CLIMATE RISK COUNTRY PROFILE

CHILE

WORLD BANK GROUP

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This profile is part of a series of Climate Risk Country Profiles developed by the World Bank Group (WBG). The country profile synthesizes most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The country profile series are designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is managed and led by Veronique Morin (Senior Climate Change Specialist, WBG) and Ana E. Bucher (Senior Climate Change Specialist, WBG).

The Chile profile was written by Andrea Cristina Ruiz (Climate Change Consultant, WBG) and MacKenzie Dove (Senior Climate Change Consultant, WBG). Additional support was provided by provided by Jason Johnston (Operations Analyst, WBG) and Yunziyi Lang (Climate Change Analyst, WBG).

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FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group is committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

The World Bank Group is investing in incorporating and systematically managing climate risks in development operations through its individual corporate commitments.

A key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all IDA and IBRD operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one-stop shop' for global, regional, and country data related to climate change and development.

Recognizing the value of consistent, easy-to-use technical resources for client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group has developed this content. Standardizing and pooling expertise facilitates the World Bank Group in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For developing countries, the climate risk profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

It is my hope that these efforts will spur deepening of long-term risk management in developing countries and our engagement in supporting climate change adaptation planning at operational levels.

Bernice Van Bronkhorst
Global Director
Climate Change Group (CCG)
The World Bank Group (WBG)

COUNTRY OVERVIEW

Chile is located in western South America, with a total land area of 2,006,096 square kilometers (km^2) and is neighbored by Peru to the north, Bolivia to the northeast, Argentina to the east and south, and the Pacific Ocean, with coasts that extend over 8,000 km. Chile experiences a wide-ranging topography (**Figure 1**) and its area extends across the western and southern part of South America, spreads in to the oceanic region via Easter Island, and extends south towards Antarctica. Chile's has four macro-bioclimates: tropical, Mediterranean, temperate, and antiborealis, which are produced primarily due to the country's latitude and altitude. Within these climates are a diverse 127 terrestrial ecosystems, with 96 marine ecosystems along the country's coast.[1] Chile experiences mostly dry southern hemisphere summers (November and January) and wet winters (May and August). 29.21% of the land area does not have vegetation, 38.74% of the land is grassland and scrub, 25.55% is forest, 4.57% is agricultural land; only 0.75% of the Chile's area is urban or industrial.[2]

FIGURE 1. Elevation of Chile[3]

Chile is a high-income country and has been one of Latin America's fastest growing economies over recent decades.[4] Chile has a population of 19.1 million people (2020) that has been growing at a rate of 0.9%. 89.7% of the population lives in urban areas concentrated in the center of the country near the capital city of Santiago, which is home to 40.1% of urban population. It is one of three Latin American countries that are members of the Organization for Economic Cooperation and Development (OECD),[5] with a Gross Domestic Product (GDP) of $252.94 billion and growth rate of 1.1% in 2019. In 2020, GDP contracted 6.0% and more than one million jobs were lost, affecting mostly women and workers in commerce, agriculture, and hospitality, further undermining the country's fragile middle class. In conjunction with the economic contraction, the fiscal deficit increased to 7.5% of

1 Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf
2 Ministerio de Agricultura (2020). Anuario Forestal. Chilean Statistical Yearbook of Forestry 2020. URL: https://wef.infor.cl/publicaciones/anuario/2020/Anuario2020.pdf
3 World Bank (2021). Climate Migration Profile – Chile.
4 World Bank (2021). Overview – Chile. URL: https://www.worldbank.org/en/country/chile/overview
5 Merco Press (2020). Costa Rica becomes 38th Member of OECD. [May 19, 2020]. URL: https://en.mercopress.com/2020/05/19/costa-rica-becomes-38th-member-of-oecd

GDP in 2020, the largest in over three decades. Although the authorities tapped into fiscal buffers, public debt rose from 28% in 2019 to 33% in 2020. Poverty is expected to have increased from 8.1% to 12%, with approximately an additional 780,000 people expected to have fallen into poverty during this time.[6]

Chile is primarily a service economy, as of 2020, services producing 56.5% of value added as a percentage of GDP and 68.8% of employment.[7] Industry, mainly represented by mining, provides 31.4% value added as a percentage of GDP and 22.8% of employment. Agriculture contributes 3.9% of value added as a percentage of GDP and 9.6% of employment. Growth in recent years has been driven by commodity markets, primarily mining activity.[8] In 2019, total natural resource rents represented 2.3% of GDP, of which mineral rents was the largest natural resource, comprising 9.82% of GDP (**Table 1**). Despite economic growth and the country's strong poverty reduction efforts, more than 30% of the population is recognized as economically vulnerable and the country's inequality remains high.[9]

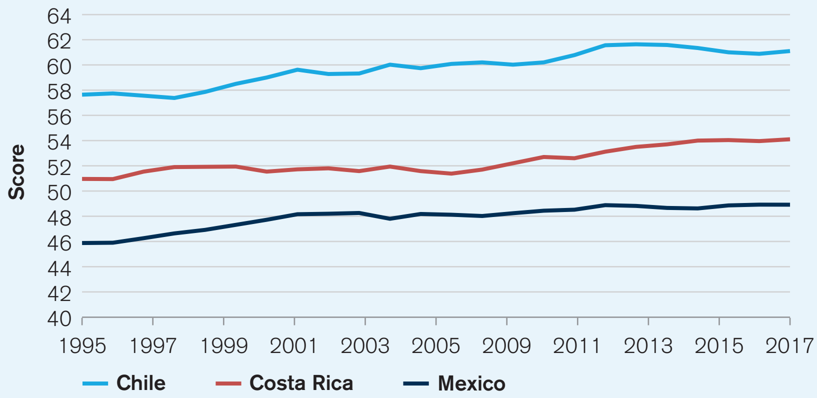
TABLE 1. Data Snapshot: Key Development Indicators[10]

Indicator	
Life Expectancy at Birth, Total (Years) (2019)	80.2
Population Density (People per sq. km Land Area) (2018)	25.2
% of Population with Access to Electricity (2019)	100%
GDP per Capita (Current US$) (2020)	$13,231.70

The ND-GAIN Index[11] ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. This Index aims to help businesses and the public sector better identify vulnerability and readiness in order to better prioritize investment for more efficient responses to global challenges. Due to a combination of political, geographic, and social factors, Chile is recognized as vulnerable to climate change impacts, and overall, is ranked 29th out of 181 countries in the 2020 ND-GAIN Index. Within the Index, Chile is also ranked 22nd in terms of vulnerability and 36th in terms of readiness. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st. **Figure 2** is a time-series plot of the ND-GAIN Index showing Chile's progress in relation to the two other Latin American countries that are also OECD members, Costa Rica and Mexico.

6 World Bank (2021). Overview – Chile. URL: https://www.worldbank.org/en/country/chile/overview
7 World Bank (2021). World Development Indicators. DataBank. URL: https://databank.worldbank.org/source/world-development-indicators
8 World Bank Open Data (2021). Data Bank: Population Estimates and Projections, Chile. URL: https://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics:-population-estimates-and-projections
9 World Bank (2021). Overview – Chile. URL: https://www.worldbank.org/en/country/chile/overview
10 World Bank (2021). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators
11 University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

FIGURE 2. ND-GAIN Index for Chile



Chile is highly vulnerable to the impacts of climate change, with key sectors such as fisheries and aquaculture, forestry, agriculture and livestock, and the country's water resources identified as vulnerable sectors.[12] Chile's Third National Communication on Climate Change (NC3) (2016) also includes energy, infrastructure, cities, and tourism as additional important sections.[13] Chile submitted its Initial Nationally Determined Contribution in 2015 and its Updated Nationally Determined Contribution (NDC) in 2020. Through these documents, Chile has confirmed its commitment to climate actions and support to international climate agreements and identified key mitigation and adaptation efforts. Chile is also working to increase the country's resilience by improving water management and sanitation, and its disaster risk management, identified through its National Climate Change Adaptation Plan (2014). Chile's Updated NDC highlights sectoral plans for key sectors, identifying financing sources to implement sectoral plans, build synergies between adaptation and mitigation, strengthen institutional capacity on adaptation, and prepare metrics to evaluate sectoral planning.[14]

Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

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[12] Chile (2020). Nationally-Determined Contribution – Updated 2020. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Chile%20First/Chile%27s_NDC_2020_english.pdf

[13] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

[14] Chile (2020). Nationally-Determined Contribution – Updated 2020. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Chile%20First/Chile%27s_NDC_2020_english.pdf

Climate Baseline

Overview

Chile's unique geography and topographical features result in a wide range of climates and environments. Chile has the Atacama Desert in the north, one of the most arid deserts in the world, the ice-capped Andes mountains in the east, the Pacific Ocean on the west, and Antarctic region in the south. Thus, Chile's unique climate zones range from tropical in the north, Mediterranean in the center, and Antarctic (antiboreal oceanic) in the South, with unique regional climates such as the arid Atacama Desert or the high peaks of the Andean mountains.

On average, Chile experiences mild southern hemispheric summers between November and January, with mean annual temperatures of 10°C–12°C, and wet winters between May and August, with precipitation of 72 millimeters (mm) to 90 mm per month.[15] Chile's climate is primarily influenced by the El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and the Antarctic Oscillation (AAO). In Chile, years with ENSO have higher probability of precipitation; together with PDO, ENSO considerably affects snow accumulation and mountain flow regimes.[16] The Andean mountains influence precipitation patterns across the country, affecting both temperature and precipitation. Chile's extensive coast benefits from upwelling, the movement of dense, cool, and nutrient rich water to the surface, is also influenced by wind and ocean temperature patterns.[17]

Temperatures in Chile vary depending on latitude and altitude, with higher temperatures occurring during southern summer months (November-February). Temperatures tend to be lower in areas with high elevations and close to the Antarctic south and warmer in areas with tropical climates. Precipitation follows a seasonal pattern; most precipitation occurs during winter and more arid conditions are experienced in the summer. Some areas, such as the Atacama Desert, seldom receive rainfall, often during winter months. Southern areas have more precipitation, primarily during the southern winter. In the central region, near Santiago, there is a large range in precipitation with most of the precipitation falling during May and July and almost no precipitation between October and March. The country is highly vulnerable to climate change as its long coastline is exposed to sea level rise, with historically high exposure to natural disasters, drought-prone areas, mountain glaciers and river systems affected by rising temperatures, forests and fragile ecosystems. Additionally, several sectors and industries remain closely tied to changes in ocean and environmental health.

