Roadmap for Infrastructure Resilience in the Republic of Chile

Government of Chile

Gobierno de Chile

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In collaboration with:

UNDRR
UN Office for Disaster Risk Reduction

CDRI
Coalition for Disaster Resilient Infrastructure

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ABBREVIATIONS AND ACRONYMS

ANDESS	National Association of Sanitary Service Companies (Asociación Nacional de Empresas de Servicios Sanitarios)
APR	Rural Drinking Water Program (Agua Potable Rural)
ASE	Agency for Energy Sustainability (Agencia de Sostenibilidad Energética)
CCA	Climate Change Adaptation
CMF	Financial Market Commission (Comisión para el Mercado Financiero)
CDRI	Coalition for Disaster Resilient Infrastructure
CEN	National Electricity Coordinator (Coordinador Eléctrico Nacional)
CNE	National Energy Commission (Comisión Nacional de Energía)
CNR	National Risk Commission (Comisión Nacional de Riesgo)
COGRID	Disaster Risk Management Committees (Comité Nacional para la Gestión del Riesgo de Desastres)
DGA	General Water Directorate (Dirección General de Aguas)
DOH	Hydraulic Works Directorate (Dirección de Obras Hidráulicas)
DRR	Disaster Risk Reduction
DIPRES	Budget Directorate (Dirección de Presupuestos)
ECLAC	Economic Commission for Latin America and the Caribbean
GAR	United Nations Global Assessment Report on Disaster Risk Reduction
GDP	Gross Domestic Product
GORE	Regional Government (Gobierno Regional)
ICSI	Coalition for Sustainable Infrastructure
ICT	Information and Communication Technologies
LMCC	Framework Law on Climate Change (Ley Marco de Cambio Climático)
MH	Ministry of Finance (Ministerio de Hacienda)
MINVU	Ministry of Housing and Urban Development (Ministerio de Vivienda y Urbanismo)
MOP	Ministry of Public Works (Ministerio de Obras Públicas)
MRV	Monitoring, Reporting and Verification (Monitoreo, Reporte y Verificación)
MTT	Ministry of Transport and Telecommunications (Ministerio de Transportes y Telecomunicaciones)
MINDEF	Ministry of National Defense (Ministerio de Defensa Nacional)
MIDESO	Ministry of Social Development and Family (Ministerio de Desarrollo Social y Familia)
MMA	Ministry of the Environment (Ministerio del Medio Ambiente)
MINEDUC	Ministry of Education (Ministerio de Educación)
MINEN	Ministry of Energy (Ministerio de Energía)
MINREL	Ministry of Foreign Affairs (Ministerio de Relaciones Exteriores)
MINSAL	Ministry of Health (Ministerio de Salud)
ONEMI	National Emergency Office of the Ministry of the Interior (Oficina Nacional de Emergencia del Ministeio del Interior)
OUA	Water Users' Organizations (Organizaciones de Usuarios de Agua)
PERHC	Strategic Water Resource Management Plans for Watersheds (Planes Estratégicos de Recursos Hídricos de Cuencas)
PNOT	National Territorial Planning Policy (Política Nacional de Ordenamiento Territorial)
PNRRD	National Policy for Disaster Risk Reduction)
RRD	Redución del Riesgo de Desastres (Disaster Risk Reduction (Política Nacional para la Reducción del Riesgo de Desastres)
SEC	Superintendence of Electricity and Fuels (Superintendencia de Electricidad y Combustibles)
SENAPRED	National Service for Disaster Prevention and Response (Servicio Nacional de Prevención y Respuesta ante Desastres)
SINAPRED	National Disaster Prevention and Response System (Sistema Nacional de Prevención y Respuesta ante Desastres)
SISS	Superintendence of Sanitary Services (Superintendencia de Servicios Sanitarios)
SNAIPCCC	National System for Access to Information and Citizen Participation on Climate Change (Sistema Nacional de Acceso a la Información y Participación Ciudadana sobre el Cambio Climático)
SNCAE	National Environmental Certification System for Educational Establishments (Sistema Nacional de Certificación Ambiental de Establecimientos Educacionales)
SSD	Decision Support System (Sistema de Soporte de Decisiones)
SUBDERE	Undersecretariat of Regional and Administrative Development (Subsecretaría de Desarrollo Regional y Administrativo)
SUBTEL	Undersecretariat of Telecommunications (Subsecretaría de Telecomunicaciones)

UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNOSAT	United Nations Satellite Centre
WSD	Water Scarcity Decree

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EXECUTIVE SUMMARY

The United Nations Office for Disaster Risk Reduction (UNDRR) Principles for Resilient Infrastructure[1] promote **robust and adaptive governance to increase resilience in infrastructure**, which stresses continuous collaboration between government, private and community sectors. **The UNDRR and Coalition for Disaster Resilient Infrastructure (CDRI) Global Methodology for Infrastructure Resilience Review** [2] builds on these principles **to assess resilience governance in critical infrastructure services by considering their actors, policies, vulnerabilities, and practices.** It aims to identify and prioritize strategies to improve resilience in infrastructure.

This report presents and discusses the results of the study "Roadmap for Infrastructure Resilience in the Republic of Chile", the result of the **implementation of this methodology in Chile.** The study involved analysis of documents and secondary information, as well as participatory processes through workshops with sectoral stakeholders. This study provides a better understanding of the country's challenges, opportunities and gaps to move towards a resilient infrastructure. The document consists of **three sections**: the first two provide an **analysis of infrastructure risks and vulnerability, and of the regulations, institutions, and governance mechanisms that oversee its operation**. On this basis, the third section summarizes the main **gaps, opportunities and priorities for moving towards a more resilient infrastructure**, and provides an implementation plan.

Chile has a strong and growing economy, housing just under 20 million people and a territory stretching from the tropics to Antarctica, which is supported by an important network of infrastructure for water and energy supply, transportation and telecommunications, as well as for the provision of essential services such as health and education. This infrastructure, however, is **exposed to many hazards**, including earthquakes, floods, tsunamis, droughts and fires, some of which are influenced by the current climate change conditions and are made more complex by the **diversity** of geographical and socioeconomic conditions in the country. In this regard, the Report shows, on the one hand, a characterization of the risk profile of the national infrastructure, identifying how, despite the historical importance of earthquakes, **hydroclimatic hazards, and especially droughts**

[1] *https://www.undrr.org/publication/principles-resilient-infrastructure*
[2] *https://www.undrr.org/publication/global-methodology-infrastructure-resilience-review*

and fires, have become increasingly relevant for Chilean infrastructure. It also shows an overview of the **exposure** conditions of infrastructure, distinguishing between its direct economic value and the critical functions it plays, as well as its **vulnerability**, highlighting how the incidence and impact of different **hazards significantly vary from one region to another,** with specific infrastructure sectors more susceptible to certain types of hazards depending on their geographic location and function.

An examination of the interactions that exist between infrastructure functions is also included, showing how these, in some sectors (such as water, for example), **lead to an increase in the risk to which the infrastructure is exposed**, while in others (such as energy) **they may lead to an increase in the impact in the event of the interruption of a function.**

More precisely, as observed, the **water sector** infrastructure is the one currently facing the highest degree of risk, especially due to the drought threatening the central and southern areas of the country, which in the north is complemented by floods and water shortages. Furthermore, water supply is highly dependent on the functioning of other key infrastructure systems (such as energy or transportation), while it can also cause service interruptions for the **education and health sectors**. These, in turn, face risks from a variety of hazards. On the other hand, in the **energy sector,** infrastructure faces significant risks from both earthquakes and the increasing frequency of droughts, especially in the central and northern part of the country, which also have the potential to generate strong cascading impacts on the supply of other crucial functions. Finally, **road and telecommunications connectivity** at the national level is affected by possible fires, floods and landslides, as well as by earthquakes, which may contribute to the disruption of the logistics network necessary for the above functions.

In contrast to this vulnerability, Chile stands out for a **significant degree of progress and proactivity in building an institutional framework** that incorporates resilience and adaptation to climate change and Disaster Risk Reduction (DRR). The recent amendment establishing the new **National System for Disaster Prevention and Response, SINAPRED**, (and the corresponding National Service, or SENAPRED, as its coordinating entity) seeks to advance in **strengthening governance by offering a systemic vision for risk management**. The reform gives **greater relevance to disaster risk prevention**, as it complements the approach previously focused more on emergency response, and builds a **multilevel and multisectoral institutional framework** that aims to promote greater coordination capacity and a more proactive and effective response to critical events.

In addition, the **Framework Law on Climate Change (LMCC)**, as well as the reform of the National Land Use Planning Policy, and the various policies implemented by the Ministry of Public Works (MOP), the Ministry of Housing and Urban Development (MINVU) and other sectoral authorities are moving in the same direction, by **adding new instruments and capacities for risk prevention**, and also contributing to the promotion of coordination between public and private actors. Likewise, these policy and legislative reforms strengthen the incorporation of **information systems** on hazards and disasters in territorial planning, and the LMCC in particular focuses on **promoting long-term planning that considers different climate scenarios** as part of the design of infrastructure. However, it is important to consider that these are still recent changes, so there are still important challenges for their effective implementation, especially due to the existing **fragmentation and scarce coordination of infrastructure policies and competencies among different sectors and autonomous institutions**. Moreover, the **weight of the private sector** as owner or operator of many critical infrastructures, **reduced oversight capacities, disparities in information and insufficient financing** for disaster risk reduction are additional challenges that must be faced in the coming years to ensure timely and effective implementation of these reforms.

Looking deeper into these general trends, there is **heterogeneity among the different sectors in their performance with respect to the Resilient Infrastructure Principles**: all show progress, but each sector shows weaknesses in at least some of the Principles. The Transport and Energy sectors, followed by Health, have a generally higher degree of performance, although with gaps to be addressed. It is noted that **all sectors must progress more effectively** in resilience literacy, community participation, collaborative management, and in providing information on risk and cost-effectiveness of disaster risk reduction actions. There is also a **significant challenge in the concrete implementation of actions**, partly due to the incipient nature of the new regulation and gaps in regulatory and oversight capacities.

On this basis, **specific gaps and opportunities are identified for each sector**, together with an **action plan** for the short, medium and long term. In general terms, a **cross-cutting priority** is identified **as continuing to improve intersectoral coordination and strengthening the SINAPRED system to build more effective governance to promote infrastructure resilience**. Specifically, this is grounded in **five priority lines of action**: a) Enactment, revision or enhancement of **policies, laws and regulations** that incorporate mandatory risk analysis in infrastructure planning and investment, and set follow-up mechanisms to ensure compliance; b) Establishment of more effective **cross-sectoral governance and coordination mechanisms**, including specific requirements for the integration of different spheres and levels of government in development plans; c) Enhance the **availability and accessibility of risk data**, through the creation of interactive platforms and the promotion of information exchange between public and private institutions; d) Develop **human and institutional capacities** in disaster risk reduction and resilience, with continuous training programs and unified protocols for emergency response; e) Promote **infrastructure projects** aimed at closing gaps identified in vulnerability analyses, prioritizing those that strengthen resilience in essential areas and priority sectors. In Chapter IV, the Report presents an implementation proposal to advance in resilient infrastructure, with **specific actions to be taken in the short, medium and long term** to achieve these guidelines, in a cross-cutting manner and within each sector.

