atmospheric weather, under the responsibility of the Meteorological Directorate of Chile (DMC), the Hydrographic and Oceanographic Service of the Navy (SHOA) and the Water General Directorate (DGA), and inter-entities cooperation for the establishment of agro-meteorological networks.



Antártica, MMA.

Meteorological Directorate of Chile

The DMC, which reports to the General Directorate of Civil Aeronautics, is the Governmental entity in charge of atmospheric weather observation. It has a stations system that every hour monitors significant variables on temperature and atmospheric pressure, rainfall, wind direction and intensity, type and height of clouds, air visibility and relative humidity. The DMC operates 96 stations with international standards from Arica to Base Frei, in the Chilean Antarctic territory, with 60 of them transmitting in real time and on line through its web page. Also, it has 23 stations that carry out three daily observations and 71 stations that only measure the rainfall and extreme temperatures parameters. It also operates a network of five radio probes allowing monitoring the atmosphere vertical profile, with variables including temperature, pressure, humidity and wind. Thirty DMC stations are a part of the world atmosphere surveillance program of the World Meteorological Organization. DMC also has 22 UV radiation monitoring stations along the country.

Hydrographic and Oceanographic Service of the Navy

The SHOA is another public entity which monitors significant variables for climate observation. Its main task is supplying information and technical assistance allowing safe navigation of the territorial sea, lakes, rivers, internal seas and open sea next to the Chilean coast. It permanently monitors sea level, water and air surface

temperature, atmospheric pressure at a series of coastal stations located along continental, island Chile and the Antarctica Chilean territory. It also monitors the ENSO phenomenon.

Water General Directorate

Given the significance of glaciers as indicators of climate change, in 2008 the DGA created the Glaciers Unit in order to have a national glaciers program to keep an inventory, to study and to monitor glaciers along the country. In 2009 the DGA published the Glaciers National Strategy (ENG) which gradual long term implementation will allow knowing the current and future response of glaciers to global warming.

National Agro-climate Network (RAN)

This network was established in 2013 by the INIA, the Cooperative Center for Viticulture Development, the Chilean Wines Association, the Chilean Exporters Association and the Foundation for Fruit Growing Development. The RAN, which was created to ensure free access, quality, opportunity and continuation of meteorological information availability for the decision making of the farming sector, is formed by 322 automatic meteorological stations belonging to Agroclima, Agromet and Meteovid networks of the members of the RAN technical consortium, who take care of their optimal operation. The RAN is the network with the wider national coverage and the greater number of stations located at sectors of interest for agricultural decisions (Agroclimático, 2013).

5.2.2. Participation in climate observation at international level

Chile participates in different international climate observation efforts. The SHOA, the DMC, the Fisheries Development Institute and the Fishery and Aquaculture Undersecretary are a part of the South Pacific Permanent Commission, together with entities from Colombia, Ecuador and Peru. Together, they coordinate observation and research activities and they monthly prepare a Climate Alert Bulletin related to the ENSO phenomenon, which reports the sea surface temperatures and sea level. Monitoring of the specific stations is also reported to the data centers acknowledged by the Global Sea Level Observing System (GLOSS), a program coordinated by the Inter-Governmental Oceanographic Commission.

In addition, through the DMC Chile contributes with 17 monitoring stations to the Global Climate Observing System (GCOS) network of the World Meteorological Organization. It contributes with 25 surface stations and 5 radio probe stations to the World Weather Watch, also of the WMO, which is in charge of atmospheric weather observation.

5.3. Climate change research programs

5.3.1. National Commission for Scientific and Technological Research (CONICYT)

CONICYT, which reports to the Ministry of Education, is oriented to two great purposes: encouraging human capital formation and strengthening the country' scientific and technological basis. Between 2008 and 2015, through different programs it financed 640 projects somehow related to climate change: 24.1% of them is related to the Energy sector, which includes new forms of energy and NCRE; 15.2% are studies on ecosystems, living beings and their adaptation to climate change; 8.6% are studies related to hydric deficit, hydrographic basins and their response to possible changes; 7.7% on agriculture and its adaptation capacity; 7.2% on the development of new biofuels of different origins, and 5.5% on glaciers and studies carried out at the Antarctica.

57% of such projects were financed by FONDECYT; 21% by PCI; 11% by FONDEF and 11% by the programs: Regional PIA, FONDEQUIP, FONDAP and FONIS.

On the other hand, some research centers that support the study of climate change in the country are financed by three CONICYT programs: the Financing Fund for the Research Center on priority areas (FONDAP), the Regional Program of Scientific and Technological Research and the Associative Research Program (PIA).



Archivo MMA.