[15] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile – Historical Data. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-historical

[16] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

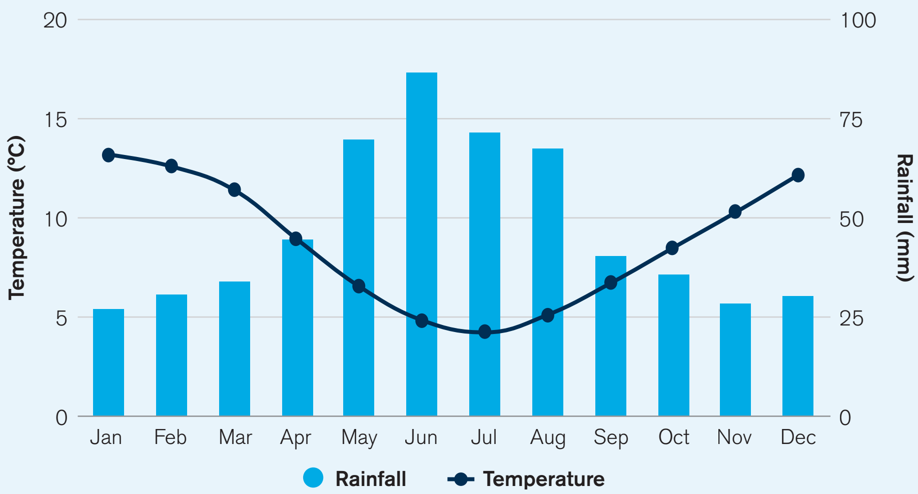
[17] Kämpf, J. and Piers C. (2016). The Peruvian-Chilean Coastal Upwelling System. Chapter 5. *Upwelling Systems of the World.* Springer, Cham, 2016. 161–201. Web. URL: https://link.springer.com/content/pdf/10.1007%2F978-3-319-42524-5_5.pdf

Analysis of data from the World Bank Group's Climate Change Knowledge Portal (CCKP) (**Table 2**) shows the most recent historical climatology, 1991–2020. Mean annual mean temperature for Chile is 8.3°C, with average monthly temperatures ranging between 11°C (December) and 4°C (July). Mean annual precipitation is 647.4 mm, with rainfall occurring throughout the year, peaking from May to August. (**Figure 3**).[18] **Figure 4** presents the spatial variation of observed average annual precipitation and temperature across Chile.

TABLE 2. Data Snapshot: Summary Statistics

Climate Variables	1991–2020
Mean Annual Temperature (°C)	**9.0°C**
Mean Annual Precipitation (mm)	**530.1 mm**
Mean Maximum Annual Temperature (°C)	**14.3°C**
Mean Minimum Annual Temperature (°C)	**3.8°C**

FIGURE 3. Average Monthly Temperature and Rainfall of Chile for 1991–2020[19]



[18] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-historical

[19] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-historical

Key Trends

Temperature

The range of climates in Chile make it important to consider regional variations in climate change. Observations in the northern regions show warming in the central valley and Andes and a cooling in the coastal regions associated with changes in the surface temperature of the Pacific Ocean.[21] Mountain glaciers have also been adversely impacted by increasing temperature, changing snow melt and runoff. The number of 'hot nights' in Chile increased approximately by 20.3 nights per year between 1960 and 2006.[22] **Figure 5** shows mean annual observed temperature for the country.

Precipitation

Rainfall patterns vary by region. The Northern (18–30°S) and Central (30–35°S) zones show significant inter-decadal and intra-decadal variation, respectively, while the Southern (37–43°S) has experienced a decrease in precipitation. Recent research suggests that historical changes have altered the flow of low elevation rivers, a trend

FIGURE 4. Map of Average Annual Temperature (°C) (left); Annual Precipitation (mm) (right) of Chile, 1991–2020[20]

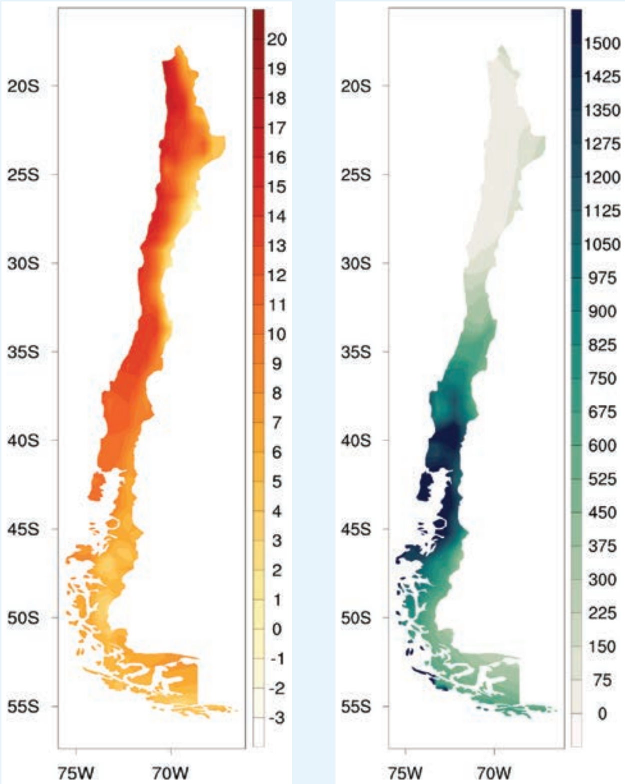
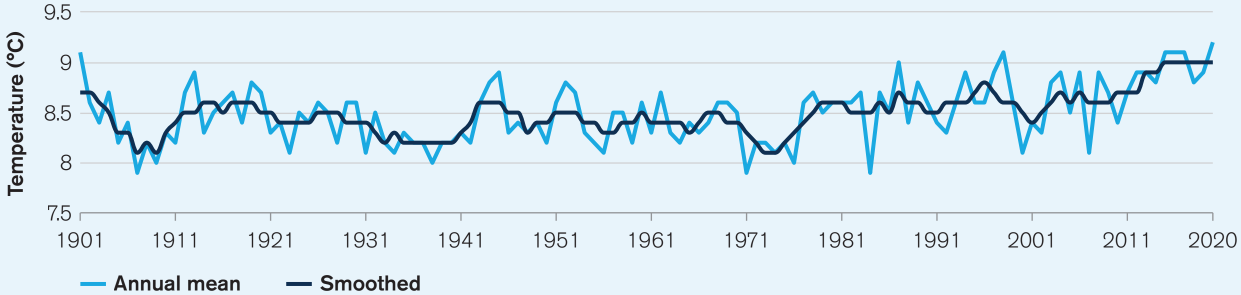


FIGURE 5. Observed Temperature for Chile, 1901–2020[23]



[20] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-historical

[21] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

[22] UNDP (2012). Climate Change Country Profiles – Chile. URL: https://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Chile/Chile.hires.report.pdf

[23] WB Climate Change Knowledge Portal (CCKP, 2021). Chile. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-historical

toward a decrease in glacial cover.[24] Annual precipitation in coastal regions has decreased by 15% to 30% in the last century. Chile experienced a severe drought again in 2008–2015 with an average deficit of 50%, however, several regions experienced deficits between 75% to 100% (concentrated near the Coquimbo province). The Atacama Desert has become more arid and advanced, gaining 0.4 km each year during the twentieth century.[25]

Climate Future

Overview

The main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP) is the CMIP5 (Coupled Inter-comparison Project No.5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes business-as-usual scenario. For more information, please refer to the RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high (RCP8.5) emission scenario in this profile. **Table 3** provides CMIP5 projections for essential climate variables under high emission scenario (RCP 8.5) over 4 different time horizons. **Figure 6** presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099.

TABLE 3. Data Snapshot: CMIP5 Ensemble Projection

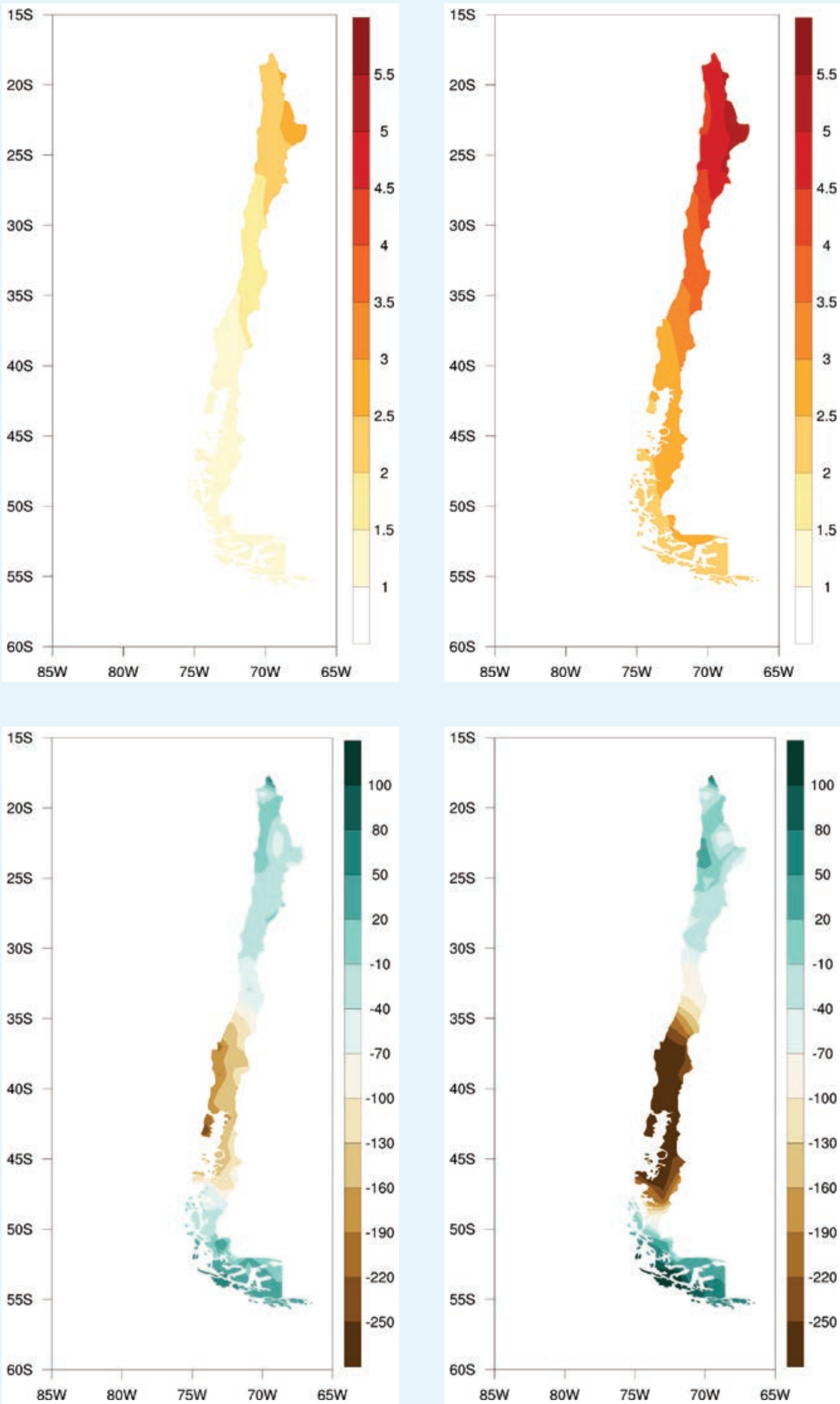
CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Annual Temperature Anomaly (°C)	**0.40 to 1.43** (+0.87°C)	**0.95 to 2.32** (+1.54°C)	**1.64 to 3.47** (+2.38°C)	**2.21 to 4.69** (+3.26°C)
Annual Precipitation Anomaly (mm)	**–19.73 to 15.47** (–2.04 mm)	**–22.84 to 16.08** (–4.36 mm)	**–27.58 to 17.56** (–6.41 mm)	**–32.84 to 19.30** (–8.85 mm)

Note: The table shows CMIP5 ensemble projection under RCP8.5. Bold value is the range (10th–90th Percentile) and values in parentheses show the median (or 50th Percentile).