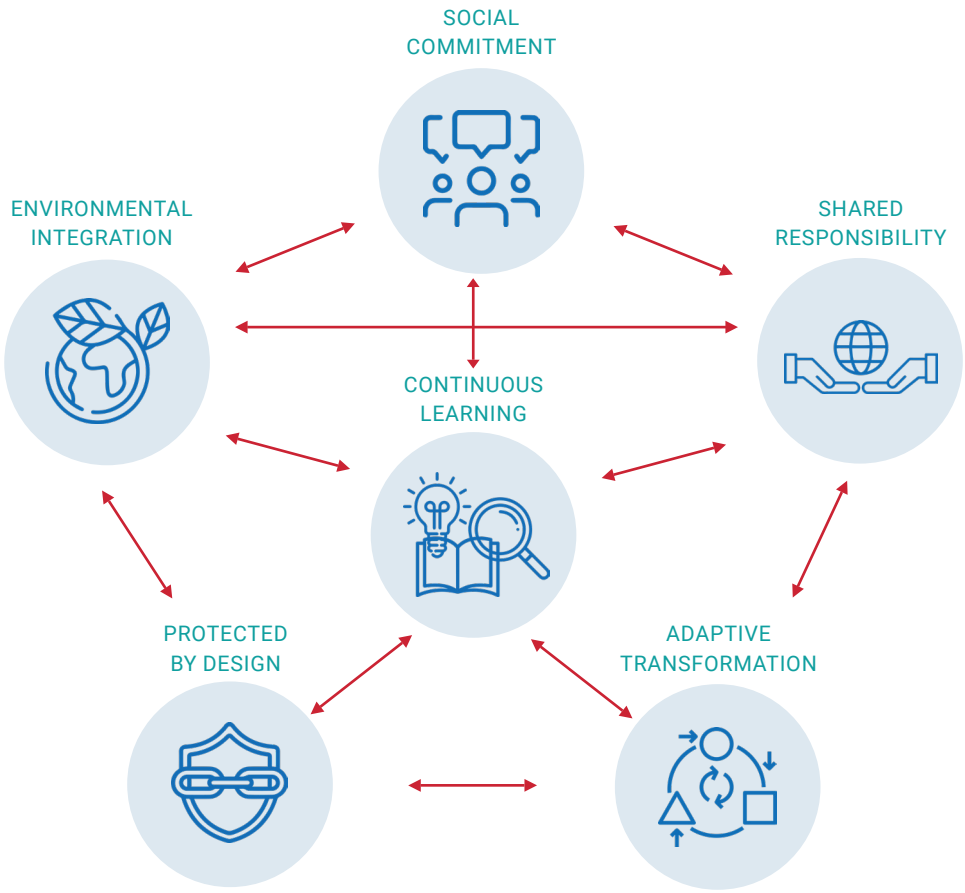
The document ends with a reflection on some **cross-cutting considerations** and possible **immediate actions** to advance in setting in motion the implementation plan outlined in the previous chapters, such as: (i) the institutionalization of the intersectoral group for critical infrastructure resilience, which was installed as part of this study; (ii) the elaboration of a regional deep-dive that complements the analysis and allows identifying gaps and proposing initiatives to improve the governance of resilient infrastructure on a territorial scale, considering the heterogeneity of the country; and (iii) the collaborative design and piloting of an integrated data center and evaluation/monitoring system for risk management and decision making (*Decision Support Tools*, DST) for resilience.

PART I.
INTRODUCTION

In an ever-changing world, where multiple and constant natural and man-made hazards threaten the stability and security of our societies, it has become imperative to **adopt proactive actions to reduce the risk of disasters**. According to data from the United Nations Office for Disaster Risk Reduction (UNDRR), between 2020 and 2021, **363,184 interruptions in the provision of basic services** (such as education and health) were reported in 44 countries due to disasters, showing the direct impact of the lack of resilient infrastructure. Furthermore, economic losses related to infrastructure disruption in low- and middle-income countries are estimated to be between **USD 391 billion and USD 647 billion** annually[3] and it has been estimated that economic losses resulting from disasters increased by **151% between 2000 and 2019**, highlighting the urgent need to strengthen infrastructure in all sectors .

In this sense, **building resilient infrastructure is a fundamental component of this effort,** as it ensures the continuous and reliable supply of essential functions for the development of human and productive activities. A resilient infrastructure requires **adequate governance**, i.e., the existence of regulatory, management, information and capacity conditions to carry out essential tasks to promote resilience. In order to move this forward, UNDRR has developed six Resilient Infrastructure Principles (**Figure 1**), aligned with the Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction 2015-2030 and other international guidelines, such as the G20 Principles for Investing in Quality Infrastructure.

FIGURE 1. PRINCIPLES OF RESILIENT INFRASTRUCTURE



[3] Sources: UNDRR (2023). "Resilient Infrastructure: Mapping resilience for sustainable development goals" y UNDRR (2022). "Global Assessment Report on Disaster Risk Reduction")
[4] Sources: UNDRR. GAR Special Report 2023: Mapping resilience for the Sustainable Development Goals.

The Principles cover the entire lifecycle of infrastructure-planning, design, construction, operation, and decommissioning-and seek to ensure the continuity of critical services in all phases of risk management: readiness, absorption, recovery, and adaptation. **Their objective is to assess national capacities to maintain critical services, promote the resilience of critical infrastructure and carry out interventions to improve it.**

In order to assess compliance with these conditions, identify gaps and provide guidelines for implementing these principles, UNDRR and the Coalition for Disaster Resilient Infrastructure (CDRI) developed the Global Methodology for Infrastructure Resilience Review which is framed within the guidelines of the Sendai Framework and the CDRI Work Plan 2020-2022. It aims to **strengthen governance and promote the responsiveness and resilience of infrastructure** to natural hazards, thereby protecting communities, fostering sustainable development and promoting disaster risk reduction.

Chile was chosen as **one of the four pilot countries**[5] to test this methodology due to its particular conditions, both geophysical and socio-political, which place it as a "natural laboratory" to explore solutions that more comprehensively integrate resilience into infrastructure development.

The Americas and the Caribbean region is one of the most exposed to phenomena such as earthquakes, floods, tsunamis and droughts, and its critical infrastructure is particularly vulnerable. In this region, extreme events have caused considerable damage to infrastructure: between 2000 and 2019, **53% of economic losses** associated with disasters came from damage to infrastructure such as energy, transportation and telecommunications (UNDRR, 2023, referred to in note 3). **Chile, particularly**, faces both significant seismic and hydroclimatic risks, as it meets 7 of the 9 conditions of vulnerability to climate change established by the United Nations Framework Convention on Climate Change (UNFCCC). This underscores **the need to strengthen the country's infrastructure to alleviate these impacts**, as has been widely seen in the damage generated by earthquakes and other disasters that have been experienced in recent years in the national territory, as will be discussed in more detail in the rest of this report.

Despite this, **Chile has shown regional leadership in building resilient infrastructure**. The implementation of the National Disaster Prevention and Response System (SINAPRED), along with policies requiring risk analysis for new infrastructure projects, are crucial steps to ensure the continuity of critical services, such as energy and transportation. As will be discussed, these advances in the adaptation of its infrastructure to risks improve the country's resilience, although there are still important gaps and challenges to be solved in order to move towards a genuinely resilient infrastructure in the face of the different threats that beset it in the country.

Having said the above, this project thus has a dual purpose: on the one hand, on the national side, it seeks to **provide inputs to improve the governance of resilient infrastructure in this country**; at the same time, from a more global perspective, it is expected to contribute **to refine and validate the proposed methodology in order to apply it in other territories**.

[5] *Bután, Chile, Madagascar and Tonga*

Methodology

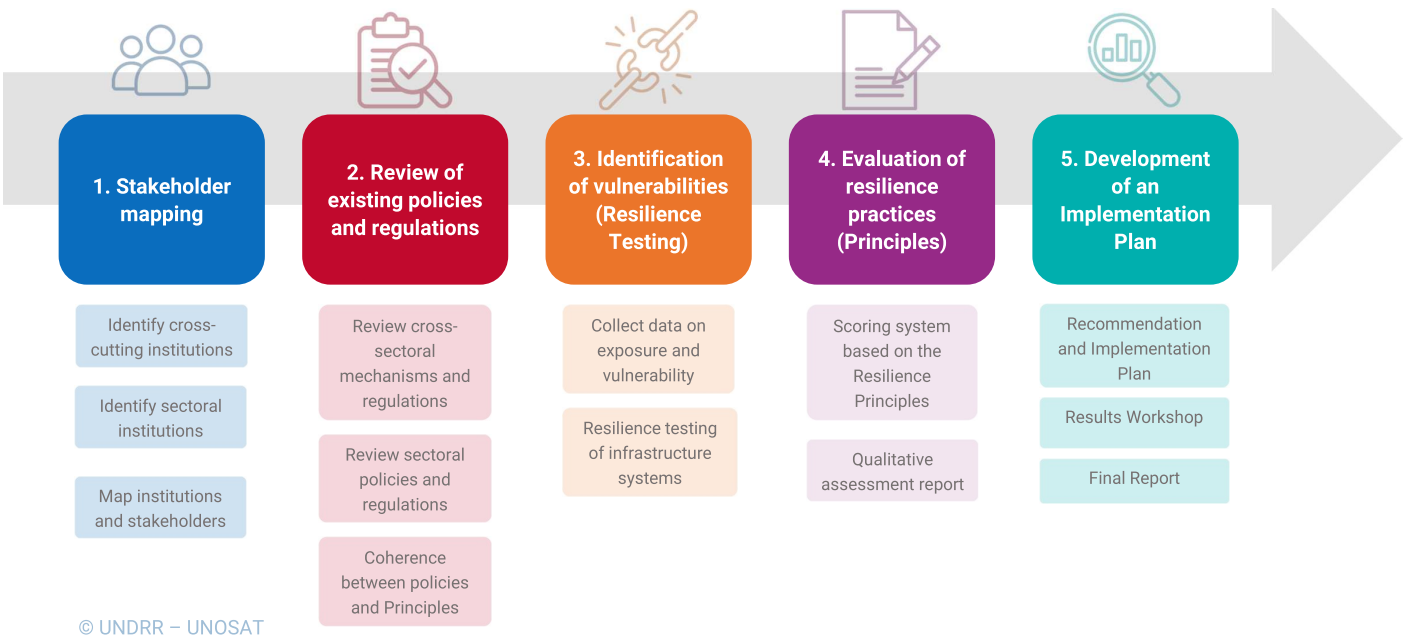
The study, carried out between June 2023 and May 2024, was the result of collaboration between UNDRR, CDRI and SENAPRED and the support of the United Nations Satellite Center (UNOSAT), the Coalition for Sustainable Infrastructure (ICSI) and a local consulting team.