Table 5. Excellence Centers on climate change

Program	Research Center	Sponsoring Entity	Year of creation
Fondap	Los Andes Excellence Center on Geothermal Energy (CEGA)	University of Chile	2010
	Solar Energy Research Center (SERC-CHILE)	University of Chile	2012
	Center on Climate Change and Resilience (CR2)	University of Chile	2012
	National Research Center for Integrated Management of Natural Disasters (Cigiden)	Pontifical Catholic University of Chile	2012
	Center for Sustainable Urban Development (Cedeus)	Pontifical Catholic University of Chile	2012
	Inter-disciplinary Center for Research on Sustainable Aquaculture (Incar)	University of Concepción	2012
	Center of Hydric Resources for Agriculture and Mining (CRHIAM)	University of Concepción	2013
Regional Program	Studies Center of Fuego-Patagonia and Antarctica Quaternary (CEQUA)	Magallanes University, Chilean Antarctica Institute, Fishing Promotion Institute,	2002
	Advanced Studies Center on Arid Areas (CEAZA)	University of La Serena, Catholic Northern University, Institute of Farming Research	2003
	Patagonia Ecosystems Research Center (CIEP)	Southern University of Chile, University of Concepción, Montana University, Siena University, University of Cordoba, Institute of Farming Research,	2005
	Hydric Resources Research and Development Center (CIDERH)	Arturo Prat University, Minera Doña Inés de Collahuasi,	2009
PIA	Center on Scientific Studies (CECS)	Center on Scientific Studies (CECS)	1984
	Oceanographic Research Center for the Oriental South Pacific (COPAS)	University of Concepción (principal) and Southern University of Chile (associate)	2002
	Corporation Institute of Ecology and Biodiversity	Corporation Institute of Ecology and Biodiversity	2008
	Valparaiso Scientific Technological Center	Universidad Técnica Federico Santa María	2009
	Center for Applied Ecology and Sustainability, CAPES	Pontifical Catholic University of Chile (principal), Adolfo Ibáñez University (associate)	2013

5.3.2. Environmental Protection Fund (FPA)

The FPA, managed by the Ministry of the Environment is the only competitive fund granted by the Chilean Government on environmental issues. It supports citizen's initiatives and entirely or partially funds projects with the purpose of protecting or repairing the environment, sustainable development, nature preservation or environmental heritage conservation. Table 6 shows some projects financed by the FPA.

Table 6. Projects related to climate change financed by the FPA

Project	Entity	Year
Forests of Andean Santiago: valuation and recovery options	School of Forestry Science and Nature Conservation, University of Chile	2012
Development of an alternative technology for stub burning by means of inoculants from anaerobic digestors	School of Agricultural Science, University of Chile	2014
Atlas of climate change at the semi-arid regime zone of Chile	School of Agricultural Science, University of Chile	2014
Determination of extreme climate indexes to visualize climate change and its possible incidence on hydric resources of the region	Research and Development Center on Hydric Resources of Arturo Prat University	2014
Nunatak-Chile, First Natural Laboratory on Glacier Pollution and Climate Change, baseline collection	Federico Santa María Technical University	2014

5.3.3. The country's participation in research activities with bilateral or multilateral international entities

Between 2011 and 2015, Chilean researchers permanently participated in different networks oriented to research on environmental sustainability and climate change at a Latin American and international level, such as the Regional Fund for Farming Technology (Fontagro), the Inter-American Institute for Global Change Research (IAI), the Economic Commission for Latin America and the Caribbean (ECLAC), the Inter-Governmental Panel for Climate Change (IPCC), Euroclimate and the Latin American Offices Network for Climate Change (RIOCC).

5.3.4. National research centers in areas related to climate change

The main entities are: the Chilean Antarctica Institute (INACH); the Center of Climate Science and Resilience (CR2); the Center of Global Change of Pontificia Universidad Católica (CCG-UC); Universidad de Concepción; the Center for Sustainable Urban Development (CEDEUS); the Center for Research and Innovation on Climate Change of Universidad Santo Tomás; the Center for Scientific Studies (CECS) of Valdivia; the Center for Solar Energy Research (SERC-CHILE) and the National Center for Research on the Integrated Management of Natural Disasters (CIGIDEN).

5.4. Education, formation and public sensitization on climate change

5.4.1. National Education Policy

The National Education Policy for Sustainable Development (2009) establishes the principles, objectives and strategic lines for education to promote citizens with an active participation in the construction of the country's sustainable development. Its main purpose is strengthening educative processes that install and develop values, concepts, skills, competences and attitudes among citizens at an individual and collective level, to build and enjoy a sustainable society. The main actions developed include the promotion of the existing activities on environmental education, the creation of information material and teaching support, and carrying out specific education sustainability projects focused on local players and contexts.



Archivo MMA.

In this area, the National System for Environmental Certification at Education Entities (SNCAE) and the Municipal Environmental Certification System (SCAM) should be highlighted, being their purpose to promote municipalities as models of integral environmental management, with the participation of officers and neighbors. A material aspect of SCAM is that it incorporates the environmental dimension to municipal standards, and it develops concrete actions to protect the environment and GHG reduction. In 2016 the system operated in all the country's regions with certified municipalities at its three levels (SCAM, 2016).

5.4.2. General Education Law

In a joint effort, the Ministry of Education and the MMA were able to include in the General Education Law of 2009 issues related to climate change in the national program, as well as in the study programs from first to sixth elementary, and from seventh to the second compulsory year. Also, they have prepared some learning resources and dissemination material, among them "Education for sustainable development: climate change" and "How do we do to become a sustainable educative community".

Graduate and postgraduate programs are given in Chile for professionals education on climate change issues (Table 7).