[24] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

[25] Ministerio de Agricultura (2016). Oficina y Políticas Agrarias. *El cambio climático y los recursos hídricos de Chile*. December 2016. Web. URL: https://www.odepa.gob.cl/wp-content/uploads/2016/12/RecursosHidricosCambioClimatico.pdf

FIGURE 6. CMIP5 Ensemble Projected Change (32 GCMs) in AnnualTemperature (top) and Precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), Relative to 1986–2005 Baseline Under RCP8.5[26]



[26] WBG Climate Change Knowledge Portal (CCKP, 2021) Chile Projected Future Climate. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-projections

Key Trends

Temperature

In Chile, average annual temperatures are expected to increase by 1.4°C–1.7°C by mid-century and by as much as 3°C–3.5°C by the end of the century. Northern areas of the country that currently experience tropical climates are expected to see a greater increase in temperature compared to the southern regions. Regional climate models project that temperature increases will be highest in the central regions.[27] The number of frost days, days when the minimal temperature is below 0°C, is projected to decrease by 12–42 days by the 2050s and 37–69 days by the 2090s. Effects are projected to occur during winter months and be most pronounced in July and August. The number of summer days (maximum temperature above 25°C) are expected to begin earlier and increase by 2–27 days by the 2050s and 17–61 days by 2090s.

Across all emission scenarios, temperatures will continue to increase for Chile throughout the end of the century. As seen in **Figure 7**, under a high-emission scenario, average temperatures will increase rapidly by mid-century. Across the seasonal cycle (**Figure 8**), temperature increases will be felt from October to April. Increased heat and heat conditions will result in significant implications for human and animal health, agriculture, water and energy resources, and ecosystems.

FIGURE 7. Projected Average Temperature for Chile (Reference Period, 1986–2005)[28]

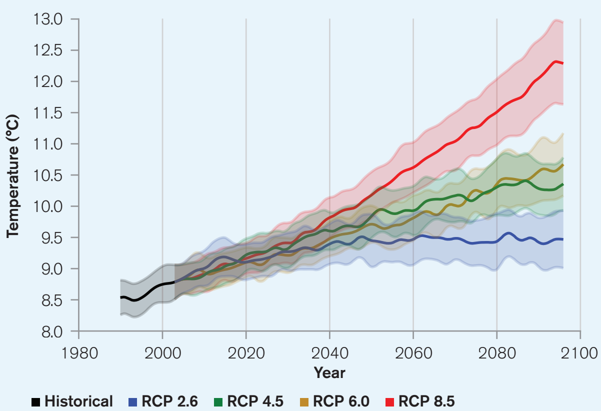
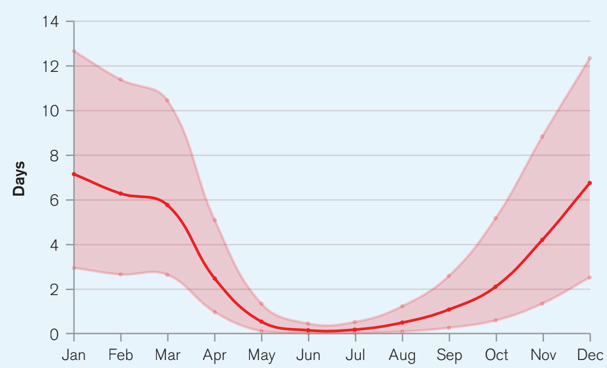


FIGURE 8. Projected Change in Summer Days (Tmax >25°C) (RCP8.5, Reference Period, 1986–2005)[29]



Precipitation

While precipitation in Chile is highly variable, it is projected to decrease consistently by 1.5 mm to 9.3 mm per month by the 2050s, to 5.5 mm to 11 mm by the 2090s. Together with growing temperatures and expected increased intensity in winds, there could be an increase in evapotranspiration pressures, which would impact surface water reservoirs. Chile's central region is expected to experience significantly greater degrees of a reduction in

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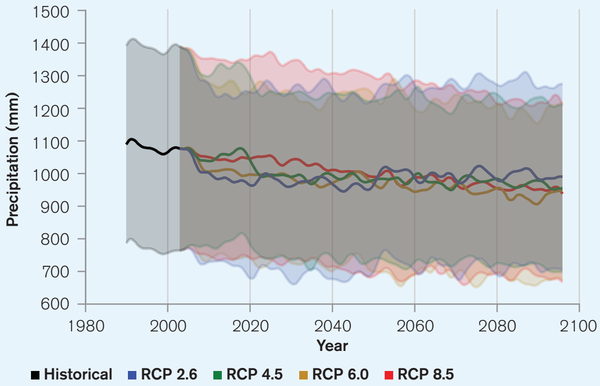
[27] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

[28] WBG Climate Change Knowledge Portal (CCKP, 2021). Interactive Climate Indicator Dashboard - Agriculture. Chile. URL https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

[29] WBG Climate Change Knowledge Portal (CCKP, 2021). Interactive Climate Indicator Dashboard - Agriculture. Chile. URL https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

precipitation than other regions.[30] Expected reduced precipitation and increased temperature are expected to impact evaporation, water balance as well as drought conditions. Water access, storage and other management options can be highly varied depending if the precipitation input comes frequently or with long periods of aridity in between rainfall. Overall, annual mean precipitation is expected to decrease through the end of the century. This is also likely to impact reservoirs from hydroelectric plants, which have already decreased energy generation due to increased aridity and drought conditions. It is highly likely, under these conditions that fossil fuels will replace a considerable share of hydroelectric generation, and thus increase emission and electricity prices. **Figure 9** below, shows the change in the projected annual average precipitation for Chile.[31]

FIGURE 9. Projected Annual Average Precipitation in Chile (Reference Period, 1986–2005)[32]



CLIMATE RELATED NATURAL HAZARDS

Overview

Chile is highly exposed and vulnerable to multiple hazards such as earthquakes, volcanic activity, and tsunamis as well as hazards which can change due to climate impacts, such as wildfires, floods, landslides, and droughts. Chile is a part of the 'Pacific Ring of Fire' and is highly exposed to the occurrence of geological and hydrometeorological disasters.[33] Chile has suffered many instances of drought. Over the period, 1965–2019, there were four major droughts with losses that, on average exceeded US $1,000 million in losses for each occurrence. Their macroeconomic impact was relevant, to the point that in the most severe case it represented 0.77% of the GDP for the year. The social and economic development of the country has not only been affected by precipitation shortages but also by floods. Over the same period, Chile has lost over US $ 5 billion from 37 events, the most important representing a loss of approximately US $ 2 billion, equivalent to 0.62% of GDP for the year.[34]

[30] Ministerio de Agricultura (2016). Oficina y Políticas Agrarias. *El cambio climático y los recursos hídricos de Chile.* December 2016. Web. URL: https://www.odepa.gob.cl/wp-content/uploads/2016/12/RecursosHidricosCambioClimatico.pdf

[31] WBG Climate Change Knowledge Portal (CCKP, 2021): Chile Water Dashboard. Data Description. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-sector-water

[32] WBG Climate Change Knowledge Portal (CCKP, 2021): Climate Data-Projections. Chile. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-sector-water

[33] Villalobos, J.A. and Perez, A. (2021). Pacific Alliance countries analyze the hydrometeorological risk impacts. World Bank Blogs, [6 January, 2021]. URL: https://blogs.worldbank.org/latinamerica/pacific-alliance-countries-analyze-hydrometeorological-risk-impacts

[34] World Bank (2020). Catastrophic risk modeling and analysis for the Pacific Alliance (Chile, Colombia, Peru, Mexico). Component 1, Stage 1. Database on historical events of hydrometeorological origin – Chile. (Unpublished).

Changes in precipitation and water management can leave forested areas vulnerable to wildfires during the fire season which ranges from October to April/ May. The area between Santiago and Puerto Montt is most exposed to fire with an average 3,000–5,000 fires each season.[35] Chile was recently affected by extensive wildfires in 2017 which impacted approximately 1,000,000 acres of vegetation and reached record proportions. Precipitation patterns, land use, wind, glacial and snow melt, and other climatic conditions will affect the country's river systems, impacting in other sector such as irrigation for agriculture, water for human consumption, and hydroelectric generation. Most flooding occurs during the rainy season between April and September. However, Chile has recently experienced flash flooding in connection to temperature changes and snow melt. Coastal areas are also vulnerable to flooding from sea level rise, though impacts will vary along the countries' coast and can range between 0.2–0.3 meters by the end of the century.[36] Temperature related hazards are mostly connected with cold temperatures and cold fronts; in 2011, a cold front impacted an estimated 25,000 people in vulnerable conditions.[37] Flooding and wildfire events occur with higher frequency while earthquakes, the third most frequent disaster, represents a significant percentage of mortality and economic damages caused by natural disasters.

Data from the Emergency Event Database: EM-Dat, presented in **Table 4**, shows the country has endured various natural hazards, including floods, landslides, epidemic diseases, and storms.

TABLE 4. Natural Disasters in Chile, 1900–2020[38]

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage (Million USD)
Drought	Drought	2	0	120,000	255,000
Earthquake	Ground movement	27	58,852	6,568,929	4,712,070
	Tsunami	3	591	3,353,055	30,800,000
Extreme temperature	Cold wave	5	2	35,150	20,000
	Severe winter conditions	4	6	50,950	1,000,000
Flood	Flash flood	3	195	336,548	1,530,000
	Riverine flood	19	352	875,144	736,700
Landslide	Avalanche	1	32	30	–
	Landslide	3	78	142	–
	Mudslide	1	141	82,811	6,000
Storm	Convective storm	6	156	276,451	–
Volcanic activity	Ash fall	9	110	86,650	615,000
Epidemic	Bacterial Disease	1	1	40	0

35 CONAF (2021). Forest Fires in Chile. Historical Statistics – National Summary Occurrence and Damage. URL: https://www.conaf.cl/incendios-forestales/incendios-forestales-en-chile/estadisticas-historicas/

36 Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

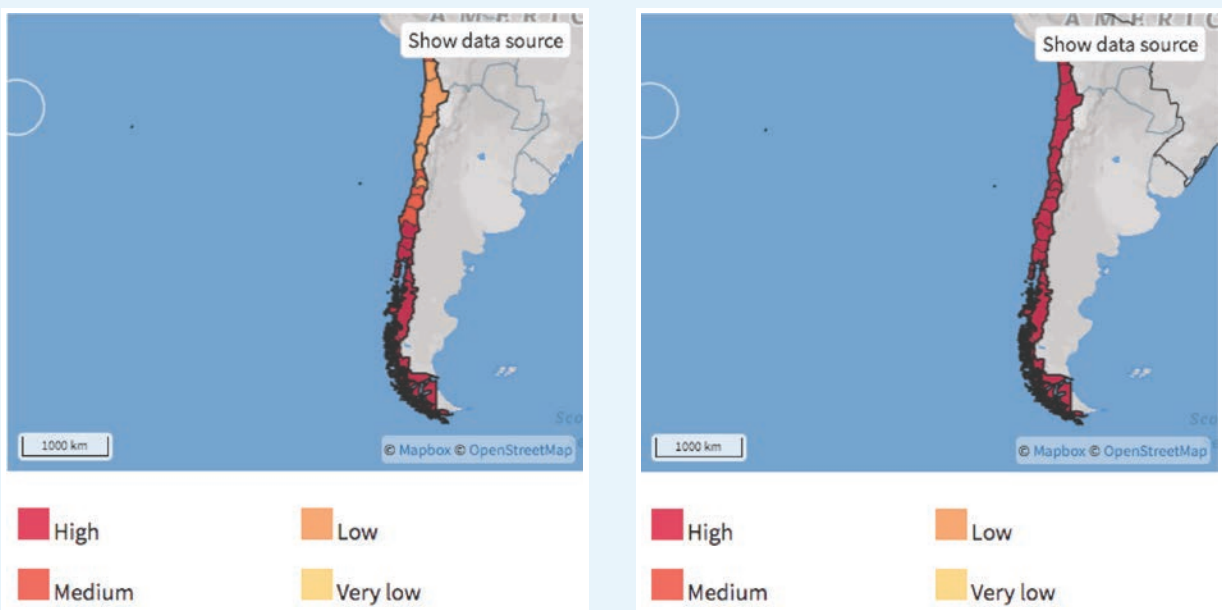
37 Center for Excellence in Disaster Management & Humanitarian Assistance (2017). Chile – Disaster Management Reference Handbook. URL: https://www.cfe-dmha.org/LinkClick.aspx?fileticket=XALlrf4ltFg%3d&portalid=0