In addition, **the work involved the participation of numerous public institutions**, including the Ministries of Public Works (MOP), Transport and Telecommunications (MTT), Energy (MINEN), Education (MINEDUC), Health (MINSAL), Social Development (MIDESO), Housing and Urban Planning (MINVU), International Relations (MINREL), Finance, Defense and Environment (MMA), as well as the Undersecretary of Telecommunications (SUBTEL).

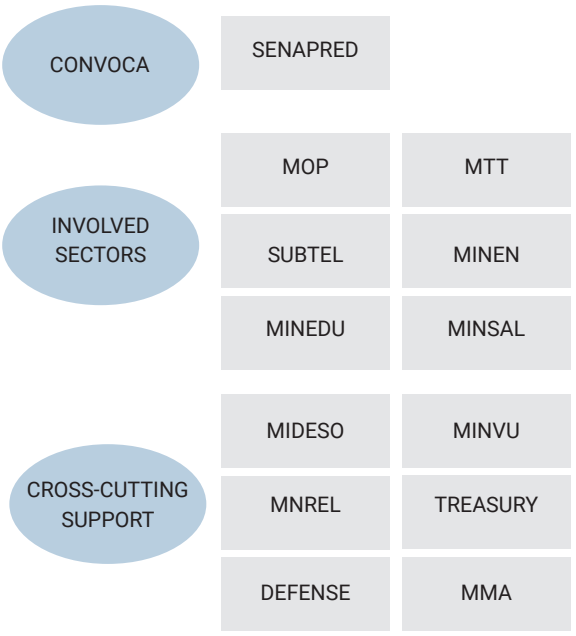
The project, consistent with the global UNDRR/CDRI Methodology, consisted of f**ive steps to analyze the actors, policies and regulations, vulnerabilities and practices relevant to infrastructure resilience governance**. This process included secondary, documentary, and primary information (through questionnaires and participatory workshops). **Six crucial sectors for the country's infrastructure** were considered (water and sanitation, energy, transportation and Information and Communication Technologies (ICTs), health, and education), which were chosen along with SENAPRED (Figure 2).

The **timelines and information** considered in each step are detailed in **Appendix 1**, while Appendix 2 summarizes the main concepts used in the report.

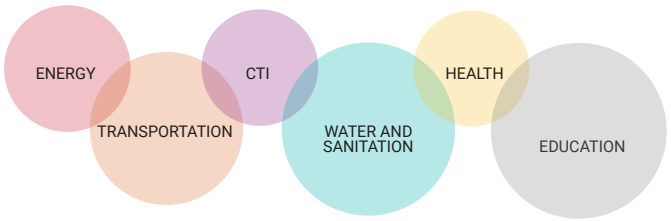
FIGURE 2. STAKEHOLDERS INVOLVED, SECTORS CONSIDERED, AND STEPS OF THE GLOBAL METHODOLOGY APPLIED IN THE PROJECT.



CROSS-SECTORAL WORKING GROUP



SECTORS CONSIDERED BY THE STUDY



DATA SOURCES:

- Secondary data
- Questionnaires and interviews
- Documentary analysis
- Participatory workshops

The results presented in this report correspond to the work of information gathering, workshops and field activities carried out between June 2023 and January 2024. Further developments, additional information or evidence-based updates of the contents of this report may be included in the regional applications of the governance methodology, when pertinent.

Document structure

The main findings of this analysis are presented in t**hree parts: Section II** presents the 'baseline', a characterization of the country's risk profile and the main vulnerabilities related to each of the sectors analyzed, including potential cascading impacts. Subsequently, **section III** describes and evaluates the existing institutional framework in Chile to address these risks, first describing briefly the governance and regulatory framework, as well as the main strengths and gaps of each sector compared to the principles of resilient infrastructure. Finally, **section IV** summarizes the main gaps and opportunities derived from the analysis, and presents a proposed implementation plan to build a more adequate governance to strengthen the resilience of infrastructure in Chile. **Section V** concludes by indicating some key actions that are recommended to be triggered immediately to follow up on the project. At last, the **Appendices** provide additional information on the main concepts used, as well as timelines and methodologies.

PART II.
RISK PROFILE OF INFRASTRUCTURE IN CHILE

This first chapter provides **a general analysis of the risks and vulnerability of Chilean infrastructure to disaster risk. Table 1**[6] shows a brief synthesis of the main results for each of the sectors analyzed, in which three variables are considered:

- **Risk:** measures the likelihood that the sector's critical functions will be affected by natural or technical hazards, classified as "high", "medium" or "low", where the hazard, exposure and vulnerability profiles are characterized for each one.
- **Economic relevance:** evaluates the economic importance of the sector's infrastructure in terms of its impact on productivity and society, associated with how it supports economic development and employment.
- **Interactions and cascading risks:** analyzes how failures in one sector affect others, causing chain effects that can amplify risks and their consequences at the national or regional level, depending on the degree of dependence of the functions on each other. In this case, the degree to which each sector suffers cascading risks from others, or contributes to produce such risks on other sectors, is distinguished.

TABLE 1. SUMMARY OF RISK, ECONOMIC RELEVANCE, AND INTERACTIONS BETWEEN THE SECTORS UNDER STUDY.

SECTOR	RISK	ECONOMIC RELEVANCE	TENDENCY TO SUFFER CASCADING RISKS	TENDENCY TO CAUSE CASCADING RISKS
WATER	High	High	High	High
ENERGY	Medium	High	Medium	High
TRANSPORTATION	Medium	Medium	Low	Medium
ICTS	Low	High	Medium	Medium
HEALTH	High	Medium	High	Low
EDUCATION	Medium	Low	Medium	Low

As shown in Table 1, the two main sectors considered as priorities in the analysis are **water and energy**; the former due to the significant levels of risk it faces, and the latter because of the potential economic impacts generated by its interruption. The main **interactions with the other sectors analyzed and the cascading risks that result from them are also discussed.**

The following sections delve into each of these aspects: first, a synthesis of the main disaster hazards in Chile is presented (II.1); then the exposure of the national infrastructure to hazards and their economic relevance is explained (II.2); then the vulnerability of Chile's infrastructure is discussed (II.3); and finally, an integrated analysis of risk and cascading impacts is given (II.4).

[6] *For risk, economic relevance and cascading impacts, the critical functions analyzed in the 6 sectors under study were grouped and values of risk, impact on the economy and cascading impacts were obtained on a scale of 0 to 1. Those sectors with values higher than 0.7 were considered as high, those with values lower than 0.7 and higher than 0.5 as medium, and those sectors with values lower than 0.5 were considered as low.*

1. Main disaster hazards in Chile

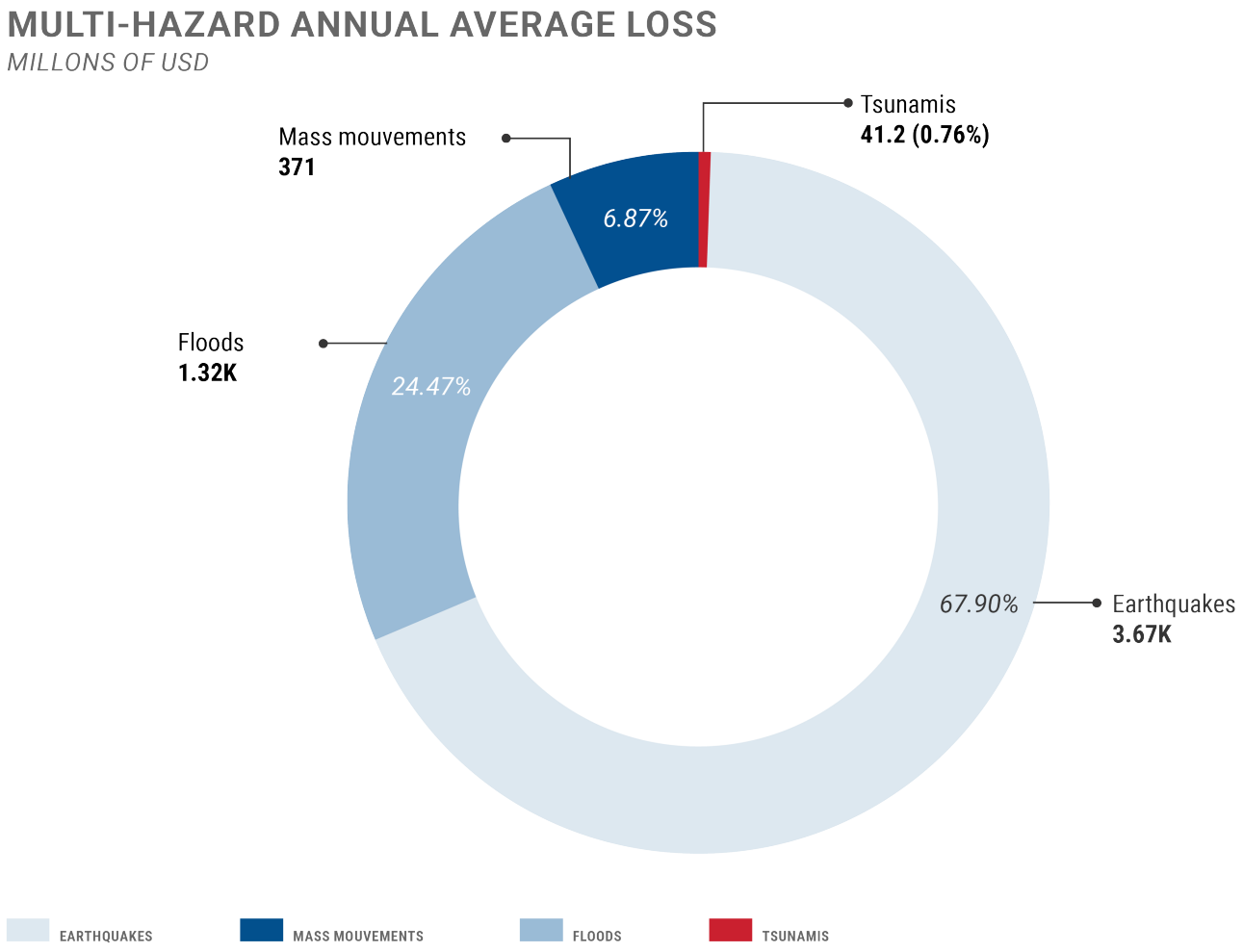
Chile, located between the Nazca Oceanic Plate and the South American Plate, is prone to large **earthquakes.** These events, although relatively infrequent, are highly destructive due to factors such as magnitude, depth and soil characteristics. The situation is even worse when the earthquakes occur in the sea, which increases the probability of causing **tsunamis**. A clear example of this is the Valdivia earthquake and tsunami in 1960, considered the strongest ever recorded, which left 5,700 people dead and caused economic losses estimated at USD 550 million at the time. Despite significant advances in construction techniques, the 2010 earthquake, with a magnitude of 8.8, also caused significant damage, with economic losses of approximately USD 30 billion. Although the number of direct victims was lower compared to the 1960 earthquake, human losses increased considerably due to the tsunami that followed. On the other hand, the country has approximately 60 active volcanoes, mainly in the southern macro zone, which represents another important natural hazard. A recent example is the eruption of the Chaitén volcano in 2008, which forced the evacuation of the city of the same name, disrupted land and air transportation, and caused significant economic damage[7].