Table 7. Postgraduate and additional education programs

Studies Program	University
Master on Climate Change	University of Concepción
Master on Natural Resources with minor on Climate Change	Pontifical Catholic University of Chile
Master on Clean Development Mechanism and Energy Efficiency	Pontifical Catholic University of Valparaiso
Certificate on Projects Environmental Planning	Pontifical Catholic University of Chile
Certificate on Technologies to Face Abrupt Climate Change	University of Santiago, Chile
Summer International Certificate on Communication for Sustainability and Climate Culture	Christian Humanism Academy University

5.4.3. Citizen's

Between 2012 and 2016 the Ministry of the Environment has carried out seven public consultation processes on strategic instruments of subjects related to climate change.

Table 8. Participation processes associated to climate change by the Ministry of the Environment

Instrument	Inicio	Cierre	Nº Observaciones recibidas
Adaptation Plan to Climate Change Forestry Farming Sector	11/06/2012	30/09/2012	566
Adaptation Plan to Climate Change Biodiversity Sector	01/07/2012	30/08/2013	159
National Adaptation Plan to Climate Change	11/11/2013	23/12/2013	322
Intended National Contribution	17/12/2014	15/04/2015	> 250
Adaptation Plan to Climate Change Fishing and Aquaculture	20/04/2015	30/206/2015	100
Adaptation Plan to Climate Change Health	05/10/2015	14/12/2015	s/i
Preliminary project to the National Action Plan on Climate Change 2017-2022 (PANCC-II)	18-04-2016	04-08-2016	s/i

5.4.4. Dissemination and public sensitization campaigns

The Environmental Education Magazine of the Ministry of the Environment prints 2000 issues twice a year, which are distributed at the SNCAE education entities. The Boletín Hora Sustentable is delivered to over two thousand persons, mostly academicians; both issues contain periodical information on climate change.

The MMA has also prepared several material and supporting resources. One of them is a climate change and carbon footprint video, which synthetizes climate change contents and how children may fight climate change through the carbon footprint. The MMA also created the animated series La plaza imaginaria, focused on climate change and environmental care, and the citizen's carbon footprint calculator which allows quantifying in a few minutes somebody's carbon footprint on the basis of the impact of his/her activities, consumption and habits, and later he/she receives advice on how to reduce his/her personal carbon footprint. Finally, during 2014 and 2015 the motto "If I don't change the climate will" was used to make interventions at the MMA social networks.

5.4.5. Perception of climate change

The Second National Survey on Environment was carried out at the end of 2015. Results indicate that the main environmental problem of the country, according to people's perception, is air pollution (33% of participants), followed by garbage in the streets (19%) and pollution in general (8%). On the other hand, 72% of the participants believe that taking care of the environment stimulates the economic growth of the country. Regarding climate change, 86% agrees that it shall have concrete consequences on daily life and 82% believes this is the main environmental challenge for this generation (MMA, 2015c).

5.5. Development of national and local capacities on climate change

5.5.1. National priorities for capacities building and encouragement

Capacity building on climate change building was one of the three priority axes, together with mitigation and adaptation, of the National Strategy on Climate Change of 2006.

The PANCC 2017-2022 eliminates this axis and it incorporates two: i) implementation means and ii) management of climate change at regional and district level. Three purposes are apparent in the new axes directly focusing on capacities encouragement: to support technology transfer for the implementation of climate change mitigation and adaptation measures; to build the national capacities for the management of climate change and to deliver technical assistance and developing capacities at regional and municipal governments (MMA, 2016).

Capacities may be understood within the framework of the needs, options and priorities that have promoted their creation and strengthening. In general, they have focused on improving dissemination, education and research on climate change; in improving the quality of the information available and of climate observation capacities, together with the development of institutional capacities to face mitigation and adaptation challenges; to develop and transfer technologies, reinforcing international cooperation and establishing synergies between climate change and other global environmental issues.

5.5.2. Capacities building in the private sector

The project “Strengthening global change capacities to face the challenges of climate change in Chile” is one of the initiatives in which the private sector has prevailed given its alliances with the academic community and the public sector for the study and analysis of climate change implications in the country, which in an innovative manner includes entities of the public sector (Innova-Corfo and the MMA) and of the private sector (the energy company Colbún) among its financing partners. It was implemented between 2009 and 2013, and the performing entity was CCG-UC, with the support of the Stockholm Environment Institute. Also, as a result of the joint management by Universidad de Chile School of Economics and Business, the Chilean-British Chamber of Commerce and the British Embassy, in 2009 the Center for Entrepreneurial Leaders on Climate Change (CLG-Chile) was created. The Latin American Climate Platform was also created, with the participation of 17 entities of the civil society and the entrepreneurial sector of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Paraguay, Peru and Uruguay.

5.5.3. Capacities building in non-governmental entities

In 2016, a significant number of NGOs participated in Chile’s national discussion on climate change in some cases supporting building and encouragement of national capacities. The most significant within this context are the Sustainable Chile Program; Fundación Terram ONG; Chile Foundation; Fundación Casa de la Paz; Adapt-Chile and Action for the Earth ONG.

5.6 Inclusion of climate change in other management instruments

Climate change has been slowly incorporating into other public policies and/or management instruments aimed to the development and planning of the country, such as: System of projects environmental assessment; Social Responsibility Policy by the companies of the Ministry of Economy; National Policy of Rural Development; Biodiversity National Strategy; Territorial Ordering Policy; Disasters Hazards Policy and Management by ONEMI.