38 EM-DAT: The Emergency Events Database – Universite catholique de Louvain (UCL) – CRED, D. Guha-Sapir, Brussels, Belgium. URL: http://emdat.be/emdat_db/

Key Trends

As discussed, climate change is expected to change the frequency, intensity, exposure, and magnitude of multiple hazards that have historically affected Chile, namely, wildfires, floods and landslides, droughts, and impacts of sea level rise. Existing trends indicate population growth will occur in vulnerable areas such as the Central region of the country, further exacerbating impacts. Changes in the frequency of El Niño events could impact temperatures and generate increased precipitation that could expose the country to extreme precipitation events and flooding as well as increased winds.[39] Projected decreases in precipitation levels, heightened during La Niña years, in the northern and central areas of the country could expose Chile to increased periods of drought. A more arid climate and changes in land use can also expose these parts of the country to higher risk for wildfires. Reductions or wider ranges in seasonal precipitation can also change traditional river flows and increase the risk of flooding. Changes in land use, land affected by wildfires, and areas with steep slopes are most vulnerable to landslides. Models estimate that temperatures will increase, changing the isothermal lines causing changes in river flow and potentially instances of flash flooding. Changes in snowmelt and glaciers can affect existing water systems and reservoirs. The accumulation of risks, exposure, and multiple hazards can have important implications for economic growth and achieving development, disproportionately affecting vulnerable populations. **Figure 10** presents the risk of coastal flooding and water scarcity for Chile.

FIGURE 10. Risk of Urban Flood (left)[40]; Risks of Wildfires (right)[41]



[39] Ministerio del Interior y Seguridad Pública (2016). Plan Estratégico Nacional parap la Gestión del Riesgo de Desastres 2015–2018. URL: https://siac.onemi.gov.cl/documentos/PLAN_ESTRATEGICO_BAJA.pdf
[40] ThinkHazard! (2020). Chile – Urban Flooding. URL: http://thinkhazard.org/en/report/51-chile/UF
[41] ThinkHazard! (2020). Chile – Wildfire. URL: http://thinkhazard.org/en/report/51-chile/WF

Implications for DRM

Chile has extensive experience and institutional capacity with disaster risk management (DRM) due to the historical abundance of seismic based natural disasters. The National Office of Emergency (ONEMI), within the Ministry of Interior and Public Safety, is the Chilean lead institution for the governance of critical risks. The ONEMI's mission is to plan, promote, coordinate, and implement preventive actions, response, and rehabilitation against collective risk situations, emergencies, and disasters caused by natural or human action.[42] ONEMI coordinates the functioning of the National Civil Protection System activities at national and local level, and the National Platform for Disaster Risk Reduction (PNRRD). ONEMI is in charge of elaborating the National Policy for Disaster Risk Management (PNGRD).

Chile's strategic plan to address disaster risk focuses on four pillars that include institutional strengthening, strengthening monitoring and early warning systems, developing a culture of prevention and resilience building, addressing transversal aspects of disaster risk (including climate change) and investing in preparedness to achieve an effective response when disasters arrive.[43] Additionally, risk management is included in sectoral plans as is the case with the National Energy Strategy, National Water Strategy, and the National Strategy for Climate Change and Vegetation Resources (Forestry). While Chile has taken important steps to address disaster risk, it recognizes the importance of addressing social, economic, and other underlying risk factors that lead to vulnerability. It also identifies the need to invest in local capacity as well as train and retain experts that can support technical data collection, analysis, and research needs for disaster risk management.

Disaster Risk Finance is one of the pillars within a comprehensive approach to Disaster Risk Management. Financial protection public policy and financial instruments support governments to become effective risk managers and help fiscal and macroeconomic goals protect lives, livelihoods, investments, and development progress. Direct and indirect financial effects of disasters can seriously affect the government finances, as the government fiscal balance become more weak expenditures rises and taxes base shrinks, the fiscal deficit increases.

Disaster Risk Finance enables the country (at regional, national and subnational levels) to understand their contingent liabilities and be prepared ex ante. Based on the timeliness of the needs of funds, the sovereigns can access different sources for facing the event in each stage, depending on the costs of use, amount available and speed of access. This is a tradeoff between cost and risks to the government. Therefore, they need to combine different instruments in a risk layer approach to protect themselves against disasters depending in the frequency and severity. This will ensure value for money as all financial instruments bear a cost.

For example, Chile issued in 2018 within the Pacific Alliance (PA) framework, a seismic cat bond in 2018 (already due), as part of their financial strategy. Currently, the PA countries are seeking a way to protect themselves against the economic and social impact of hydrometeorological risks, through a transfer instrument that could become the first Hydrometeorological Cat Bond or, if the seismic risk is included, in the first Multi-Risk Cat Bond.[44,45]

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42 ONEMI (2014). National Platform for Disaster Risk Reduction, ONEMI. URL: https://www.onemi.gov.cl/plataforma-de-reduccion-de-riesgos-de-desastres/

43 Ministerio del Interior y Seguridad Pública (2016). Plan Estratégico Nacional parap la Gestión del Riesgo de Desastres 2015–2018. URL: https://siac.onemi.gov.cl/documentos/PLAN_ESTRATEGICO_BAJA.pdf

44 Gomez, J.P., Huerta, M. J. and Martínez, G. (2020). Contingent Liabilities Report, 2020. Publication of the Directorate of Budgets of the Ministry of Finance. (Unpublished).

45 Villalobos, J. A. and Pérez, A. (2021). Pacific Alliance countries analyze the hydrometeorological risk impacts. [January 06, 2021]. World Bank Blogs. URL: https://blogs.worldbank.org/latinamerica/pacific-alliance-countries-analyze-hydrometeorological-risk-impacts

Chile is highly vulnerable to climate variability and change in the immediate as well as longer-term, particularly for the country's water, agriculture, energy, and health sectors as well as its coastal zones. Water scarcity and increased aridity for many areas are expected to continue to increase risks of food insecurity and increase needs for appropriate resource management. The country faces increasing challenges to agriculture, health, and the tourism sector, which are expected to be further compounded by climate stressors Furthermore, environmental degradation, impacted water resources, and loss of biodiversity and the increased vulnerability to risks and natural hazards constitute significant obstacles to the country's continued development and poverty reduction efforts and increases the importance for sustainable adaptation and resilience measures.[46]

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[47]

Agriculture

Overview

Agriculture is a priority sector for the Chilean economy. The country's diverse climate allows it to produce a wide range of crops and is one of the largest exporters of agricultural products, as of 2019, valued at over $15.6 billion in food exports. Chile is the world leading exporter of fresh blueberries, cherries, grapes, and dehydrated plums and apples.[48] While innovation in the sector is relatively low, Chile has made strategic investments in its agricultural value chains with significant advances in efficiencies in the agroindustry.[49]. Agricultural production has been a consistent key element of GDP and the sector employs approximately 6.3% of the population.[50] On average, agricultural income is lower than average country incomes.[51] Agricultural employment and GDP contributions are concentrated in[52] the O'Higgins, Maule and Bio-Bio region, where agriculture accounts for 18%, 13.8% and 15.6% of regional GDP

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[46] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf

[47] World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: https://openknowledge.worldbank.org/handle/10986/23425

[48] FAO (2019). Chile Country Profile. URL: http://www.fao.org/countryprofiles/index/en/?iso3=CHL

[49] InvestChile (2019). Food Industry – Foreign Investor's Guide. URL: https://investchile.gob.cl/key-industries/food-industry/

[50] World Bank Open Data (2021). Data Bank: Population Estimates and Projections, Chile. URL: https://databank.worldbank.org/data/reports.aspx?source=health-nutrition-and-population-statistics:-population-estimates-and-projections

[51] Reforma Agraria (2018). Sector Contribution to the Economy of Chile by 2030 – First Section Reflection and Challenges by 2030: Institutional Perspective of PASO. URL: https://www.odepa.gob.cl/wp-content/uploads/2018/01/economia4parte.pdf

[52] These statistics do not account for Chile's newly added Ñuble Region, established in 2017.

and 13.9%, 18.3%, and 15.9% of employment, respectively;[53] for the center-south, agriculture represents 6%–11% of GDP.[54] Agricultural production and forestry are responsible for 73% of water extraction used to irrigate approximately 1.1 million hectares located almost completely between the Coquimbo and Los Lagos regions.[55] The agricultural sector has been affected by episodes of drought, particularly in 2013, which led to updates to the National Commission on Irrigation which incentivized private investments in irrigation technology and advance water management infrastructure.[56] In addition to managing water to ensure availability for irrigation, the sector is challenged by the need to manage contaminated water and runoff from agricultural land.[57]

Climate Change Impacts

Climate change is expected to not only change climatic conditions and the seasonality suitable for agriculture, but also increase the occurrence of extreme events, such as the extreme rainfall in the 2020–2021 season estimated to have impacted more that 50% of fruit harvests.[58] Climate change models predict that the average daily maximum temperatures in Chile will increase by around 2C° by the 2050s. Precipitation patterns are also predicted to vary across north and south of the country, with decreases in precipitation in the north and minimal to positive changes in precipitation in the south. Projected change in annual rainfall seasonality for the country is expected to remain unchanged by mid-century and increase slightly to 0.06 mm by the end of the century. Days of consecutive dry spells are expected to be higher in the central-north compared to the south, with stronger effects between November and March. Changes in temperature is likely to also reduce risks of freeze, while also challenging crops and livestock who are sensitive to high temperatures, particularly in northern, arid regions. Northern and central regions face the challenge of decreased precipitation, which could challenge both rain-fed and irrigated agriculture. In southern regions of the country, where temperatures are colder on average, increases in temperature could make these regions more suitable for agricultural production. Southern areas of the country are also expected to experience minimal to positive changes in precipitation patterns. Climate models project that the average growing season length in Chile will grow by 26 days by the 2040s and 54 days by the 2090s.[59] Changes in ocean currents, such as the Humboldt current, are resulting in lower sea surface temperatures, which reduced precipitation in coastal areas by 15–30% in the last century.[60] Changing climatic conditions are also predicted to impact erosion levels by increasing erosion particularly in the Bío-Bío region, where agricultural practices are increasing pressure on soil health.[61]

53 Ficha Nacional (2020). National and Regional Statistics. Oficina de Estudios y Polïticas Agrarias. URL: https://www.odepa.gob.cl/estadisticas-del-sector/ficha-nacional-y-regionales

54 Reforma Agraria (2018). Sector Contribution to the Economy of Chile by 2030 – First Section Reflection and Challenges by 2030: Institutional Perspective of PASO. URL: https://www.odepa.gob.cl/wp-content/uploads/2018/01/economia4parte.pdf

55 Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

56 FAO (2015). Country Programming Framework. FAO Technical Assistance (2015–2018). URL: http://www.fao.org/3/a-bp548s.pdf

57 Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

58 Villena, M. (2021). Rains impact more than 50% of th3 harvests of some fruits in the central zone. PULSE. [January 31, 2021]. URL: https://www.latercera.com/pulso/noticia/lluvias-impactan-mas-de-50-de-la-cosecha-de-algunas-frutas-en-la-zona-centro/AM2Z56UBWBERTL56NGKB5NQVPA/