Chile's high susceptibility to climate change has also led to a significant increase in hydro-climatic disasters. **Forest fires**, especially concentrated in the Central-South macro-zone, have experienced a significant increase since 2010 and have become the second threat that has required more resources from the State, with an expenditure of close to 42,000 million pesos (approximately USD 50 million). Droughts have also increased in frequency and severity, especially in the central areas, which have experienced a nearly continuous megadrought since 2010. 53% of Chile's territory is considered at high risk of drought, and 23% at high risk of desertification. Additionally, other phenomena such as **landslides, heat waves and floods** also affect predominantly from the Northern macrozone to the Southern macrozone. The latter in particular rank third in the allocation of state resources for disaster response, with more than 3 billion pesos allocated during the 2016-2020 period.

This situation is reflected when looking at the data in terms of the likely impact implied by disasters in economic terms. According to CDRI data, the average annual loss due to disasters in Chile is USD 4.5 billion (equivalent to about 1.5% of the total national GDP), where earthquakes stand out as one of the most relevant events, followed by floods (**Figure 3**).

[7] *Sources: ECLAC. (2010). Terremoto en Chile: Evaluación del impacto socioeconómico del terremoto y tsunami del 27 de febrero de 2010. Comisión Económica para América Latina y el Caribe. Lara, L. E., Moreno, H., & Silva, C. (2013). Volcanic hazard assessment in the Southern Andes. Journal of Volcanology and Geothermal Research, 267, 47-60. https://doi.org/10.1016/j.jvolgeores.2013.08.005 Lomnitz, C. (2004). Major earthquakes of Chile: A historical review, 1535–1960. Seismological Research Letters, 75(3), 368-378. https://doi.org/10.1785/gssrl.75.3.368*

FIGURE 3. AVERAGE ANNUAL LOSS BY HAZARD TYPE. SOURCE: CDRI



On the other hand, in the 2016-2020 period, earthquakes accounted for a significant portion of the resources allocated to state disaster response, with more than 3 billion pesos (USD 3.2 million). However, most of the funds were directed to combat droughts and fires, with 86 billion pesos (USD 91 million) and 42 billion pesos (USD 45 million) allocated, respectively (**Figure 4**).

This highlights the increasing significance of these threats for the country, and it is expected that this situation will worsen even more in the coming years due to climate change.[8]

Based on the above, and also considering the work carried out in the workshops with sectoral stakeholders, **Table 2** shows the priority hazards for infrastructure in Chile (Table 2). Violence, sea level rise, atmospheric pollution, invasive exotic species, and diseases were other threats that were considered, but were later discarded from further analysis due to their limited impact on infrastructure specifically.

[8] *Official data for Chile regarding future projections of climate change and its associated risks can be found at https://arclim.mma.gob.cl/atlas/index/*

FIGURE 4. RESOURCES ALLOCATED BY ONEMI IN RESPONSE TO THE OCCURRENCE OF DIFFERENT HAZARDS

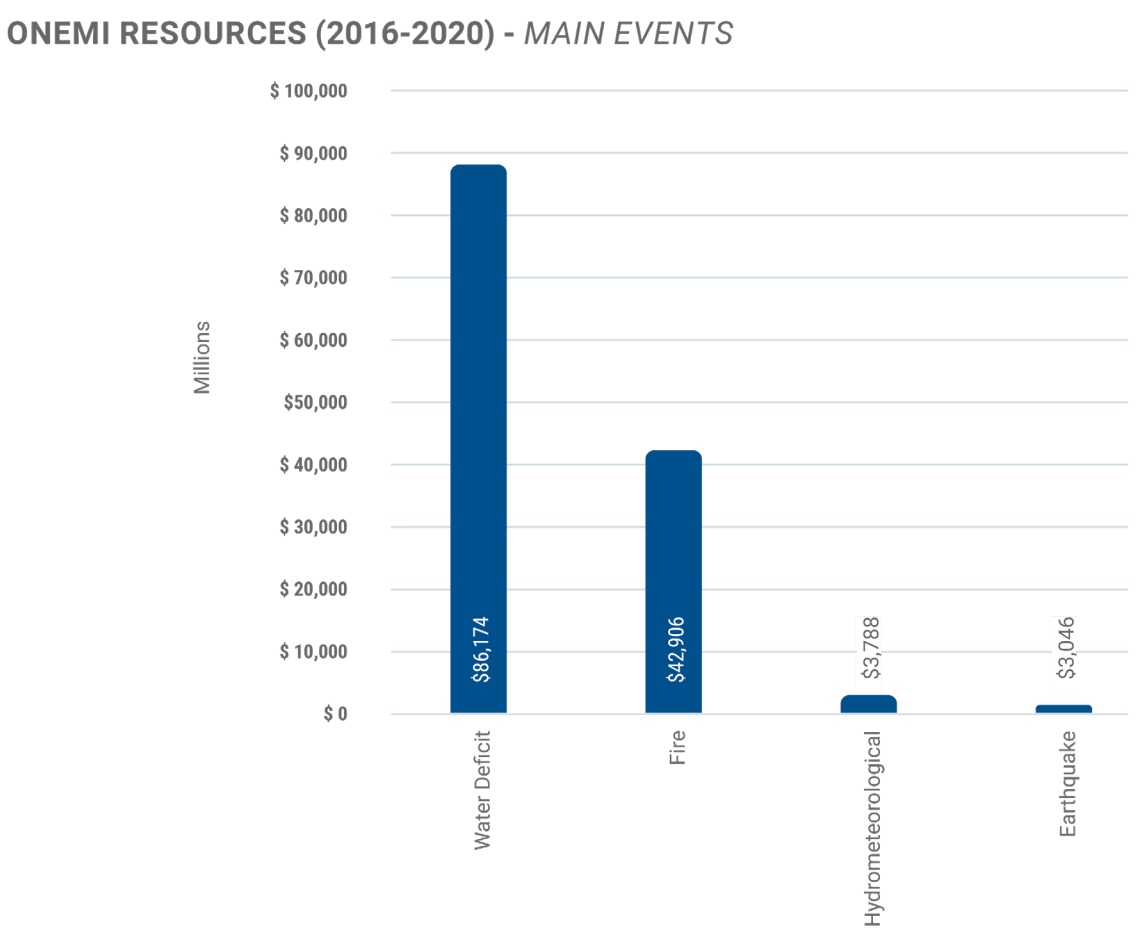


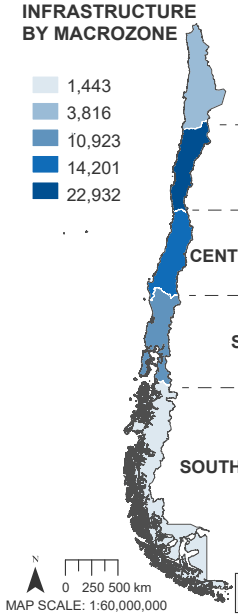
TABLE 2. PRIORITIZATION OF THREATS. DEVELOPED BASED ON DATA ANALYSIS AND WORKSHOP RESULTS.

THREAT	EVENTS	REASON
VERY HIGH	Drought and fires	Frequent, growing trend, high impacts in most sectors
HIGH	Floods and landslides	Potentially very high impacts but on smaller territories or population groups
	Earthquakes and tsunamis	Potentially very destructive and present throughout the country, but there is already good preparedness for them.
AVERAGE	Heat waves	Significant effects on health, but less of a priority on infrastructure
	Tidal waves and volcanic eruptions	Relevant in a more limited geographic area and easier to prevent

Although these data provide a general overview of the country, it is important to consider that Chile is a diverse country in both biophysical and socioeconomic terms. Therefore, **assessing its risks requires a territorial approach**. Due to its diverse geography, climate, and ecosystems, each territory is exposed to unique hazards, which require efforts that consider each local context (**Figure 5**). At the

same time, Chile remains highly centralized in terms of its economy and population distribution, with nearly 40% of the national population and more than 40% of total economic activity concentrated in the Santiago Metropolitan Region alone. This high population concentration has also led to around one third **of the critical infrastructure being located in the central area**. While this creates greater exposure to risk in the central regions of the country, regions farther from the center often exhibit greater vulnerability because there is little redundancy or structural limits to the available infrastructure assets.

FIGURE 5. DISTRIBUTION OF HAZARDS IN MACRO-ZONES OVER THE PERIOD 2000-2023[9]



	Wildfire	Drought	Heat wave	Volcano	Earthquake >4.5M_L	Tsunami	Landslide	Flood
NORTH	439	13	72	0	**248**	1	412	**75**
CENTRAL	32,094	**181**	130	0	73	1	289	54
CENTRE-SOUTH	**81,163**	30	145	2	42	1	**447**	**75**
SOUTHERN	35,854	5	**187**	**7**	5	1	44	56
SOUTHERNMOST	1,211	4	87	0	0	0	403	8
TOTAL	**150,761**	**233**	**621**	**9**	**368**	**4**	**1,595**	**268**

[9] *In response to droughts, Water Scarcity Decree (WSD) were issued, legal instruments enacted by the Chilean Presidency upon technical recommendations from the General Directorate of Water (DGA). They suspend ordinary water regulations and the authority of water management organizations in extremely critical situations. When a territory is subject to the WSD, user organizations are no longer responsible for water distribution, but the State is responsible for enforcing private water rights. Among these powers are the authorization of groundwater use, the construction of wells, and the suspension of ecological flows, to name a few. Storm surges are not included in this presentation, as the available records only cover the period 2008-2017, which does not match the record of the other hazards and could lead to inconsistent analyses.*

2. Exposure: Infrastructure in Chile and its Economic Relevance

Although Chile is a relatively small country with a population of 19.6 million, it is also **one of the strongest and most developed economies in the Latin American region**, as it recorded in 2022 a total GDP of about USD 301 billion and a per capita income of USD 15,638, the highest in Latin America[10]. Chile has an employment rate of 91.7% of the labor force and relatively low poverty rates, even though these increase considerably when multidimensional indicators are considered; there is also a significant difference in this regard between the different regions of the country.

The economic sectors that contribute most to GDP are, in order, financial intermediation (22.4%), personal and community services (18.3%), mining and quarrying (15.9%), trade (11.9%), manufacturing sectors (10.8%), transportation, storage and communications (7.9%). These figures have some nuances that are important to consider. Mining, in addition to its relevance for GDP, is also crucial for the trade balance, but its contribution to employment is rather small, and in recent years its economic and social impacts have been questioned. Conversely, forestry and agriculture have a much smaller weight in terms of GDP (3.9%), although it is a key source of employment in rural areas, with still sustained rates of Family Farming, as well as a relevant engine for the food sector, exports and food security. Similarly, energy generation, transmission, and distribution account for 2.4% of GDP but are essential for sectoral and national services. Health and pharmaceutical companies have also had a growing importance in the country, and health is one of the most important items of public spending, along with social security. An important part of health and education in Chile is privately managed.