6 Needs and support received regarding climate change

Chapter 6 of the 3CN delivers significant information regarding specific needs on climate change in Chile, including detected barriers and gaps, and the international support received either through financial resources, capacity building and technical assistance, or technology transfer.

6.1. Financing needs, gaps and barriers, capacity building and technical assistance

Chilean needs on financing, capacity and technology shown by the different areas of climate change (mitigation, adaptation, reports, inventory, international negotiation) increase the country's vulnerability, since obstacles and gaps must be constantly overcome in the preparation and implementation of climate change policies which in a developing country like Chile, compete with other national priorities such as health, education and labor.



Quintay, Archivo MMA.

The main gaps faced by the country are the lack of adequate institutions and a financing strategy. Currently, both issues are approached by virtue of the sectors intentions. The need to have a permanent legal framework that establishes responsibilities and competences by the players involved has been detected for the optimal development of the country on climate change issues, allowing to comply with the commitments undertaken in its INDC.

The following are the main needs, gaps and barriers as regards financial resources, capacity and technical assistance for the two main issues of Chile's INDC: adaptation and mitigation of climate change.

6.1.1. Mitigation

Identifying the needs in the mitigation area and defining the gaps and barriers that hamper the start-up of mitigation actions is particularly significant at this time, since Chile wishes to comply with its voluntary commitment to reduce GHG emissions by 2020 and to establish solid grounds for the implementation of its INDC and future updates.

Five NAMA have been recorded with the NAMA Registry which implementation seeks for support. Trainings have been performed focused on NAMA and MRV within the framework of international projects and the RETC Platform of the MMA and the HuellaChile Program are available. Nevertheless, greater financial and capacity efforts are

required to strengthen the development of sectorial mitigation actions and the measurement, reporting and verification (MRV) systems. It is a priority that all institutions developing actions with a potential to reduce GHG emission collect the adequate information in order to allow a correct follow-up. On the other hand, it is necessary to build local capacities on mitigation issues, to strengthen management by the local governments and municipalities, and to increase their capacity to implement NAMA and other mitigation measures.

6.1.2. Adaptation

Thanks to the permanent line of work at the MMA on adaptation issues, it was possible to prepare and approve the National Adaptation Plan in 2014, and the sectorial specific plans on Forestry and Farming (2013), Biodiversity (2014) and Fishing and Aquaculture (2015). Other six sectorial adaptation plans are in different development stages and they will be focused on the Health (2016), Infrastructure (2017), Cities (2017), Hydric Resources (2018), Energy (2018) and Tourism (2018) sectors. The preparation of these policies has been possible thanks to the active participation by the sectorial ministries which have led their adaptation processes and the joint effort to identify vulnerabilities and the development of lines of action to face the impacts of climate change, everything coordinated by the MMA.



Rapel, Jorge Herrerios.

Financing has been sought for pilot projects based on the approved sectorial plans. The project “Enhancing resilience to climate change of the small agriculture in the O’Higgins Chilean Region” is under development, approved by the Adaptation Fund which will allow for implementation of a series of measures from the Forestry and Farming Plan at the dry land areas at the center of the country. Other two projects, financed with international contributions will allow implementing actions in the Biodiversity, and Fishing and Aquaculture sectors, the “Biodiversity National Monitoring Network” (CTCN) and “Strengthening the adaptive capacity to climate change in the fisheries and aquaculture sector of Chile (GEF)”, respectively. It is necessary to ensure financing for adaptation actions of the approved and of future plans, and to increase capacities, particularly at regional governments and municipalities for the implementation of adaptation actions in the territory. Also, it is necessary to improve institutions coordination at a national, regional and local level.

6.2. International support to climate action

This section summarizes the climate change initiatives for which Chile, as a developing country, has received international support. The information is classified according to the type of support received as financial resources, capacity building and technical assistance, and technology transfer.

Most of financial resources received during the term 2011-2016 correspond to resources classified as Development Assistance (ODA). This source of international cooperation has played a material role in the climate agenda in Chile. Nevertheless, given the current level of Gross Domestic Product per capita of the country, it is expected that Chile stops being beneficiary of ODA resources as from 2017.

6.2.1. Financial Resources

Financial Resources managed through the public sector

During the reporting term (January 1, 2011 to July 30, 2016), the donor countries and institutions have approved US\$ 29,731,460 to carry out activities of Chile's climate agenda (Table 9).

Table 9. Financial Resources managed through the public sector

Type of supporter	Financial Resources (US\$)	Area					Sectors
		R	M	I	A	N	
Bilateral/countries	4,811,582						
United Kingdom	2,317,802						Cross Energy Transportation
Swiss Confederation	1,800,000						Forestry
Australia Commonwealth	166,000						Energy
Canada	323,000						Cross
Mexico	204,780						Biodiversity Hydric Resources
Funds and Multilateral Entities	17,421,772						
Global Environmental Facility (GEF)	7,261,772						Cross Energy Forestry Fishing and aquaculture
CMNUCC	250,000						Biodiversity
Adaptation Fund	1,900,000						Forestry and farming
UN REDD	560,000						Forestry
World Bank	7,450,000						Energy financial securities
International Financial Entities	2,750,663						
Inter-American Development Bank	2,179,663						Transportation Forestry
KFW	571,000						Energy
Other multilateral contributions	4,747,443						
NAMA Facility	19,800						Energy
Federal Republic of Germany Australia Commonwealth European Commission	1,584,000						Cross
The Children's Invest Fund Foundation Climate and Development Alliance Swiss Confederation Kingdom of Denmark	1,853,265						Cross
Swiss Confederation The Children's Invest Fund Foundation	1,290,378						Cross
Total	\$ 29,731,460						