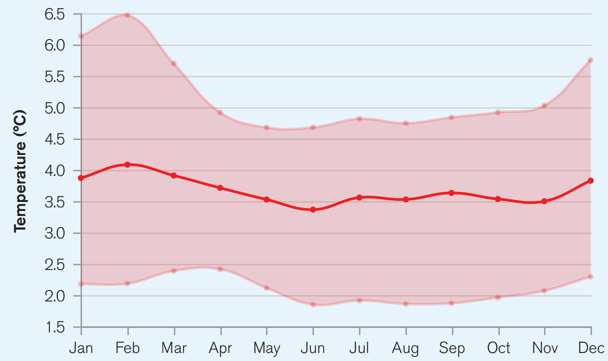
59 WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Projections. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-projections

60 Reforma Agraria (2018). Chilean Agriculture Reflections and Challenges by 2030 – Second Section Reflections and Challenges by 2030. URL: https://www.odepa.gob.cl/wp-content/uploads/2018/01/cambioClim12parte.pdf

61 Chile (2013). Plan de Adaptacion al Cambio Climatico del Sector. URL: https://www.scribd.com/document/176284308/Plan-Adaptacion-CC-S-Silvoagropecuario

Decreased water availability is likely to reduce yields and the reduction in soil moisture may alter suitable areas for agriculture or the production of specific crops. Increased heat and water scarcity conditions are likely to increase evapotranspiration, expected to contribute to crop failure and overall yield reductions. This may also result in the need for increased cooling and cold chain management to preserve and maintain feedstock at points of production as well as at ports while awaiting export. **Figure 9** shows the average daily max temperature across the seasonal cycle. These higher temperatures have implications for impacts to soil moisture and crop growth and as seen in **Figure 11**, Chile will experience increased average temperatures of approximately 3.5°C throughout the year.

FIGURE 11. Projected Change in Average Daily Maximum Temperature for Chile (RCP8.5, (Reference Period, 1986–2005)[62]



Adaptation Options

While climate change impacts present a source of risk to agricultural production, these changes could also result in opportunities for diversification as well as the adoption of Climate Smart Agriculture Technologies. Changes in climatic conditions are expected to have a strong impact in agricultural production in southern regions of the country which currently have low population density and little economic activity.[63] In response to agricultural emergencies such as extreme temperature, precipitation events, or other natural stressors, the government established a National Advisory Commission for Agricultural Emergencies, which supports the implementation of agrometeorological and early warning systems. This commission supports coordination with the private sector as well as ministries to develop policies that reduce risk and damages from such events.[64] Additionally, the Department for Risk Management in the Ministry of Agriculture connects the public to updated information with agricultural relevant information,[65] risk sharing products, early warnings, capacity building, and dissemination of preventive and adaptive measures through sharing best practices and agricultural extension.[66] The proposed climate change sectoral adaptation plans for both fisheries and agricultural production, introduces more efficient use in natural resources, especially in the case of water, energy, and fertilizer usage. Increasing the diversity of agricultural production, an increase use of local inputs, and diversifying approaches to pest management are also proposed. The proposal also considers the

[62] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Agriculture. Dashboard URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

[63] Reforma Agraria (2018). Chilean Agriculture Reflections and Challenges by 2030 – Second Section Reflections and Challenges by 2030. URL: https://www.odepa.gob.cl/wp-content/uploads/2018/01/cambioClim12parte.pdf

[64] Ministry of Agriculture (2019). Agriculture Emergency Unit, Chile. URL: https://www.odepa.gob.cl/emergencia-agricola

[65] The Ministry has developed the Atlas de Reisgos Climaticos (ARCLIM), launched in 2020, which analyzes threats, exposition and crop suitability for 14 agricultural value chains. ARCLIM can be found at this link: https://arclim.mma.gob.cl/atlas/sector_index/agricultura/

[66] Ministry of Agriculture (2018). Soil and Water Conservation Practices and their Adaptive Effects on Impacts of Climate Change in the Drylands of Chile. URL: http://dgir.minagri.gob.cl/wp-content/uploads/2017/05/Pr%C3%A1cticas-Conservacionistas-de-Suelo-y-Agua-y-sus-Efectos-Adaptativos-sobre-los-Impactos-del-Cambio-Clim%C3%A1tico-en-el-Secano-de-Chile.pdf

importance of sustainable soil use practices and measures to reduce erosion as well as investing in crops that are resilient to extreme heat, water, or salinity conditions. In regard to extreme events, the proposal highlights a focus on emergency response and early warning systems.

Water

Overview

Chile is endowed with abundant water resources with 1,251 rivers, 101 watersheds, and 15,000 lakes and ponds. Water systems in Chile are as diverse as the number of ecosystems and environments in the country. The country has an annual per capita water availability of 53,000 m^3/year; however, availability varies regionally with ranges from 52 m^3/year to 2.9 million m^3/year in others.[67] The Atacama Desert in Northern Chile is one of the most arid areas of the world. Water availability increases gradually toward southern latitudes and becomes abundant near Aysén. Chile is currently in the midst a mega-drought, with Chile's recurring drought scenarios becoming the new normal. Central Chile has experienced an uninterrupted sequence of dry years since 2010, with mean rainfall deficits of 20% to 40%. This has resulted in direct consequences for water security, with growing conflict over accessibility, supply and ultimately livelihoods. Furthermore, the droughts have in turn impacted forest fires.[68] Additionally, water scarcity in Chile has also impacted electricity prices and increase in emissions. Energy is already the highest emitting sector, and decreased precipitation and/or increased drought conditions impact hydroelectric generation being replaced by fossil fuels.

National water usage in 2010 amounted to 4,710 m^2 annually. An estimated 99% of urban and 87% of rural populations in 2015 had access to running water (98% country wide) and 99% of urban and 79% of rural areas had access to sanitation services.[69] The agricultural sector requires the most water resources (approximately 73% of extracted water), followed by industry (12%), mining (9%), and sanitation (6%).[70] Chile uses water resources to produce hydroelectricity with reservoirs, and run-of-of river plants, with a hydroelectric energy potential of 9GW/h. Water is a strategic input to productive sectors and forms the backbone of the country's water-intensive economy. As such, the Chilean economy that has shifted towards a water intensive, export-orientated economy. Historical trends point to challenges of water distribution and availability between regions which may become more pronounced with a changing climate. Precipitation and water availability in Chile are closely connected to the El Niño Southern Oscillation cycle. La Niña years tend to experience higher precipitation while El Niño years are associated with lower levels of precipitation. The Pacific Decadal Oscillation can also influence sea surface

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[67] Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

[68] Garreaud, R. et al. (2020). The Central Chile Mega Drought (2010–2018): A climate dynamics perspective. International Journal of Climatology. DOI: https://doi.org/10.1002/joc.6219

[69] Chile (2017). Agenda 2030 Objetivos de Desarrollo Sustentable. Sustainable Development Goal Report, September 2017. URL: www.cl.undp.org/content/dam/chile/docs/ods/undp_cl_ODS_Informe_ODS_Chile_ante_NU_Septiembre2017.pdf

[70] Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

temperature and through this, affect precipitation trends particularly in the central and northern regions of Chile.[71] The Antarctic Oscillation also has an incidence in Chilean climate, particularly in southern sub-Antarctic zones.[72] Recent years have shown trends toward a 20–30% decrease in precipitation in the regions between Coquimbo and Valdivia.[73]

Climate Change Impacts

Climate change is expected to change water availability and seasonality as well as temperatures, which could also impact snowmelt and accumulation in the Andes. Changing temperatures are expected to have the highest impacts on the water systems in the Andean regions, especially in latitudes 30–40° and decrease in intensity from north to south.[74] The majority of the population is concentrated in the center north while the southernmost areas of the country are sparsely populated, in large part due to historically challenging climatic conditions. Ensemble projection models estimate that annual severe drought likelihood for the country will increase by 34% by mid-century and by 63% by the end of the century.[75] Some regions of the country are expected to experience desertification as the Atacama grows in surface area while other regions may experience scarcity. The areas between Coquimbo and O'Higgins are projected to see a 20%–25% decrease in precipitation by mid-century. Concurrently, the southern regions of the country may experience consistent or increased water availability on an annual basis with light decreases in spring and summer. The Chilean government estimates that precipitation in the Antiplano and regions of Arica and Parinacota could experience a 15%–25% increase in precipitation by the 2050s.[76]

The Standardized Precipitation Evapotranspiration Index (SPEI) is an index which represents the measure of the given water deficit in a specific location, accounting for contributions of temperature-dependent evapotranspiration and providing insight into increasing or decreasing pressure on water resources. Negative values for SPEI represent dry conditions, with values below –2 indicating severe drought conditions, likewise positive values indicate increased wet conditions. This is an important understanding for the water sector in regards to quantity and quality of supply for human consumption and agriculture use as well as for the energy sector as reductions in water availability impacts river flow and the hydropower generating capabilities. Drought and water scarcity are projected to be concentrated in the central and northern regions compared to southern regions. SPEI projections estimate that precipitation in Chile will be –1.42 standard deviations from the historical mean by the 2050s. However, while projections estimate a

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71 Valdés-Pineda, R., Cañón, R., and Valdés, J.B. (2018)."Multi-decadal 40-to 60-year cycles of precipitation variability in Chile (South America) and their relationship to the AMO and PDO signals. *Journal of Hydrology* 556 (2018): 1153–13. URL: https://doi.org/10.1016/j.jhydrol.2017.01.031

72 Valdés-Pineda, R., Cañón, R., and Valdés, J.B. (2018)."Multi-decadal 40-to 60-year cycles of precipitation variability in Chile (South America) and their relationship to the AMO and PDO signals. *Journal of Hydrology* 556 (2018): 1153–13. URL: https://doi.org/10.1016/j.jhydrol.2017.01.031

73 WBG (2015). Integrated Water Resources Management and Infrastructure Development Project. URL: http://documents.worldbank.org/curated/en/881091467998209964/pdf/PAD1275-PAD-P152319-R2015-0205-1-Box393228B-OUO-9.pdf

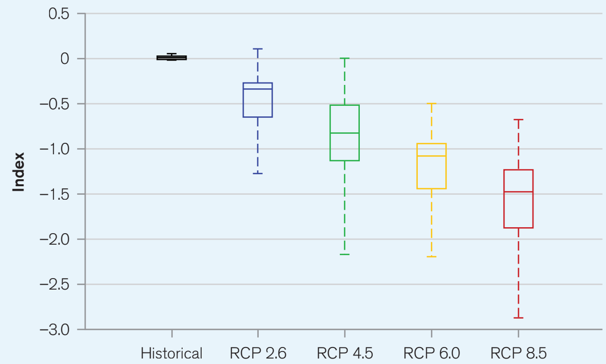
74 Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

75 WBG Climate Change Knowledge Portal (CCKP, 2021): Chile Projections. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-data-projections

76 WBG (2015). Integrated Water Resources Management and Infrastructure Development Project. URL: http://documents.worldbank.org/curated/en/881091467998209964/pdf/PAD1275-PAD-P152319-R2015-0205-1-Box393228B-OUO-9.pdf

decrease of –1.41 standard deviations in Antofagasta in the North, the southernmost areas of the country, such as Punto Arenas are expected to see no change in mean annual drought.[77] As seen **Figure 12**, Chile is projected to experience significantly heightened dry conditions and significant drought severity, which will likely increase pressure on water resources for the country and region.