One way to understand the economic relevance of infrastructure is to look at its **total monetized value** (Table 3). The transportation sector, among the six sectors considered, has the highest value in this dimension because of its extensive road network that connects the various regions of Chile, with more than 6,619 bridges and one of the longest highways in the world. This infrastructure is essential for the country's mobility and economic development, which justifies its high value in terms of investment and strategic relevance. This is followed by the **health sector**, which has over 4,417 medical centers in the national territory, 925 of which are located in the Metropolitan Region, and many of which have a high cost in terms of construction work. Likewise, the **energy and telecommunications** sectors, which also have an important infrastructure network at national

They are no longer responsible for water distribution; instead, the State is now responsible for enforcing private water rights. This includes authorizing the use of groundwater, approving the construction of wells, and suspending ecological flow rates, among other powers. Storm surges are not included in this presentation, as the available records only cover the period from 2008 to 2017, which does not align with the records of other hazards and could lead to inconsistent analyses.

[10] *Data from UN-ECLAC and World Bank.*

level, such as power generation, transmission and distribution systems, wiring, antennae, internet networks, etc. Both sectors also play a fundamental role in the development of key vital and productive functions, as well as in guaranteeing connectivity and emergency response.

TABLE 3. SECTORS WITH THE HIGHEST ECONOMIC VALUE OF EXPOSED ASSETS. SOURCE: CDRI, 2023.

SECTOR	EXPOSED VALUE (MILLIONS OF DOLLARS)
WATER	17,000
EDUCATION	36,800
HEALTH	274,080
ENERGY	147,100
TRANSPORTATION	345,500
TELECOMMUNICATIONS	109,000

Although the **education and water** sectors show lower figures in these indicators, due to the lower commercial value of the works required in these sectors, they perform functions of great relevance for the health and welfare of the population, and the human and productive development of the country, the interruption of which also presents a high degree of urgency in planning for resilience.

For a better understanding of the above, it is helpful to supplement consideration of the monetized value of infrastructure with an examination of the **critical roles** it plays, both in providing the direct delivery of goods and services and in facilitating the functioning of key economic activities.

In the participatory stakeholder workshops, ten critical infrastructure roles were identified as the most relevant for the country. These are listed in **Table 4**.

TABLE 4. CRITICAL INFRASTRUCTURE ROLES BY SECTOR

INFRASTRUCTURE SECTOR	CRITICAL ROLES IDENTIFIED	DIRECT GOODS AND SERVICES	INDIRECT ECONOMIC RELEVANCE
ENERGY	**Electricity generation**	Consumption of electricity, household appliances, heating, fuel for vehicles, etc. Its interruption has short-term, immediate impacts on electro-dependent people.	Key for multiple economic sectors, such as mining, health, commerce, sector, public administration, etc. Its interruption leads to losses in the absence of backup systems.
	Electricity transmission and distribution		
	Fuel supply		

WATER	**Water distribution and sanitation**	Basic for human health and wellbeing, domestic hygiene, subsistence agriculture, irrigation of gardens and green areas, etc. Access to water of adequate quality and quantity is a human right.	Crucial for agri-food activities, health and education, mining and other sectors. Interrupted or insufficient water supply affects these activities in the absence of storage systems.
ICTS	**Telecommunications**	Communication between people, entertainment, access to information, teleworking, etc. Their interruption causes problems, especially in isolated or difficult to access communities.	Key to the financial sector, commerce, telemedicine, public administration, etc. Their interruption affects logistics and paralyzes activities (e.g. trade, digital services, health, etc.).
TRANSPORTE	**Transportation of goods**	Many people rely on transportation systems to get to work or educational institutions, see beloved ones, access services, and entertainment.	Transportation of goods is key to logistics, associated with several of the items identified. Disruption can lead to delays in activities, loss of inputs, and other economic losses.
	Passenger transportation		
HEALTH	**Provision of health services**	Fundamental for the life and well-being of people. Disruption can result in loss of life.	Indirectly contributes to the functioning of other sectors, such as the food sector.
EDUCATION	**Provision of educational services**	Education is key to the country's development, although disruption for limited periods generates less striking effects than other functions.	Educational infrastructure also serves a secondary role in logistics and administration, e.g. as a shelter or collection center in case of emergency.
	Emergency response services		

Thus, we can say that **all the sectors considered in this study have a very significant relevance for people and the economy.**

3. Vulnerability of infrastructure in Chile

The vulnerability analysis examines both the **structural characteristics** of the infrastructure and the social, territorial, and economic factors that influence its susceptibility and adaptive capacity during disasters. This analysis demands a **territorial approach**, as it takes into account the geographical and socioeconomic characteristics of the country to design measures that promote infrastructure resilience (**Figure 6**).

FIGURE 6. INFRASTRUCTURE VULNERABILITY INDICATORS CLASSIFIED BY REGION

Region	Water Sector		Electricity Sector		ICT Sector		Transportation Sector	Population			
Arica y Parinacota	1.34	100%	19.7	**96.8%**	7.75	59 338	44.9%	20798	9.2%	73 787	32.7%
Tarapacá	1.34	100%	22.25	98.9%	6.6	78 748	41.2%	36 361	11%	102 174	31%
Antofagasta	2.28	100%	17.94	99.4%	7.15	170 883	44.1%	46 173	7.6%	173 303	28.5%
Atacama	**3.49**	100%	20.16	98.8%	7.55	61 437	36.6%	23 466	8.2%	93 732	32.7%
Coquimbo	2.87	**9.95%**	12.85	**97.1%**	7.45	164 315	42.1%	59 849	7.9%	253 874	33.5%
Valparaíso	2.59	**9.43%**	**9.13**	99.6%	8.65	486 077	**15.1%**	119 850	6.6%	593 244	32.7%
Metropolitana	0.86	100%	**8.23**	99.9%	**12.9**	**1 993 514**	**10.3%**	312 964	4.4%	**2 145 103**	**30.2%**
O'Higgins	2.99	**9.99%**	16.62	99.6%	7.55	170 000	40%	64 019	7%	298 696	32.6%
Maule	2.27	**9.96%**	21.18	99.5%	5.9	181 455	52.1%	89 866	8.6%	341 855	32.7%
Ñuble	2.99	**9.99%**	12.24	99.6%	4.7	78 488	72.5%	58 154	12.1%	159 002	33%
Bío-Bío	2.99	100%	12.74	99.7%	7.1	388 750	67.9%	116 760	7.5%	498 622	32.1%
Araucanía	2.89	**9.97%**	27.64	98.8%	5.7	166 393	75.9%	111 038	11.6%	320 253	33.5%
Los Ríos	3.27	100%	19.46	99.2%	5.7	67 512	60.2%	22 705	5.9%	125 496	32.6%
Los Lagos	**4.72**	**9.99%**	15.93	99.4%	5.75	148 255	65.3%	58 010	7%	265 065	32%
Aysén	**6.03**	100%	14.43	**97.2%**	8.65	19 760	74.2%	**4 126**	**4%**	32 493	31.5%
Magallanes	2.15	100%	**8.09**	99.8%	6.35	49 343	67.5%	**5 662**	**3.4%**	50 307	**30.2%**
	Outage rate with respect to the number of customers	*% of urban population with drinking water coverage*	*Average SAIDI (2019-2022)*	*Households that have electricity from the public grid*	*Rate of complaints per 1000 people (2020-2021)*	*Number of fixed internet connections*	*% of road network not paved*	*Poverty*		*Children under 14 and Elderly*	

As shown in the figure, in the **water and sanitation** sector, high vulnerability conditions are observed due to reliance on surface and underground water sources, which have been severely affected by the mega drought. These effects are more pronounced in rural areas, as they affect access to drinking water, irrigation and other needs. In urban areas, supply cuts have been limited thanks to contingency measures taken by the supply companies. Nevertheless, these measures have generated conflicts with rural water users and have prompted the search for new sources, such as desalination plants, which raise environmental and equity concerns.

The **telecommunications** sector is vulnerable to destructive, high-impact threats, such as forest fires and earthquakes Although service is generally stable in urban areas under normal conditions, interruptions are frequent during extreme weather events or earthquakes, while in rural areas, service tends to be less reliable even under normal conditions. This sector is essential to ensure connectivity and communication in social and economic spheres, and its importance increases in emergencies to coordinate responses and assistance.

The **transportation** sector is vulnerable to a variety of hazards, from heavy rainfall and landslide events to earthquakes and volcanic eruptions. In the Valparaíso and Metropolitan regions, the high proportion of paved roads reduces susceptibility to these hazards, making them more reliable for emergency evacuations.

The **power generation** sector is less vulnerable due to the diversity of energy sources available. Power outages in Chile are generally low, but there is a notable heterogeneity between urban and rural territories, and between regions. The regions of La Araucanía and Tarapacá record the highest rates of disruptions.

In the **education and health** sectors, hospital and educational coverage, the quality and modernity of infrastructure, the availability of qualified professionals, and accessibility vary significantly by locality. These conditions are generally poorer in rural areas, peripheral regions, islands, and under-served areas. In addition, the vulnerability of certain demographic groups, such as children under 14 years of age, people over 65 years of age, people with pre-existing diseases and those in poverty, must be considered in the face of various threats.

Regionally, many of the indicators (with the exception of the rate of ICT complaints) **show worse performance outside the Metropolitan Region,** and especially in the southern regions (particularly between Maule and Araucanía), while in the case of power outages the worst performance is in the southern region. It should be noted that the regions of La Araucanía and Tarapacá have higher poverty rates, and about 30% of their population belongs to vulnerable demographic groups, with approximately 20% under 14 years of age and 10% over 65 years of age.

These results are consistent with what emerges from the participatory work with sectoral stakeholders: the stress test workshop demonstrated that, while the country's infrastructure is highly exposed to earthquakes, which is to be expected given Chile's geographic location, vulnerability to these risks is mitigated by Chile's historical preparedness for such events. In contrast, there is a high degree of vulnerability to fires and droughts, especially in the education, electricity, health and water sectors, due to the significant impact of fires and the reduction in the quality of life associated with droughts. As for ICTs and transportation, fires and earthquakes are the main threats, highlighting the potential loss of connectivity and communication that these events can generate. More discussion will be provided in the following section.