R: Report; M: Mitigation; I: INGEI; A: Adaptation; N: International negotiation

Source: Climate Change Department of the MMA

The following are among the projects carried out with financial international support for the strengthening of climate action and policy: Mitigation Options to Face Climate Change (MAPS Chile) 2011-2015; Low Emission Capacity Building-Chile (LECB-Chile) 2012-2016 and Partnership for Market Readiness (PMR) 2011-2017.

Financial Resources channelled to projects of the private sector

This category considers financial support from entities of development banks and institutions and funds focused on financing actions for climate change mitigation and the transition to a low carbon emission economy. The projects included in this section are not necessarily sponsored by the Chilean Government, since this is a requirement depending on the standards of each financing source.

Table 10 shows a summary of the financial flows for the projects considered, which amount to a total value of US\$ 832,201,250.

TABLE 10. Financial Resources –channeled to the private sector – including concessional/ non concessional

Type of donor / offerer	Financial Resources (US\$)	Area					Sectors
		R	M	I	A	N	
Funds and multilateral entities							
Green Climate Fund	49,000,000						Energy
Clean Technology Fund	117,000,000						Energy
International Financial Entities							
Inter-American Development Bank (IDB)	324,400,000						Energy
International Finance Corporation (World Bank)	341,801,250						Energy
Total	\$ 832,201,250						

R: Report; M: Mitigation; I: INGEI; A: Adaptation; N: International Negotiation

Source: Climate Change Department of the MMA.

6.2.2. Capacities and technical assistance building

The main international initiatives focused on capacities building with a permanent participation in Chile between 2011 and 2016 are Information Matters; Euroclima; the Regional Platform for Latin America and the Caribbean (LEDS LAC); the Latin American Office for Climate Change (LARIOCC); Global Research Alliance (GRA); International Partnership on Mitigation and MRV; Mitigation Action Implementation Network (MAIN); The Mitigation Momentum Project and Cartagena Dialogue for Progressive Action.

6.2.3. Technology transfer

The main activities carried out thanks to the support received by the country in the technology transfer are between 2011-2016 are the Go-generation Encouragement Program, the use of solar energy for electricity and heat generation, the promotion of solar energy (focus on CSP), acquisition of equipment to measure GHG, high precision phenotype characterization of wheat (genetic improvement to achieve drought-tolerant grown species) and the challenge of achieving potato and wheat varieties tolerant to climate change.

63. National support for climate action

It is worth highlighting that although the country has received significant financial contributions, as well as different types of support, during the last year its own funds have been devoted to financing actions to locally face climate change, and in compliance with Chile's INDC commitment, the Chilean Government is making efforts to develop a climate financing strategy.

During the term 2015-2016, the MMA, together with the Ministry of Finance and with the support of the LECB-Chile Project has implemented the "Climate Expenditure" project. A pilot is being applied with a methodology called Climate Public Expenditure and Institutional Review (CPEIR) for its assessment. The 2015 pilot performance has allowed the identification of current conditions of access, availability and consistence of the information required, apart from the strengths and shortcomings of CPEIR methodology to obtain a robust figure on climate change expenditure.

The objective information currently available corresponds to the resources aimed to climate initiative projects developed in Chile through the Chilean International Cooperation Agency (AGCI). The total amount for the term 2011-2016 is US\$ 20,370,000.