FIGURE 12. Projected Annual SPEI Drought Index in Chile (Reference Period, 1986–2005)[78]



Adaptation Options

Water is a strategic resource that is closely linked to human health, environmental health and economic development, as such, the Government of Chile has taken special care to consider sustainable management of its water resources.[79] Chile has a strong record of institutional governance, however, increased climate change considerations can further support effective water management. Effective water resource management mechanisms should be adapted to current and future climate conditions to support the sector's adaptation efforts and can also support longer-term mitigation goals.[80] Institutional efforts, specifically around water resource management, can better incorporate climate change scenarios and projected water scarcity. Essential water management/governance mechanisms can be further adapted to projected climate conditions to help reduce and mitigate uncertainty. Increasing data into policy design and programming will also support resilience efforts for the sector.[81] While differences in water availability present challenges, the existence of diversity in water resource levels could present an opportunity if current resources are managed sustainably, and future resources are effectively distributed within the country. Chile is challenged by scarce water resources and higher water demand for key industries in the North and abundance in the South where water demand is lower. Water availability and quality is being further constrained due to industrial, mining and agricultural contamination.[82] Chile has recognized the importance of improving waste water management and reducing runoff from economic sectors such as agriculture, mining, industry, and urban centers. Water for irrigation currently surpasses reservoir capacity in the Paloma-Recoleta-Cogotí system. Government of Chile projections estimate that population and economic growth could result in an additional 4 million m^3/year, placing demand on limited, and decreasing, water resources in some regions. The Government of Chile developed a hydrologic resource policy that identified the following as primary risks associated with climate change: increased risk of drought in the central zone, decrease risk of frost in the south which would support increased agricultural production, increased risk of heavy rainfall

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77 WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Water Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

78 WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Water Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

79 Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

80 World Bank (2015). Performance and Learning Review of the Country Partnership Strategy for the Republic of Chile for the period FY11-FY16. URL: http://documents1.worldbank.org/curated/en/160901468238175546/pdf/942710CPS0P149070Box385413B00OUO090.pdf

81 World Bank Group (2019). Wastewater: From Waste to Resource – The Case of Santiago, Chile. World Bank, Washington, DC. © World Bank. URL: https://openknowledge.worldbank.org/handle/10986/32744

82 Chile (2011). Diagnóstico de la gestión de los recursos hídricos. Departamento de Medio Ambiente y Desarrollo Sostenible, Región para América Latina y Caribe. Washington, DC: World Bank. URL: http://documents1.worldbank.org/curated/en/452181468216298391/pdf/633920ESW0SPAN0le0GRH0final0DR0REV-0doc.pdf

(higher than 10 mm/day), higher vulnerability for communities using traditional agricultural practices, and changes in hydroelectric power generation capacity. The Chilean National Water Resources Strategy 2012–2025 identified five axes for water management that consider the above-mentioned risks. The five components for water policy include: 1) efficient and sustainable management, 2) improving institutional capacity, 3) confronting water scarcity, 4) social equity: connecting rural areas with potable water, and 5) creating an informed citizenry. The World Bank has engaged in a series of advisory services to the Government of Chile, which include, Strengthening the legal framework for IWRM (2015); supporting development of the Institutional Framework of Water Sector in Chile (2014); providing support to the Institutional Reform Plan IWRM (2014) and Planning Water Infrastructure (2014); and supporting the Water Resources Management Assessment Study (2011). The results of these knowledge services have advised regulatory reforms, discussions of the legal framework, and the discussion on the institutional modernization needs.[83]

Energy

Overview

To reach the ambitious decarbonization goals as established in Chile's updated NDC, as well as the national Energy Strategy 2018–2020 and the Energy Policy 2050, continued water availability is a critical component. As of December 2020, Chile's energy sector has an installed capacity of 26.31 GW/h Chile has a diversified energy mix, although it strongly relies on thermal generation (52% of installed capacity) with coal generation being 32%, natural gas 8%, and diesel 1% (December 2020). Conventional hydrogeneration reached 32% and non-conventional renewable energy 27% (with small run-of-river hydro being 3%).[84] On average, between 2010 and 2015, hydroelectric plants represented over 40% of the electricity produced in winter, while in 2016–2019 that figure dropped to 24%.[85] In Chile, the National Electric System (SEN) has a maximum demand of 10,907 MW. Approximately 65% of energy in 2015 was from net energy imports and energy intensity was of 11.16 ppp/$/kg of oil equivalent. Chile's national demand for final consumption was of 25.1 Mtoe, which was 15% higher than demand ten years prior.[86] Energy is used principally by industry (mining sector), which used 43% of total final consumption, followed by transport (33.5%), residential (15.6%) and other commercial uses, which account for the rest. Electrification rates are high nationally (99.8%) and in rural areas 98.3% of the population has access to electricity. The current energy strategy (*Ruta Energetica 2018–2022*) includes a mitigation and adaptation to climate change approach to ensure a clean matrix, foster distributed generation and the use of carbon pricing instruments. The National Energy Policy 2050 aims to have 70% of locally produced energy from renewable sources, including small hydro (of up to 20 MW).[87]

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83 Chile (2013). Chile Cuida su Agua, Estrategia nacional de Recursos Hídricos 2012–2025 (National Water Resources Strategy). URL: https://www.mop.cl/Documents/ENRH_2013_OK.pdf

84 Ministerio de Energía (2021). Reporte Mensual – Sector Energético. Eneri, 2021, Vol. No.71. URL: https://www.cne.cl/wp-content/uploads/2021/01/RMensual_v202101.pdf

85 Generadoras de Chile (2019). Due to the drought, hydroelectric plants accounted for only a quarter of electricity production this winter. [September 10, 2019]. URL: http://generadoras.cl/prensa/por-la-sequia-centrales-hidricas-explicaron-solo-un-cuarto-de-la-produccion-electrica-este-invierno

86 IEA (2019). Central and South America. URL: http://www.iea.org/publications/freepublications/publication/EnergyPoliciesBeyondIEACountriesChile2018Review.pdf

87 Chile (2016). Energy 2050. URL: http://www.energia2050.cl/wp-content/uploads/2016/08/Energy-2050-Chile-s-Energy-Policy.pdf

Climate Change Impacts

Climate change is expected to have several changes in energy systems by impacting both demand, sources of electricity, and potential to generate electricity from renewable resources. Chile is vulnerable to changes to its water availability induced through climate change, these can impact energy production as well as water availability for economic uses that could result in increasing energy demand for irrigation and pumping water from areas in the country with less scarcity. Chile's Energy Policy 2050 estimates potential for hydroelectricity generation is expected to fall by 11% by mid-century and 22% by the end of the century.[88] Hydroelectric power is a significant source of energy (slightly less than 50%, although due to the continues drought it has decreased to level of 27% in 2020) for the regions from Taltal to the south. Climate change could reduce generation capacity by the end of the century in planned projects located in the Maule, Biobío, and Toltén basins by up to 70%.[89] Climate change is also likely to highly impact run-of-river small hydroelectric generation as hydrology patterns change. This hydro generation will be likely replaced by fossil fuels (as has already been the case), impacting on emissions. Moreover, as temperatures increase, the projected number of cooling degree days are expected to increase, primarily between December and March, reaching a height of 15.6°F (range of 1–53°F) in January while Chile experiences its summer season.[90] Heat increase has the potential to impact in increased energy consumption for cooling in the agro-industrial processes, commercial and residential uses, especially in those regions with hotter climates. Changes in extreme weather events (like flooding or seismic events) could also impact electricity infrastructure such as transmission lines and distribution infrastructure. Higher temperatures could also reduce cooling efficiency for power generation, which could constrain thermal power generation, which continues to be a significant source of energy. Furthermore, higher temperatures can also increase transmission losses and reduce viscosity of transport fuels as well.[91]

Cooling Degree Days show the relationship between daily heat and cooling demand, typically sourced through a form of active cooling or an evaporative process. The change in cooling degree days provides insight into the potential for extended seasons of power demand or periods in which cooling demand (power demands) might increase. Seasonal increases for cooling demands are expected to increase over an extended summer period (November to April) (**Figure 13**). The Warm Spell Duration Index represents the number of days in a sequence of at least six days in which the daily maximum temperature is greater than the 90th percentile of daily maximum temperature. As shown in **Figure 14**, warm spells are expected to sharply increase in the second half of the century.

[88] Chile (2016). Energy 2050. URL: http://www.energia2050.cl/wp-content/uploads/2016/08/Energy-2050-Chile-s-Energy-Policy.pdf
[89] Chile (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3%20Chile_19%20December%202016.pdf
[90] WBG Climate Change Knowledge Portal (CCKP, 2021): Chile Energy Sector. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-sector-energy
[91] IEA (2019). Central and South America. URL: http://www.iea.org/publications/freepublications/publication/EnergyPoliciesBeyondIEACountriesChile2018Review.pdf

FIGURE 13. Projected Change in Cooling Degree Days (65°F) in Chile for the Period 2040–2059 (Reference Period, 1986–2005)[92]

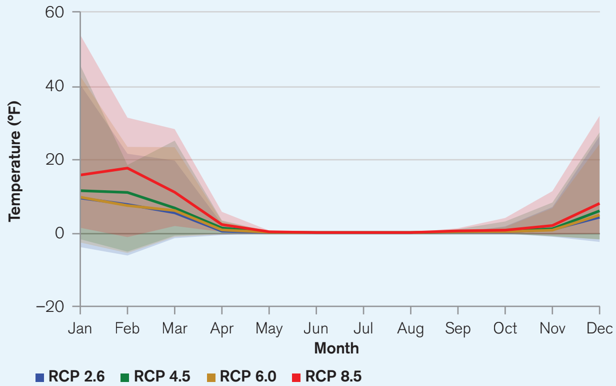
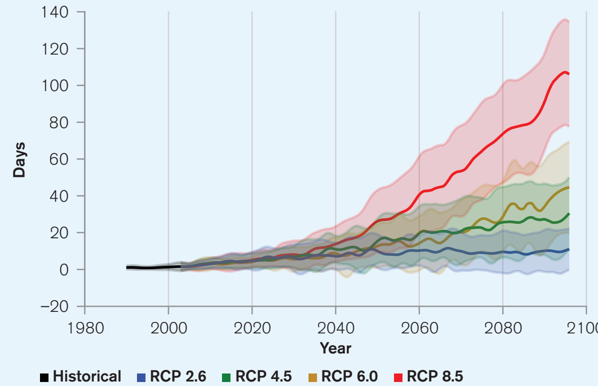


FIGURE 14. Projected Warm Spell Duration Index in Chile (Reference Period, 1986–2005)[93]



Adaptation Options

Chile's National Adaptation plan emphasizes the mitigation potential of the energy sector while also considering adaptation options. The country has committed to increase investment in its ecosystem services to protect water basins that support areas with hydroelectric energy potential.[94] The Ministry of Energy has instituted significant reforms to increase the integration of non-conventional renewable sources and improve security of supply, including reforms to the auctions and transmission sector, as well as transmission investments to connect the main part of the country into one electricity system and reduce congestion. The country approved the Energy Efficiency Law with specific emission reduction targets and has developed a comprehensive strategy involving appliances and end-use energy efficiency and electromobility. Moreover, the country is successfully implementing a solar roof top program and has launched incentives to promote end-users to increase solar rooftop, which may also increase the adaptation of the system in cases of climate events or blackouts. However grid flexibility may have to be assessed to increase the adaptation opportunities in the electricity sector. Chile's current energy policy also contemplates increased societal energy awareness[95] that is connected with a goal of monitoring and encouraging energy and smart monitors in Chile's building stock.[96] More recently, the Ministry of Energy has launched an ambitious plan to develop green hydrogen and take advantage of the increasing share of non-conventional renewable energy, while also helping to decarbonize important hard to abate sectors of the economy such as mining, feedstock and

92 WBG Climate Change Knowledge Portal (CCKP, 2021). Chile – Energy. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-sector-energy

93 WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Energy Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/energy/oil-gas-and-coal-mining?country=LSO&period=2080-2099

94 Chile (2013). Plan de Adaptacion al Cambio Climatico del Sector. URL: https://www.scribd.com/document/176284308/Plan-Adaptacion-CC-S-Silvoagropecuario

95 Chile (2016). Energy 2050. URL: http://www.energia2050.cl/wp-content/uploads/2016/08/Energy-2050-Chile-s-Energy-Policy.pdf

96 Chile (2013). Plan de Adaptacion al Cambio Climatico del Sector. URL: https://www.scribd.com/document/176284308/Plan-Adaptacion-CC-S-Silvoagropecuario

freight/long distance transport. The development of these new industries is directly linked to the use of water for the electrolysis process for producing green hydrogen and thus in a context of water scarcity assessing solutions, especially in the drier areas of the country, such as the use of desalinized water, will be fundamental.[97] Going forward, work to reduce risk of natural disasters and impact on natural, social, and built infrastructure would also be important to include in adaptation strategies for the energy sector.