4. Integrated risk analysis and cascading impacts

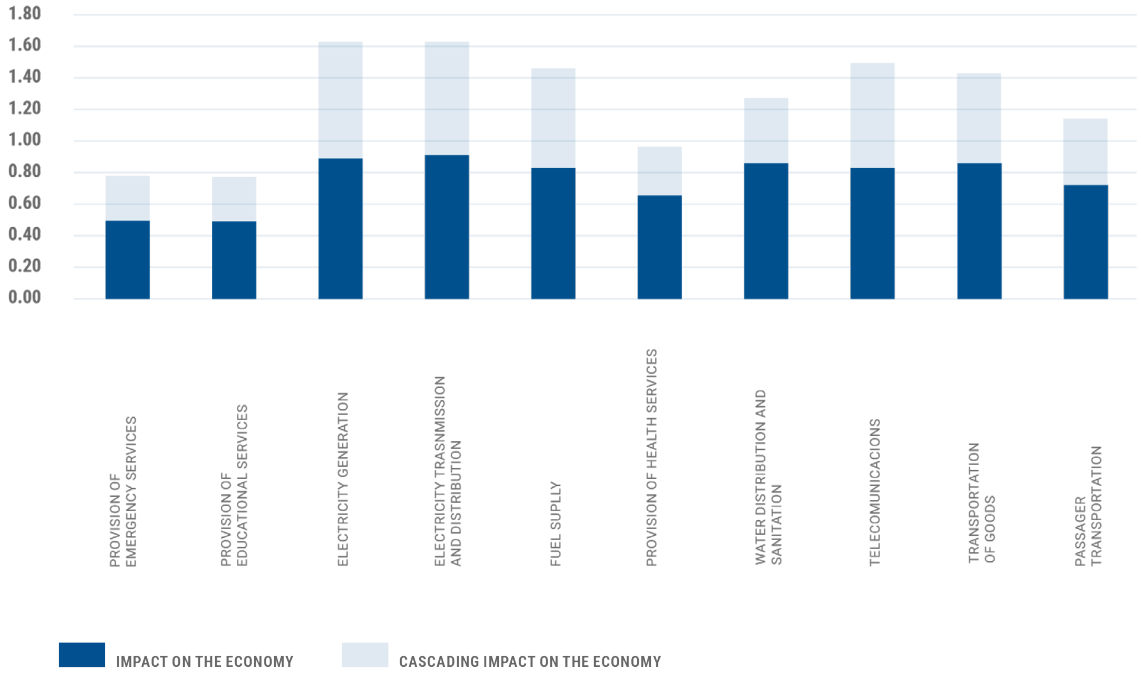
Besides the direct risks that each critical function suffers from the different hazards considered, there are also possible **cascading risks**. Cascading risks arise when there are situations of dependency or interaction between the critical functions of the infrastructure, where the disruption of one function may also affect the proper performance of other functions, in the same sector or others, and trigger a greater impact on the economy.

So as to be able to assess these risks, using the stress test methodology proposed by UNDRR/CDRI in Step 3 of the Global Methodology, the **interactions between critical infrastructure functions were analyzed together with key players in each sector, and two situations were identified**:

- Tendency to **cause** cascading risks: when a critical function is indispensable for other functions, what happens to that critical function may also have repercussions on the functions that depend on it.
- Tendency to **undergo** cascading risks: when a critical function depends on other functions, what affects the latter may also have repercussions on it;

In Chile, **the first situation is typical, among others, of functions related to the generation, transmission and distribution of electricity, transportation of goods, telecommunications and water distribution and sanitation** (Figure 7): Electricity, in fact, is essential for the functioning of most other infrastructures; transportation and telecommunications are essential for connectivity and logistics, both in normal and emergency conditions, and access to water is essential for many of the services offered by the infrastructure, including health services, education, etc. These interactions magnify the level of impact arising from the possible affectation of some of these functions, giving priority to take priority measures to protect these functions and thereby the good performance of the entire system.

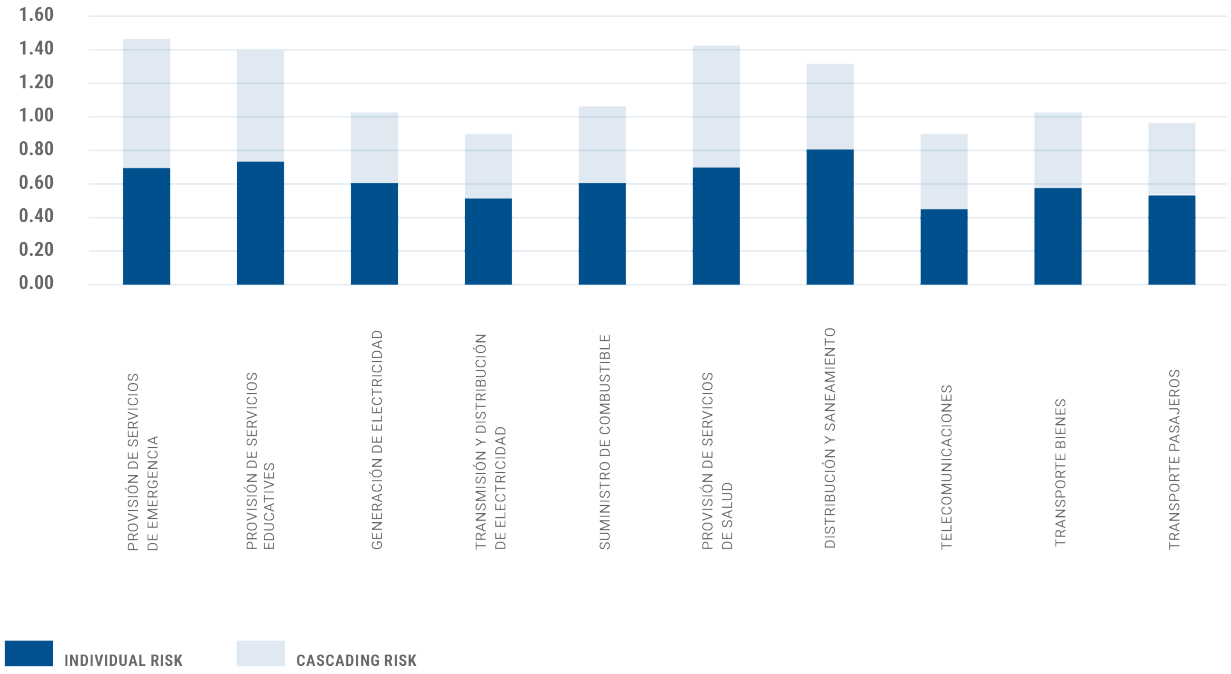
FIGURE 7. POTENTIAL IMPACTS OF THE DISRUPTION OF THE DIFFERENT FUNCTIONS ASSOCIATED WITH THE SECTORS UNDER STUDY ON ECONOMIC ACTIVITY.



On the contrary, **functions such as the provision of emergency, educational and health services, as well as water distribution and sanitation present a high degree of dependence on other functions examined**, which multiplies the level of risk to which they are exposed (**Figure 8**). Here it is worth noting that all these functions already had high levels of risk even when considered individually, which exacerbates the pressure to which they are exposed. The critical importance of education, health, and emergency services in hazard response, as well as the fundamental role of water distribution in sectors like agriculture, underscores the need for a comprehensive, strategic approach to mitigate these risks.

In view of the above, **prevention and response measures should be strengthened in these critical areas to ensure the safety and well-being of the population and sustainable development**.

FIGURE 8: LEVEL OF INDIVIDUAL AND CASCADING RISK TO WHICH THE DIFFERENT FUNCTIONS ASSOCIATED WITH THE SECTORS UNDER STUDY ARE SUBJECT



Given the above, we can also review the potential risks suffered by the different economic items that depend on each critical function, considering both the direct risks they suffer and the cascading risks. From this analysis, metallic metal mining and the construction and real estate sector stand out as those with the highest degree of risk and importance in the national economy[11], followed by food and beverage services, food manufacturing and health. This finding underscores the need to strategically address the risks linked to dependence on water resources, a particularly relevant concern for these sectors. Yet, **all the productive sectors considered, with the sole exception of pharmaceuticals, present significant levels of both risk and economic relevance**. These results emphasize the importance of implementing risk management measures adapted to the specific characteristics and needs of each sector, in order to promote their sustainable development and the resilience of the economy as a whole.

[11] *Construction and real estate play a vital role in employment generation, while mining contributes significantly to the country's Gross Domestic Product.*

PART III.
ASSESSMENT OF THE GOVERNANCE AND PRACTICES OF RESILIENT INFRASTRUCTURE IN CHILE

In this chapter, we proceed to **analyze the challenges, strengths, gaps and priorities in terms of governance and resilience of Chilean infrastructure in the face of disasters**. Chile has yet to develop an integrated regulatory framework for resilient infrastructure, but **there are several legal and institutional bodies that address specific dimensions** of this problem. Next, the main strengths and gaps in these different dimensions of governance are described and evaluated, starting in point **III.1** with a description of the **sectoral regulations** and the governance they define in relation to the processes of planning, design, construction, operation and decommissioning of infrastructure. Additionally, section **III.2** examines cross-sectoral regulations, including the regulatory and institutional framework associated with planning and public finance (**III.2.1**), Disaster Risk Reduction (**III.2.2**), climate change (**III.2.3**), land use planning (**III.2.4**), and management and access to information (**III.2.5**), with emphasis on how these may affect the resilience of the infrastructure.

1. Institutional and legal framework for the infrastructure sector

In Chile, the **functions of infrastructure regulation and planning are distributed among different sectoral ministries** (Energy, Transportation and Telecommunications, Defense, Education, Health, and Public Works, among others). Each has established its own legislative and institutional bodies, processes, and structures for the definition of goals and policies, norms and standards, management mechanisms, financing and monitoring of infrastructure works. In some sectors, there is even evidence of the co-participation of more than one ministry or state service in the management of different infrastructure works, or different stages of their life cycle, in which the case of the water sector stands out due to a high degree of fragmentation and multiplication of governance processes, which creates recognized challenges in terms of coordination and implementation of comprehensive policies (e.g. the General Water Management (DGA) and the Superintendency of Sanitation Services (SISS) play crucial roles, but their functions tend to overlap in some areas).

All sectors have made progress in regulations, policies and institutional developments that increase the resilience of infrastructure. However, **each sector has moved forward to different degrees and in different ways. Significant coordination, planning and implementation challenges remain.**

This scenario is reflected in **Table 5**, which summarizes the progress and challenges in different sectors. In energy, for example, the sector Ministry has implemented the Energy Policy 2050 and

the Tariff Equity Law, but still needs greater cross-sectoral coordination to ensure resilience of energy supply. In transportation, the Ministry of Transportation and Telecommunications has made progress with Law No. 21,364, but regulatory plans need to be updated to improve planning and coordination of transportation projects.