Bibliography

- AGRIMED, 2008. Análisis de la vulnerabilidad del sector agropecuario, recursos hídricos y edáficos de Chile, frente a escenarios de cambio climático. Universidad de Chile, CONAMA, Santiago. 126 pp.
- AGRIMED, 2014: Atlas del Cambio Climático en las Zonas de Régimen Árido y Semiárido.
- Albrecht, F., & Shaffer, G. (2016). Regional Sea-Level Change along the Chilean Coast in the 21st Century. *Journal of Coastal Research*. Agroclimático (2013). "Inauguración de la Red Agroclimática Nacional RAN". Recuperado de <http://agroclimatico.minagri.gob.cl/2013/08/27/puesta-en-marcha-de-la-red-agroclimatica-nacional>.
- Albrecht, F., y Shaffer, G. (2016). "Regional Sea-Level Change along the Chilean Coast in the 21st Century". *Journal of Coastal Research*. Doi: <http://dx.doi.org/10.2112/JCOASTRES-D-15-00192.1>.
- Aldunce, P., Bello, F., Bórquez, R., Farah, M. L., Echeverría, I., Indvik, K., y otros (2015). "Evaluación de término del Plan de Acción Nacional de Cambio Climático, PANCC 2008-2016". Ministerio del Medio Ambiente, Licitación N° 608897-101-LE14.
- Bakun, Andrew, and Kenneth Broad. "Environmental 'loopholes' and fish population dynamics: comparative pattern recognition with focus on El Niño effects in the Pacific." *Fisheries Oceanography* 12.4-5 (2003): 458-473.
- Bambach, N., Meza, F. J., Gilabert, H., y Miranda, M. (2013). "Impacts of climate change on the distribution of species and communities in the Chilean Mediterranean ecosystem". *Regional Environmental Change*, 13(6), pp. 1245-1257.
- Boisier, J. P., Rondanelli, R., Garreaud, R. D., y Muñoz, F. (2016). "Anthropogenic and natural contributions to the Southeast Pacific precipitation decline and recent megadrought in central Chile". *Geophysical Research Letters*, 43(1), pp. 413-421. Doi: [10.1002/2015GL067265](https://doi.org/10.1002/2015GL067265).
- Bown, F., Rivera, A., y Acuña, C. (2008). "Recent glacier variations at the Aconcagua basin, central Chilean Andes". *Annals of Glaciology*, 48(1), pp. 43-48. Doi: [10.3189/172756408784700572](https://doi.org/10.3189/172756408784700572).
- Casassa, G., Espizua, L. E., Francou, B., Ribstein, P., Ames, A., y Alean, J. (1998). "Glaciers in South America". En W. Haerberli, M. Hoelzle y S. Suter (eds.). *Into the second century of worldwide glacier monitoring: PROSPECTS and strategies*. París: United Nations Publications, pp. 125-146.
- Caviedes, C., y Waylen, P. R. (1998). "Respuestas del clima de América del Sur a las fases de ENSO". *Bulletin de l'Institut français d'études andines*, 27(3).
- Centro de Agricultura y Medio Ambiente (Agrimed) (2014). Atlas del cambio climático en las zonas de régimen árido y semiárido. --- (2008). "Análisis de la vulnerabilidad del sector agropecuario, recursos hídricos y edáficos de Chile, frente a escenarios de cambio climático". Santiago: Facultad de Ciencias Agronómicas de la Universidad de Chile, Conama. Recuperado de www.sinia.cl/1292/articles-46115_capituloV_informefinal.pdf.
- Centro de Cambio Global UC (CCG-UC) (2012). "Enfoque metodológico para evaluar la adaptación al cambio climático en la infraestructura pública del MOP". Informe final para el Ministerio de Obras Públicas de Chile. Recuperado de http://cambioglobal.uc.cl/en/component/docman/cat_view/6-proyectos.html.
- Centro de Energía . (2016). Consultoría para diseño de una estructura de contabilidad nacional de reducciones/absorciones de gases de efecto invernadero e integración con sistemas de medición, reporte y verificación de acciones de mitigación existentes. Santiago: FCFM, Universidad de Chile .
- Comisión Económica para América Latina y el Caribe (Cepal) e Instituto de Hidráulica Ambiental de la Universidad de Cantabria (2011). Efectos del cambio climático en la costa de América Latina y el Caribe: dinámicas, tendencias y variabilidad climática. Cepal.
- (2009). Cambio climático y desarrollo en América Latina y el Caribe. Reseña 2009. Recuperado de <http://repositorio.cepal.org/bitstream/handle/11362/2975/lcl3140.pdf?sequence=1>.
- CNIC, Agenda de innovación y competitividad 2010-2020. Disponible en línea: <http://www.cnid.cl/wp-content/uploads/2015/04/Agenda-Innovaci%C3%B3n-2010-2020.pdf>, consultado 30 de Septiembre del 2016
- Contreras-López, M., Winckler, P., y Molina, M. (2012). "Implicancias de la variación del nivel medio del mar por cambio climático en obras de ingeniería costera de Chile". *Anales del Instituto de Ingenieros de Chile*, 124(2), pp. 53-66.
- Cortés, G., Vargas, X., y McPhee, J. (2011). "Climatic sensitivity of streamflow timing in the extratropical western Andes Cordillera". *Journal of Hydrology*, 405(1-2), pp. 93-109. Doi: [10.1016/j.jhydrol.2011.05.013](https://doi.org/10.1016/j.jhydrol.2011.05.013).
- Danerí, G., Dellarossa, V., Quiñones, R., Jacob, B., Montero, P., y Ulloa, O. (2000). "Primary production and community respiration in the Humboldt Current System of Chile and associated oceanic areas". *Marine Ecology Progress Series*, 197, pp. 41-49.
- Dirección General de Relaciones Económicas Internacionales (Direcon) (2015). "Informe anual. Comercio Exterior de Chile 2014/15". Recuperado de [/www.direcon.gob.cl/wp-content/uploads/2015/07/Informe-anual-de-Comercio-Exterior-de-Chile-2014-2015.pdf](http://www.direcon.gob.cl/wp-content/uploads/2015/07/Informe-anual-de-Comercio-Exterior-de-Chile-2014-2015.pdf).
- Fossing, H., Gallardo, V.A., Jørgensen, B.B., Huettel, M., Nielsen, L. P., Schultz, H., y otros (1995). "Concentration and transport of nitrate by the mat-forming sulphur bacterium *Thioploca*". *Nature* 374, pp. 713-715.
- Garreaud, R., Aldunce, P., Araya, G., Blanco, G., Boisier, J. P., Bozkurt, D. y otros (2015). "La megasequia 2010-2015: Una lección para el futuro". Informe técnico del Centro del Clima y la Resiliencia (CR2). Recuperado de www.cr2.cl/megasequia.
- Guisan, A., y Zimmermann, N. E. (2000). "Predictive habitat distribution models in ecology". *Ecological Modeling*, 135, pp. 147-186.
- GreenLab UC (2012). "Identificación de impactos, evaluación de vulnerabilidad del sector Salud frente al cambio climático y propuestas para la adaptación". Estudio solicitado por la Subsecretaría de Medio Ambiente. Recuperado de www.greenlabuc.cl/wp-content/uploads/2013/11/2012-ILSC-InformeFinal.pdf.
- Grupo Intergubernamental de Expertos sobre el Cambio Climático (IPCC) (2014). "Climate Change 2014: Impacts, Adaptation, and Vulnerability". Recuperado de www.ipcc.ch/report/ars/wg2.
- (2013). "Climate Change 2013: The Physical Science Basis". Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Recuperado de www.ipcc.ch/report/ars/wg1.
- International Partnership on Mitigation and MRV. (julio de 2014). International Partnership on Mitigation and MRV. Obtenido de <http://mitigationpartnership.net/>
- Larkin, N. K., y Harrison, D. E. (2002). "ENSO warm (El Niño) and cold (La Niña) event life cycles: Ocean surface anomaly patterns, their