Health

Overview

Chile has made significant gains in public health in the past decade. Although the majority of Chile's population lives in cities, 1.85 million people continue to live in rural areas. Chile has a mixed public health system where 73.2% of the population had public health insurance in 2015. Chile spends 8.1% of its GDP on health, which is comparable with other OECD countries. Chile's childhood mortality of 6.9 deaths per 1,000 live births remains higher than the OECD average of 3.9,[98] maternal mortality rate in 2014 was of 13.5 for every 100,000 live births. The main causes for mortality are non-communicable diseases although there are some cases of tuberculosis (14.2/100,000 people) and hepatitis B (6.8/100,000 people). Air pollution continues to be a challenge, with several deaths due to acute respiratory infections and respiratory diseases.[99] Despite significant gains, health outcomes and health access differs by gender, ethnicity, and socio-economic status. Chile continues to have high levels of socio-economic inequality measured by Gini index of 47.7 in 2015; for example, the top 20% of the population has 53.6% of income share while the bottom quintile has 4.8% of income shares. Challenges associated with climate can affect populations differently, thus making it important to consider inequality inside cities as well as differences between urban and rural populations.

Climate Change Impacts

Changes in climatic conditions can have impacts on public health in Chile by altering the incidence or severity of existing causes of mortality while also changing the factors that could allow other diseases or pathogens to enter the country.[100] There is the likely increased incidence of diseases transmitted by rodents and ticks in the central part of the country and the increased risk for vector transmitted diseases in northern areas of the country. Changes in temperature can also cause stress in populations, especially in urban areas where the urban heat island effect can exasperate the impact of temperature changes. The annual probability of heat waves in Chile could also increase by 8% by the 2040s and 20% by the 2090s. In certain scenarios, increased heat can lead to increase demand for energy from cooling, which could increase exposure from fossil fuel generated energy emissions. Changes

97 Energy Partnership Chile-Alemania. (2020). Chile Presents National Strategy to Become a World Leader in Green Hydrogen. [November 3, 2020]. URL: https://www.energypartnership.cl/newsroom/chile-hydrogen/

98 OECD (2019). OECD Health Statistics. Chile [Requested Data. June 2018]. URL: https://www.oecd.org/els/health-systems/health-data.htm

99 WHO (2015). Chile: WHO Statistical Profile. URL: http://www.who.int/gho/countries/chl.pdf?ua=1

100 Chile (2013). Plan de Adaptacion al Cambio Climatico del Sector. URL: https://www.scribd.com/document/176284308/Plan-Adaptacion-CC-S-Silvoagropecuario

in wind patterns and ventilation can also exacerbate existing health concerns associated with air pollution and respiratory health. Some regions of the country may experience an increase in days with noticeable increases in wind.[101] In southern regions of the country, there is also increased risk to health from extreme events and flooding. Changing hydrological structures present additional challenges for maintaining access to clean, potable, and safe drinking water. Climate change is expected to impact vulnerable populations the most, particularly those exposed to contaminated water and people with limited capacity to adapt to changes in temperature and exposure to reduced air quality.[102]

Rising temperatures are of increasing concern, although against a nationally aggregated average, Chile is not expected to experience high heat indices; although this is different for inland areas in the northern and central regions. The annual distribution of days with a high-heat index provides insight into the health hazard of heat. **Figure 15** shows the expected Number of Days with a Heat Index >35°C. Tropical Nights (**Figure 16**) represents the projected increase in tropical nights (>20°C) across different emission scenarios.

FIGURE 15. Projected Days with a Heat Index >35°C (Reference Period, 1986–2005)[103]

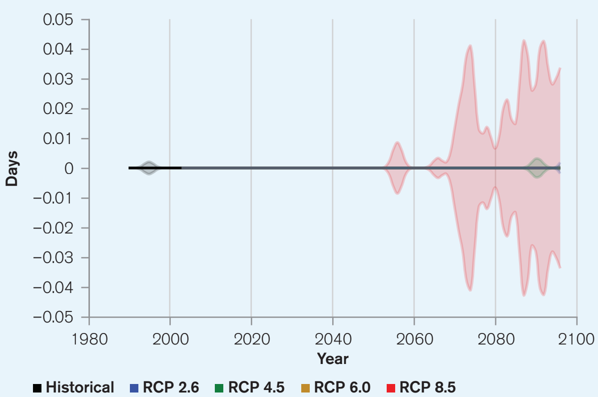
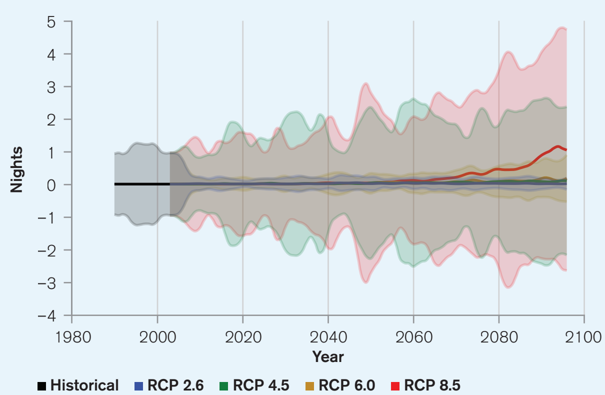


FIGURE 16. Projected Number of Tropical Nights (Tmin >20°C) (Reference Period, 1986–2005)[104]



[101] WBG Climate Change Knowledge Portal (CCKP, 2021): Chile – Health Sector. URL: https://climateknowledgeportal.worldbank.org/country/chile/climate-sector-health

[102] Chile (2013). Plan de Adaptacion al Cambio Climatico del Sector. URL: https://www.scribd.com/document/176284308/Plan-Adaptacion-CC-S-Silvoagropecuario

[103] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Health Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

[104] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile Health Sector. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=CHL&period=2080-2099

Adaptation Options

The 2016 Climate Change Health Adaptation Plan comprised sixteen actions to support institutional and human capital strengthening, surveillance, emergency response and decreased vulnerability. In addition to adaptation actions by the health ministry, other sectors such as energy and cities are considering health by including provisions for pollution reduction and changing urban management, respectively. Axis 7 in Chile's Adaptation Plan considers the connection between health and vulnerability in both urban and rural areas. The focuses primarily on reducing vulnerability through securing drinking sources during drought while also addressing water quality issues. The policy also focuses on reducing malnutrition and supporting overall improvements in health. Among some of the policies proposed in the Health Climate Change Strategy, the country aims to create a unit to coordinate the execution of climate change that would connect the Ministry of Health with other actions. The country also aims to invest in building human capacity by supporting professionals in fields such as environmental health and vector borne diseases, investing in regional capacity development, supporting research to better understand the impact of climate change on the country in collaboration with academics as well as projections on changes in demand for public health services. Other approaches include mainstreaming climate into existing public health goals in support of behavior change and reducing exposure to pollution.

Coastal Zones

Overview

Chile's coast is vast, diverse, and one of the world's most productive. The coastline stretches 4,200 km along the Pacific Ocean, with 161,338 km^2 of territorial waters and an Exclusive Economic Zone (EEZ) five times larger than the terrestrial national territory. The EEZ includes five ecological regions, including the Humboldtian which is well known for intense upwelling, large-scale climatic phenomena (ENSO), and endemism. The northern coast is influenced little by freshwater inputs and has a narrow coastal shelf. Moving south, the coastal shelf widens, and freshwater inputs are more common. The coastal topography of northern and central Chile is dominated by rocky coasts with some protected bays and few sandy beaches. The far south is dominated by freshwater inputs and a topographically diverse network of islands, fjords, estuaries, and channels. Chile is the sixth largest exporter of seafood in the world. In 2016, its seafood exports were valued at $3.45 billion, approximately 1% of GDP. The majority of mari-culture production occurs in the Los Lagos Region in southern Chile. Many Chilean fisheries are already in a vulnerable state due to overfishing and illegal fishing.

Since the 1980s, coastal activities related to tourism, marine resource extraction, energy generation, and urban and rural development has increased significantly. Nearly a third of Chile's municipalities are in the coastal zone, including Chile's main urban centers outside of its capital Santiago, such as Antofagasta, Valparaiso-Viña del Mar, Concepción-Talcahuano, Coquimbo-La Serena, and Puerto Mont-Puerto Varas. While legal protection of marine areas has improved, coastal environmental policies and management remain weak. Increased challenges for scaling coastal urban zones, infrastructure and tourism continues to add pressure to coastal zone environments.[105]

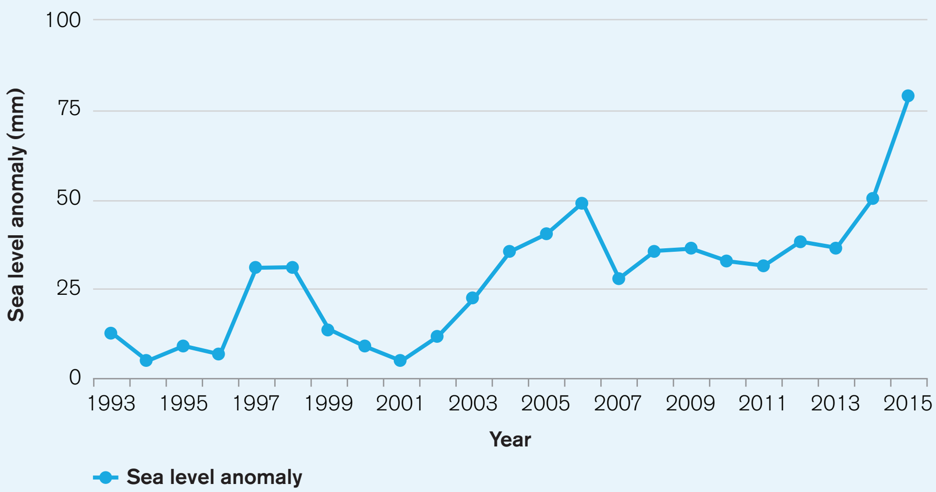
[105] David and Lucile Packard Foundation (2019). Chile Marine Strategy (2019–2012). URL: https://www.packard.org/wp-content/uploads/2019/01/Chile-Marine-Strategy-2019-2021-02.19.pdf

Climate Change Impacts

In Chile, coastal erosion is a significant and growing challenge, responsible for negative impacts on urban coasts, which is affecting economic activities and sustainable development. Given its location and long coastline, Chile is expected to also be directly affected by rising sea levels due to climate change. Coastal erosion has been much greater in places affected by abnormal storms responsible for a transitory sea level increase and the related complex responses on the coast. The magnitude of these storms can cause violent changes along the coast, affecting lives, communities, and infrastructure. The impact of storms on erosion processes may be increased due to the generalized urbanization in the coastal zone. The magnitude of coastal erosion on urbanized coasts is associated with a greater intensity and recurrence of extreme events, the cause of which could be associated with inter-decadal phenomena (ENSO phases), climate variability and global environmental change. Along the Catalan coast, for example, damage to infrastructure has increased by 40% in the last 50 years due to both coastal erosion and explosive urban growth.[106]

Sea level rise, increasing storm surge and coastal flooding are expected to become increasingly devastating to Chile, especially in low-lying coastal areas, which could completely disappear. Much of the coastal zone has already shown impacts from coastal erosion. For example, the Andalién River (a mixed estuary), along the central coast, northeast of Concepción, the country's second most populous city, is expected to experience increased tides and intensity of flooding, which will likely damage infrastructure and coast line.[107] **Figure 17** shows the annual average of seal level change from 1993 through 2015.