TABLE 5. KEY ACTORS, PROGRESS AND CHALLENGES ASSOCIATED WITH INFRASTRUCTURE GOVERNANCE IN DIFFERENT SECTORS

SECTOR	REGULATORY BODIES	OWNERS AND OPERATORS	SIGNIFICANT PROGRESS	REMAINING CHALLENGES
WATER	Ministry of Public Works, General Directorate of Water, Superintendency of Sanitation Services	Private (sanitation companies) in urban areas and local associations (through the Rural Drinking Water Program, APR) or State (MOP) in rural areas.	Legislative reforms have been implemented to improve water management, such as the Strategic Plans for Water Resources in Basins.	There is still a lack of coordination and effective planning to ensure infrastructure resilience.
ENERGY	Ministry of Energy	There are generation, transmission and distribution companies that may be owned by the State or by private companies, but much of the infrastructure is private.	It has been a pioneer in implementing disaster risk reduction (DRR) strategies, with initiatives such as the Energy Policy for 2050 and the Tariff Equity Law.	Greater cross-sectoral coordination is required to ensure resilience of energy supply.
TRANSPORTATION	Ministry of Transportation and Telecommunications	Infrastructure is often owned by the state or state-owned enterprises, but operators are often private.	Efforts have been made to develop policies and regulations that promote infrastructure resilience, such as Law No. 21,364 establishing SINAPRED[12].	The need to update regulatory plans to improve planning and coordination of transportation projects is identified.
ICTS	Ministry of Transportation and Telecommunications, Undersecretariat of Telecommunications	All of the sector's infrastructure assets correspond to private entities, and the operators are also private.	It has taken proactive measures to strengthen the resilience of critical infrastructure, such as the implementation of an Emergency Communications Network and the strengthening of the Emergency Alert System.	Further cooperation between the government and companies in the sector is still required.
HEALTH	Ministry of Health	There are public, private and subsidized private facilities and operators.	They lack specific policies to promote infrastructure resilience. Nevertheless, although steps are being taken to integrate disaster risk management into planning, there is still work to be done to ensure the safety and continuity of services.	
EDUCATION	Ministry of Education	There is one public and one private health system, and some assets operate under public-private concessions.		

[12] *https://www.bcn.cl/leychile/navegar?idNorma=1163423*

In terms of infrastructure planning, implementation and management, the historical r**egulatory dispersion** continues to limit coordination capabilities. While in recent years there has been an attempt to move towards an intersectoral approach in these matters (discussed in more detail in III.2), many of the key aspects of infrastructure associated with energy, telecommunications, transportation, education, health, water and sanitation continue to be regulated, coordinated and **operated in a partially autonomous manner** according to the specific legislative bodies of each sector, each of which defines a different set of rules, institutions and policies, which limits the capacity for intersectoral articulation.

Indeed, even within each sector (especially in the water sector), we observe a **fragmented governance,** with multiple public and private stakeholders, as it often operates in a disjointed manner on different parts of the infrastructure services provided without an integrative view (allowing, for example, to capture chain risks and interactions). Also, **definitions** of "resilient infrastructure" and even what is meant by critical infrastructure can vary significantly between sectors, reducing clarity on the scope of policies and regulations and the possibilities for joint work.

Furthermore, the relationship between the Public Administration and the Private Sector in the management of infrastructure must be taken into account. Currently, in most of the sectors evaluated, **a significant portion of the infrastructure is privately owned or operated under a system of concessions**. This is not a fortuitous fact, but the result of specific public policies implemented by Chile which, since the 1980s, have favored processes of privatization of infrastructure and economic services of general interest in areas that were formerly managed by the State.

In this context, a series of provisions and mechanisms were also generated and implemented that restricted the State's capacity to intervene in the operation of these markets, in line with the neoliberal management logic adopted in the country during that period. Despite the fact that in recent decades there has been a shift towards greater public regulation, especially with regard to critical infrastructure, many of the regulations introduced during that period remain in force, which l**imits effectively the State's capacity to exercise effective regulation or comprehensive political leadership over the state, development and operation of infrastructure**. Added to this is the persistent gap in terms of technical and personnel capacities in public institutions, as well as the extension and, at times, difficult accessibility to the national territory, which restricts the capacity for oversight and, ultimately, reduces the effectiveness of regulations. These limitations hinder the capacity to systematically advance towards a more resilient infrastructure.

Beyond these general considerations, there is **notable variability and fragmentation in the degree of progress**. Indeed, **many sectors have made progress in developing and implementing standards and policies**. In the **ICT** sector, for example, the Undersecretariat of Telecommunications has set up an Emergency Communications Network and has strengthened the Emergency Alert System, although greater cooperation between the government and companies in the sector is still needed to make the implementation of these initiatives effective. In the **water** sector, there is a lack of effective planning and coordination to ensure infrastructure resilience and to incorporate an integrated and long-term vision. Recently, significant legislative reforms have been enacted, such as the Strategic Plans for Water Resources in Basins, which could allow progress in this direction, but they are

still at a very early stage of design and lack a robust institutional framework that could allow their implementation. In the **energy** field, there are also policies that have sought to promote progress towards a more complete, integrative and coordinated institutional framework and governance, with a long-term approach. However, other sectors and areas - such as education and health, for example - remain more separated in their management. This uneven progress reflects both the diversity of challenges specific to each sector and the variability in institutional capacity and resource availability.

On the other hand, **these differences have begun to become more nuanced** in recent years in tandem with the strengthening of cross-sectoral regulations, which are discussed in more detail in the following section.

2. Intersectoral institutional and legal framework for infrastructure

2.1 PLANNING AND PUBLIC FINANCE

Although, as indicated in the previous section, infrastructure planning, design, construction, operation and decommissioning processes are generally handled according to each sector's own regulatory and institutional frameworks, there are cross-cutting institutions such as the MOP, MINVU and MIDESO. These cross-cutting institutions support integration efforts by promoting common standards and oversight, as well as coordination mechanisms that have the potential to help articulate and bring greater coherence to the different sectors.

The progress led in recent years by the MOP in establishing regulations and policies, such as the Infrastructure Master Plan for 2010-2025 or the Plan for Adaptation and Mitigation of Infrastructure Services to Climate Change for the period 2017-2022 (currently being updated) that seeks to strengthen the resilience of infrastructure, is particularly important to highlight. However, the jurisdiction of this Ministry varies from case to case, depending on the type of project and the legal provisions applicable to each sector.

Regarding financing, Chile has safeguards and strategies to protect infrastructure maintenance budgets; however, these usually exclude the additional costs of adaptation and resilience promotion (e.g., under the Concessions Law, infrastructure subject to this regime must be maintained by concessionaires during the concession period, including the costs in their budgets and facing fines

or enforcing insurance policies in case of non-compliance). On the other hand, specific funds have also been created to finance and promote investments in infrastructure related to DRR, such as the Infrastructure Fund or Country Development Fund, the Public-Private Investment Plan for DRR, the Risk Prevention and Mitigation Program (PREMIR) of the Undersecretary of Regional Development (SUBDERE), and the "constitutional 2%" of the President of the Republic to cover the effects of disasters or public calamities, which may include funding for DRR initiatives.

A methodology has also been developed to evaluate disaster risk in investment projects, which emphasizes the importance of DRR at the national, regional, and community levels. Still, its implementation remains incipient due to the fact that many of the instruments established in Law 21.364 for disaster risk management are in the process of being drafted, developed, and preliminarily applied.

In this matter, the leadership belongs to the Budget Directorate (DIPRES), under the Ministry of Finance, which has the task of allocating funds and resources for the management and maintenance of all planning, execution, and maintenance of infrastructure, as well as for the development of DRR measures. That said, DIPRES receives support from MIDESO, which through the National Disaster Risk Management Policy was instructed to incorporate the disaster risk variable in the social evaluation of public investment projects to contribute to the formulation of disaster-resilient infrastructure projects. It should be noted that MIDESO is also in charge of the entire Social Protection System, as well as the promotion of the Sustainable Development agenda.

For the private sector, there is no coherent regulation governing the inclusion of disaster risk management (DRM) in planning or credit evaluations. While all infrastructure, including privately owned or operated infrastructure, must adhere to existing regulations and laws in some essential matters, such as those associated with the Seismic Standard (Nch 433[13]) and fire protection (NCh934[14]), in other matters the inclusion of resilience measures is largely at the discretion of each owner company, which often do not have sufficient incentives to do so, while the attempt to add new regulations faces significant legislative and oversight difficulties, already discussed in the previous section.

Here again an exception is made for concessioned works: according to the Concessions Law, private concessionaires are obliged to inform the MOP about everything involved in these projects, including potential risks, as well as planning and risk prevention mechanisms during the construction and, to a more limited extent, operation stages, in addition to the obligation of the concessionaire to maintain insurance policies for damages to third parties, catastrophic risks and non-compliance of the concessioned services.

The banks and financial players, in turn, often do not include these items in their evaluation, although there are some exceptions. The Financial Market Commission (CMF) regulates companies involved in the credit market and those in which the State has a shareholding of more than 50% or in which it appoints the majority of the members of their boards of directors, although it specifically targets insurers and reinsurers. The CMF has established an Operational Risk and Cybersecurity Standard

[13] *https://www.preventionweb.net/files/28726_normachilenadisenosismico.pdf*
[14] *https://www.slideshare.net/JoacinRamirez/n-ch934-2008*

requiring companies to conduct a comprehensive identification and assessment of operational risk, including periodic self-assessments and regular review of operational risk appetite. On the other hand, Ethical Banking started operating less than a decade ago in Chile, and has parameters related to the care of the environment and the absence of environmental damage to finance projects.

2.2 DISASTER RISK MANAGEMENT

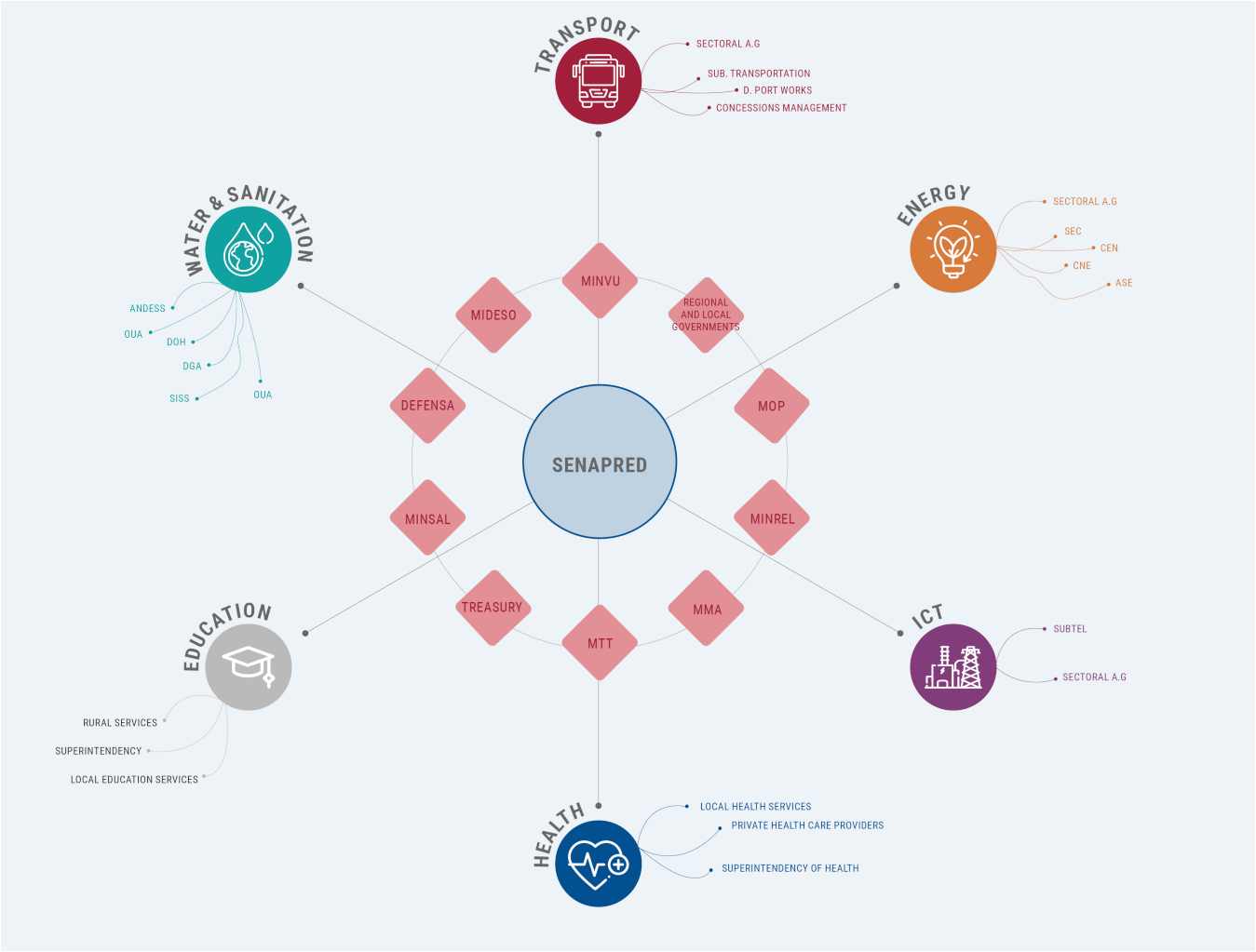
Historically, the main institution in charge of disaster risk management in Chile was the National Emergency Office of the Ministry of the Interior and Public Safety (ONEMI). Even though this institution had a positive record concerning the capacity to join efforts -public and private- in the face of disasters, its work had **historically been focused on the response and reconstruction stages.**