- symmetries, asymmetries, and implications". *Journal of Climate*, 15(10), pp. 1118-1140.
- Luebert, F., y Pliscoff, P. (2006). Sinopsis bioclimática y vegetacional de Chile. Santiago: Universitaria.
- Magrin, G. O., Marengo, J. A., Boulanger, J. P., Buckeridge, M. S., Castellanos, E. G. Poveda y otros (2014). "Central and South America". *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC*. Cambridge University Press, pp. 1499-1566.
- Marquet, P., Abades, S., Armesto, J., Arroyo, M. T. K., Barría, I., Cavie- res, L., y otros (2010). "Estudio de vulnerabilidad de la biodiversidad terrestre en la eco-región mediterránea, a nivel de ecosistemas y especies, y medidas de adaptación frente a escenarios de cambio climático". Santiago: Ministerio de Medio Ambiente.
- Masiokas, M. H., Christie, D. A., Le Quesne, C., Pitte, P., Ruiz, L., Villalba, R., y otros (2016). "Reconstructing the annual mass balance of the Echaurren Norte glacier (Central Andes, 33.5° S) using local and regional hydroclimatic data". *The Cryosphere*, 10(2), pp. 927-940.
- Masiokas, M. H., Rivera, A., Espizua, L. E., Villalba, R., Delgado, S., y Aravena, J. C. (2009). "Glacier fluctuations in extratropical South America during the past 1000 years". *Palaeogeography, Palaeoclimatology, Palaeoecology*, 281(3), pp. 242-268.
- Masiokas, M. H., Villalba, R., Luckman, B. H., Lascano, M. E., Delgado, S., y Stepanek, P. (2008). "20th-century glacier recession and regional hydroclimatic changes in northwestern Patagonia". *Global and Planetary Change*, 60(1), pp. 85-100.
- McPhee, J., Cortés, G., Rojas, M., García, L., Descalzi, A., y Vargas, L. (2014). "Downscaling Climate Changes for Santiago: What Effects can be Expected?". En K. Krellenberg y B. Hansjürgens (eds.). *Climate Adaptation Santiago*. Berlín y Heidelberg: Springer, pp. 19-41.
- Mernild, S. H., Beckerman, A. P., Yde, J. C., Hanna, E., Malmros, J. K., Wilson, R., y Zemp, M. (2015). "Mass loss and imbalance of glaciers along the Andes Cordillera to the sub-Antarctic islands". *Global and Planetary Change*, 133, pp. 109-119.
- Ministerio de Vivienda y Urbanismo (Minvu) (2016). N. Romero: Identificación preliminar de eventos climáticos relevantes para el sector ciudades Proyecto (en el marco del Proyecto PNUD, N° 90.298 "Implementación de la Política Nacional de Desarrollo Urbano").
- Ministerio del Medio Ambiente (MMA) (2016a). "Anteproyecto del Plan de Acción Nacional de Cambio Climático (2017-2022)". Recuperado de <http://portal.mma.gob.cl/plan-de-accion-nacional-de-cambio-climatico-2017-2022-pancc-ii>.
- (2016b). "Elaboración de una base digital del clima comunal de Chile: línea base (años 1980-2010) y proyección al año 2050". Recuperado de www.cl.undp.org/content/chile/es/home/library/environment_energy/elaboracion-de-una-base-digital-del-clima-comunal-de-chile--line.html.
- (2016c). "Reporte: Plan Nacional de Adaptación al Cambio Climático". Equipo Técnico Interministerial de Cambio Climático (ETICC).
- (2015). "Directrices para un marco genérico de MVR de NAMAS en Chile". Recuperado de <http://portal.mma.gob.cl/wp-content/uploads/2016/05/Directrices-MRV-Namas.pdf>.
- (2015a). "Plan de adaptación al cambio climático en pesca y acuicultura". Recuperado de <http://portal.mma.gob.cl/plan-de-adaptacion-al-cambio-climatico-en-pesca-y-acuicultura>.
- (2015b). "Ministro Pablo Badénier lanza Academia de Formación Ambiental 'Adriana Hoffmann'". Recuperado de <http://portal.mma.gob.cl/ministro-pablo-badenier-lanza-academia-de-formacion-ambiental-adriana-hoffmann>.
- (2015c). Segunda Encuesta Nacional de Medio Ambiente. Recuperado de <http://portal.mma.gob.cl/segunda-encuesta-nacional-de-medio-ambiente>.