FIGURE 17. Historical Sea Level Anomaly of Coastal Chile, 1993–2015 (observed anomalies relative to mean of 1993-2012)[108]



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[106] Martinez, C., Winckler, P., Contreas, M., and Godoy, E. (2017). Coastal Erosion in central Chile: A new hazard? Ocean and Coastal Management. URL:

[107] Rojas, O. et al. (2018). Flooding in Central Chile: Implications of Tides and Sea Level Increase in the 21st Century. Sustainability 10(12). https://doi.org/10.3390/su10124335. URL: https://www.mdpi.com/2071-1050/10/12/4335/htm

[108] WBG Climate Change Knowledge Portal (CCKP, 2021). Chile. Impacts- Sea Level Rise. URL: https://climateknowledgeportal.worldbank.org/country/chile/impacts-sea-level-rise

Adaptation Options

Chile's coastal zones need to be strengthened through immediate adaptation and mitigation measures to increase its resilience to coastal erosion and sea level rise. Efforts must be made to protect or conserve coastal zones, coastal communities and coastal estuaries in order to increase natural resilience, and protect the country against the high costs of implementing structural measures to protect future residential areas. The 1991 Fisheries and Aquaculture Law forms the foundation of seafood regulation in Chile. Industrial fisheries management has evolved from open access to a framework based on total allowable catch and market-based instruments to allocate and trade quota. However, since the administration of additional biodiversity conservation instruments in Chile has become more complicated with multiple agencies capable of establishing, vetoing, and administering different aspects of ocean and coastal resources. As such, in 2009, the Chilean government initiated environmental policy reforms in order to strengthen the legal frameworks for biodiversity conservation; this also led to the creation of the Ministry of Environment.[109] Chile is committed to extending its Natural Species Protected Areas[110] and has established a roadmap for the creation of the Biodiversity and Protected Areas Service. This institution will be the first to have the power to protect nature inside and outside protected areas through its mandate to use nature-based solutions to help communities and the economy adapt to climate change; however, the primary bill to enact these services has been under debate for the last eight years. Additionally, Chile has yet to commission research for the detailed analysis of erosion processes in key vulnerable zones in central Chile and elsewhere along the coast, where tectonic processes, climate change and human pressures combine.[111] Chile has also seen positive adaption examples through the construction of artificial beaches in Iquique, Tocopilla, and Antofagasta. Outcomes of these examples should be used to support the expansion of future projects on Valparaíso Bay. In Chile's major beach tourism areas, 'beach nourishment' could be a positive practice to reduce areas with high erosion rates and to regenerate spaces for recreation. More research in these areas is necessary to understand challenges, opportunity and costs for such undertakings.

ADAPTATION

Institutional Framework for Adaptation

Chile has been a signatory of the United Nations Framework Convention on Climate Change since 1992, signed and ratified the Kyoto Protocol in 1998 and 2002, ratified the Montreal Protocol in 1990 and, most recently, signed and ratified the Paris Agreement in 2017.[112] At the time of writing, the country is currently developing a long-term climate strategy, updating the Adaptation Plan to Climate Change in the Agricultural and Forestry Sector PANCC SAP), its draft Climate Change Framework Law is currently under discussion in the National Congress, and the Chile National Restoration Plan is currently under public consultation.

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[109] Chile (2018). Chile's Third Biennial Update Report. URL: https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/5769410_Chile-BUR3-1-Chile_3BUR_English.pdf

[110] Squeo, F. et al. (2012). Towards the creation of an integrated system of protected areas in Chile: achievements and challenges. Plant Ecology & Diversity. 5(2). DOI: https://doi.org/10.1080/17550874.2012.679012

[111] Martinez, C., Winckler, P., Contreas, M., and Godoy, E. (2017). Coastal Erosion in central Chile: A new hazard? Ocean and Coastal Management. URL: https://www.researchgate.net/publication/318643085_Coastal_erosion_in_central_Chile_A_new_hazard

[112] Chile (2017). Agenda 2030 Objetivos de Desarrollo Sustentable. Sustainable Development Goal Report, September 2017. URL: www.cl.undp.org/content/dam/chile/docs/ods/undp_cl_ODS_Informe_ODS_Chile_ante_NU_Septiembre2017.pdf

At a national level, the Ministry of the Environment, principally the Climate Change Unit, is the primary entity that engages in climate policy and environmental policy. In 2016, Chile created a Committee of Ministries for Implementation of Sustainable Development, which plays a critical role in guiding the country's environmental agenda. While the Ministry of Environment leads the Committee, it is unable to singularly propose policies, which must be proposed to the President by the Committee.[113] The Committee is composed of the following ministries: International Affairs, Economy, Tourism, Social Development, and Environment.[114] The Ministry of the Environment works with the Ministerial Council for Sustainability who is advised by the Permanent Presidential Advisory Committee. It also forms a consultative council composed of civil society, private and public sector, academia, sector associations, and NGOs. Within the country, regional Climate Change Committees (Comités Regionales de Cambio Climático), which are composed of municipalities, mayors, and ministry representatives, work to promote and facilitate development and implementation of climate change plans and actions at a regional and local level.[115] As part of the National Climate Change Adaptation Plan for Forestry and Farming, Chile established the Red Agroclimática Nacional (RAN), a national agroclimatic network that collects relevant climate information and communicates it with the agricultural sector. The following infographic illustrates how climate change policy is designed and implemented within Chile.

Policy Framework for Adaptation

Chile's Third National Communication to the UNFCCC was finalized in 2016 and Chile submitted its Updated Nationally Determined Contribution in 2020. The National Adaptation Plan is updated every five years and currently includes nine priority areas like hydroelectric resources, health, fishing and agriculture, aquaculture, infrastructure, tourism, energy, and cities.[116] The government has developed climate change adaptation strategies for nine priority sectors: agriculture and forestry, fishing and aquaculture, health, energy, and disaster risk management, and is in the process of mandating climate change strategies for all sectors and is producing plans for climate change adaptation in cities and developing an energy adaptation plan. In addition to government agencies, Chile has an active civil society working on climate change, including climate change adaptation.[117]

[113] Ministerio del Medio Ambiente (2015). Consejo de Ministros para la Sustentabilidad. URL: http://areasprotegidas.mma.gob.cl/consejo-de-ministros-para-la-sustentabilidad/#:~:text=Home%20%2F%20Consejo%20de%20Ministros%20para%20la%20Sustentabilidad&text=Proponer%20al%20Presidente%20de%20la,de%20los%20recursos%20naturales%20renovables

[114] Chile (2015). La Gobernanza del Cambio Climático. URL: http://www.cr2.cl/wp-content/uploads/2018/03/Gobernanza_CambioClimatico.pdf

[115] Chile (2017). Agenda 2030 Objetivos de Desarrollo Sustentable. Sustainable Development Goal Report, September 2017. URL: www.cl.undp.org/content/dam/chile/docs/ods/undp_cl_ODS_Informe_ODS_Chile_ante_NU_Septiembre2017.pdf

[116] Chile (2017). Agenda 2030 Objetivos de Desarrollo Sustentable. Sustainable Development Goal Report, September 2017. URL: www.cl.undp.org/content/dam/chile/docs/ods/undp_cl_ODS_Informe_ODS_Chile_ante_NU_Septiembre2017.pdf

[117] Chile (2013). Plan de Adaptacion al Cambio Climatico del Sector. URL: https://www.scribd.com/document/176284308/Plan-Adaptacion-CC-S-Silvoagropecuario

National Frameworks and Plans

- Updated Nationally Determined Contribution (2020)
- National Action Plan on Climate Change 2008–2012
- National Action Plan on Climate Change 2017–2022 (Spanish)
- National Climate Change Adaptation Plan, 2014
- National Strategy for Climate Change and Vegetative Resources 2017–2025
- National Energy Strategy 2012–2030
- National Strategy for Disaster Risk Management 2015–2018 (Spanish)
- First National Communication, 1999
- Second National Communication, 2011
- Third National Communication, 2016
- Nationally Determined Contribution, 2016
- Second Biennial Update Report, 2016

Recommendations

Research Gaps

- Continue to invest in the development, collaboration and expansion of regional forecasts and models catered to Chile's unique physical and climatic conditions across the Pacific Alliance[118]
- Improve awareness of Chile's unique vulnerabilities and exposure to climate risks through targeted research efforts for improved adaptation and resilience efforts
- Need to increase number of experts and resources with climate change adaptation specific knowledge at a national and regional level
- Lacking knowledge of Ecosystem-based Adaptation and Ecosystem-based Disaster Risk Reduction (Eco-DRR) and other techniques that enable the implementation of these projects[119]

[118] World Bank (2020). Modelación y análisis de riesgos catastróficos para la Alianza del Pacífico (Chile, Colombia, Perú, México). Base de Datos sobre eventos históricos de origen hidrometeorológico. (Unpublished)
[119] Chile (2018). Chile's Third Biennial Update Report. URL: https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/5769410_Chile-BUR3-1-Chile_3BUR_English.pdf

Data and Information Gaps

- Update existing climate risk and needs assessments for key sectors such as, health, food security, water resources, and renewable energy to ensure these compliment the country's green growth opportunities and mitigation efforts[120]
- Continue to increase awareness and access to Chile's observation and monitoring networks, produced by ONEMI, in particular its early warning and alert systems[121]
- Strengthen management models, and data, in forest wildfire prevention and restoration of burned areas. Forestry efforts can be further strengthened through social validation based on participatory processes with local communities, indigenous peoples and vulnerable groups, including a gender perspective; and the strengthening of a public institution that is in line with the strategic importance of the forest sector[122]

Institutional Gaps

- Need for the continued development and alignment of policies across and between key sectors to better support strategic planning, adaptation, mitigation efforts as well as to attract climate co-benefits
- Need for enhanced international cooperation in early warning and monitoring systems for ENSO and other regionally relevant systems through the Pacific Alliance
- Increase experience in disaster risk management across sector in order to better incorporate climate and disaster preparedness
- Need to increase the number of permanent professionals on technical teams requiring hiring of external consulting as well as lack of capacity
- Improve the technical knowledge to submit proposals for funding for adaptation

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CLIMATE RISK COUNTRY PROFILE

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