- (2014). "Adaptación urbana al cambio climático. Propuesta para la adaptación urbana al cambio climático en capitales regionales de Chile". Adapt-Chile, Centro de Desarrollo Urbano Sustentable (CEDEUS) y Centro de Cambio Global UC (CCG-UC).
- (2014a). "Plan de adaptación al cambio climático en biodiversidad". Recuperado de www.mma.gob.cl/1304/articles-55879_Plan_Adaptacion_CC_Biodiversidad_Final.pdf.
- (2014b). "Plan nacional de adaptación al cambio climático". Recuperado de <http://portal.mma.gob.cl/wp-content/uploads/2016/02/Plan-Nacional-Adaptacion-Cambio-Climatico-version-final.pdf>.
- (2013). "Plan de adaptación al cambio climático para el sector silvoagropecuario". Recuperado de www.mma.gob.cl/1304/articles-55879_InstrumentoFinalCC_Silvoagropecuario.pdf.
- Ministerio de Salud (Minsal). (2015). Plan Nacional de Adaptación al Cambio Climático para Salud. Borrador para consulta pública. Recuperado de <http://portal.mma.gob.cl/plan-nacional-de-adaptacion-al-cambio-climatico-para-salud>. Gobierno de Chile.
- OCDE y Cepal (2016). "Evaluaciones del desempeño ambiental: Chile 2016". Recuperado de http://repositorio.cepal.org/bitstream/handle/11362/40308/S1600413_es.pdf.
- Pellicciotti, F., Ragetti, S., Careno, M., y McPhee, J. (2014). "Changes of glaciers in the Andes of Chile and priorities for future work". *Science of The Total Environment*, 493, pp. 1197-1210. Doi: 10.1016/j.scitotenv.2013.10.055.
- Rivera, A., Bown, F., Casassa, G., Acuña, C., y Clavero, J. (2006). "Glacier shrinkage and negative mass balance in the Chilean Lake District (40° S)". Recuperado de http://repositorio.uchile.cl/bitstream/handle/2250/117757/Rivera_A.pdf?sequence=1.
- Rivera, A., Acuña, C., Casassa, G., y Bown, F. (2002). "Use of remotely sensed and field data to estimate the contribution of Chilean glaciers to eustatic sea-level rise". *Annals of Glaciology*, 34, pp. 367-372.
- Rojas, M. (2012). "Estado del arte de modelos para la investigación del calentamiento global. Informe para Opciones de Mitigación para enfrentar el Cambio Climático, MAPS Chile".
- Rubio-Álvarez, E., y McPhee, J. (2010). "Patterns of spatial and temporal variability in streamflow records in south central Chile in the period 1952-2003". *Water Resources Research*, 46(5), W05514. Doi: 10.1029/2009WR007982.
- Santibáñez, F., Santibáñez, P., Caroca, C., González, P., Gajardo, N., Perry, P., y Pliscoff, P. (2013). "Plan de acción para la protección de la conservación de la biodiversidad, en un contexto de adaptación al cambio climático". Agrimed, Universidad de Chile.
- Servicio Nacional de Turismo (Sernatur) (2014). Estrategia Nacional de Turismo 2012-2020. Recuperado de http://portal.mma.gob.cl/wp-content/uploads/2014/10/1_Estrategia-Nacional-de-Turismo-2012-2020.pdf.
- Sistema de Certificación Ambiental Municipal (SCAM) (2016). "¿Qué es SCAM?". Recuperado de <http://educacion.mma.gob.cl/sistema-de-certificacion-ambiental-municipal>.
- TECO Group y CCG-UC (2015). Tercer informe del estudio "Base para la planificación territorial en el desarrollo hidroeléctrico futuro. Ministerio de Energía". Licitación N° 584105-11-LP14. Recuperado de http://dataset.cne.cl/Energia_Abierta/Estudios/Minerg/informe_final_primeira_etapa_estudio_cuenca.pdf.
- Vuille, M., Franquist, E., Garreaud, R., Lavado Casimiro, W. S., y Cáceres, B. (2015). "Impact of the global warming hiatus on Andean temperature". *Journal of Geophysical Research Atmospheres*, 120 (9), pp. 3745-3757. Doi: 10.1002/2015JD023126.
- Yáñez, E., Barbieri, M. A., Plaza, F., y Silva, C. (2014). "Climate change and fisheries in Chile". *Vulnerability of Agriculture, Water and Fisheries to Climate Change*. Dordrecht: Springer, pp. 259-270.





Ministerio del
Medio
Ambiente

Gobierno de Chile

Executive Summary 2016



Chile's Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change



Tercera
Comunicación
Nacional
sobre
Cambio
Climático



www.theGEF.org