This area of governance is undergoing a significant transformation With the enactment, in 2021, of Law No. 21,364, the **National Disaster Prevention and Response Service (SENAPRED)** was created to replace the former ONEMI, and the **National Disaster Prevention and Response System (SINAPRED)** with SENAPRED in charge of coordinating the system.

SINAPRED is structured through a network of public and private bodies, organized in a deconcentrated manner at different levels: national, regional, provincial and communal, through planning mechanisms and institutions for each of these territorial levels, such as the Disaster Risk Management Committees (COGRID). The main stakeholders involved in this system are described in **Figure 9**[15].

[15] *It should be noted that the mapping of stakeholders in Fig. 9 was carried out in a limited manner according to the scope of the project, and therefore, under no circumstances can it be understood as the totality of stakeholders with current and/or potential interests.*

FIGURE 9. MAIN STAKEHOLDERS OF RESILIENT INFRASTRUCTURE IN CHILE. SOURCE: OWN ELABORATION[6,17,18,19,20].



These include in particular:

- The **National Disaster Prevention and Response Service (SENAPRED)**, under the aegis of the Ministry of the Interior, is responsible for advising, coordinating, organizing, planning, and supervising DRR activities at the national level. It adheres to principles of prevention, mutual support, coordination, transparency, participation, scalability, and timeliness.
- Sectoral authorities, such as the **Ministries of Energy, Transportation and Telecommunications, Education, and Health**, are responsible for the identification and monitoring of risks and vulnerabilities in infrastructure and services under their jurisdiction, in addition to coordinating preventive and response actions.
- Cross-cutting institutions such as the **Ministry of Public Works** collaborate in the identification and monitoring of critical points in all public infrastructure; while the **Ministry of Social Development** provides support and relief measures for affected families, including the management of shelters and damage assessment through the Basic Emergency Record. The **Ministry of Defense** provides essential logistical and strategic support, which facilitates everything from road recovery to the construction of temporary shelters and ensures protection during all phases

[16] *MOP: Ministry of Public Works; MINVU: Ministry of Housing and Urbanism; MTT: Ministry of Transportation and Telecommunications; MINSAL: Ministry of Health; MMA: Ministry of Environment; MIDESO: Ministry of Social Development and Family; MINREL: Ministry of Foreign Affairs; DEFENSE: Ministry of Defense; TREASURY: Ministry of Treasury*
[17] *Water and Sanitation: SISS: Sanitation Services Superintendency; CNR: National Risk Commission; DGA: General Water Directorate; DOH: Directorate of Hydraulic Works; OUA: Organization of Water Users; ANDESS: National Association of Sanitation Services Companies*
[18] *Transportation: A.G. Sectoral: sectoral trade associations; SUBTRANSPORTS: Undersecretary of Transportation; D. Port Works: Directorate of Port Works.*
[19] *Energy: ASE: Agency for Energy Sustainability; A.G. Sectorial: sectorial trade associations; SEC: Superintendence of Electricity and Fuels; CNE: National Energy Commission; CEN: National Electricity Coordinator;*
[20] *ICTs: A.G. Sectorial: sectorial trade associations; SUBTEL: Undersecretariat of Telecommunications*

of the risk cycle. Finally, the **Ministry of Finance** plays a key role in the planning and allocation of financial resources necessary for disaster prevention and response, as well as in the financial protection of infrastructure.

This system encompasses the stages of mitigation, preparedness, response and recovery as integrated phases of the disaster risk management cycle, as it establishes policies, plans, procedures and other relevant instruments for each phase. The new structure established by Law No. 21,364 emphasizes prevention, aligning with the principles of the Sendai Framework for Disaster Risk Reduction. This focus complements the guidelines outlined in cross-cutting instruments such as the National Policy for Disaster Risk Reduction 2020-2030 (PNRRD).

Under the umbrella of this new system, **Disaster Risk Reduction Plans are being generated for all sectors, regions and communes of the country**, which will be an important step towards the adoption of a proactive approach to DRM in the country. In spite of this, the design and execution of these new instruments and institutions is still in its initial stages.

The establishment of SINAPRED introduces a formal DRR governance structure and an articulation that promotes intersectoral coordination and cooperation. SENAPRED, in its role as coordinator of SINAPRED, can assist in the development and proposal of DRR regulations and/or policies, favoring the active incorporation of the risk approach in the planning and implementation of infrastructure works.

However, as this institutional framework and the regulations that establish it are **recent, its implementation is still incipient**, so it is early to see the results, and it is necessary to build capacities, especially at local levels. The **regional differences** in Chile, both in risk profile and in progress and preparedness for DRR are important. In rural areas and in areas farther away from economic flows and administrative centers, there tends to be a greater lag and gaps in considering infrastructures beyond those of the agricultural sector.

Note that **SENAPRED is more of an "articulator" than a "regulator" of infrastructure**, i.e., it does not have direct involvement in the sectoral regulation of infrastructure, but rather its role is to coordinate and support such efforts. This may limit its effectiveness when there is insufficient political support, or when there are conflicts of vision with sectoral authorities. In this sense, mention should also be made of the fact that **DRR in Chile tends to leave out of its scope the infrastructure linked to productive activities** (its focus is mainly on "people and their goods"), so SENAPRED's articulating capacity in this area is also limited. Furthermore, **the importance of private stakeholders** in the operation of infrastructure in Chile also limits the capacity that SENAPRED can have in terms of regulation.

2.3 CLIMATE CHANGE

Just one year after the creation of SINAPRED, Law No. 21,455 on Climate Change (LMCC) was enacted. This law also provides for a structured and articulated institutional system throughout

all sectors and territorial levels of the country, involving national ministries and services, regional governments and municipalities, among others. It mandates all sectoral, regional, and municipal authorities to implement strategies to mitigate greenhouse gas emissions and promote climate change adaptation and resilience. The Law introduces financial instruments, mechanisms for information management and access, monitoring and evaluation, and public participation and coordination, many of which are currently in the process of implementation.

Under the LMCC, SENAPRED is tasked with validating and reporting on Sectoral Climate Change Adaptation Plans Nevertheless, it is necessary to strengthen institutional coordination between these two new legal systems, for example, associated with the division of tasks to avoid redundancies, specific coordination mechanisms in the formulation and implementation of plans at the subnational level, or the alignment of standards in diagnostic methods and information and monitoring systems, among others. Such efforts would refine and harmonize these structures, fostering greater coherence and synergy between climate change management and risk reduction in Chile.

This institutional coordination is important because of the potential **synergies and complementarity between the functions and capacities of SENAPRED and the Ministry of Environment**. An example of synergies is that SENAPRED has experience with local stakeholders in response and 'hard' measures of infrastructure improvement or capacity building, while the Ministry of Environment has a comprehensive and prospective vision focused on future scenarios, social vulnerability reduction, and nature-based measures. A possible complementarity is that the Environmental Plans do have explicit jurisdiction over risks associated with economic activity, and slow development hazards (including water scarcity and desertification), areas in which SENAPRED has not historically been very active.

2.4 LAND MANAGEMENT AND PLANNING

The **Ministry of Housing and Urbanism (MINVU)** has shown its engagement since 2010 in integrating DRM in land management and planning, which is reflected in requirements (vg.g) Article 2.1.17 of the General Ordinance of Urbanism and Constructions), which are included in reforms to the **General Law of Urbanism and Constructions**. In addition, resilience is emphasized as a guiding principle in the **National Urban Development Policy**, in force since 2013, which seeks to identify and consider natural and anthropic risks to contribute to environmental balance. The new **National Land Management Policy**, enacted in 2019, indicates the need to address both DRR and Climate Change Adaptation (CCA), promoting resilient territorial development and considering high-risk areas and natural hazards. Finally, progress is highlighted in the updating of **building codes** to ensure the seismic resistance of structures, which prioritize the prevention of fatalities during earthquakes, although their full implementation is only achieved in large-scale public infrastructure, particularly hospitals, due to the high cost involved.

These policies represent a **tangible advance** in the direction of integration and coordination at the national level. However, they are not exempt from **challenges**, and we will primarily highlight three of them.

First, there is an urgent need to **harmonize territorial planning regulations with those associated with climate action, on the one hand, and DRR, on the othe**r. Regions and municipalities, being closer to disaster-prone areas, are well-positioned to implement effective prevention and mitigation measures, so the path towards decentralization and multilevel management of these situations is undoubtedly correct, especially in a context as heterogeneous in regional terms as Chile. However, a lack of harmonization across planning spheres risks duplicating functions and tasks, potentially leading to inefficiencies and policy misalignment.

Second, as discussed in previous sections, there is still an important **gap in the effective implementation of regulations and policies in this regard.** In this regard, one of the main challenges identified is the lack of updated regulatory plans in several municipalities, some of which are decades old. This inadequacy compromises the ability to address emerging risks, thereby jeopardizing critical infrastructure.

Finally, linked to the above, there is an urgent need to strengthen subnational capacities. Even though the efforts made in recent years in terms of decentralization have brought decisions closer to the territories, effectively addressing this requires adapting national policies to local contexts while empowering subnational authorities with the resources and autonomy to implement them effectively, which reinforces decentralization as an integral part of the strategy. This is a far-reaching goal, which demands medium- to long-term strategies, but starting down this path is urgent and crucial for the effective deployment of these policies in the territories, since strengthening subnational capacities ensures that the communes have the resources and competencies to update their regulations and face risks proactively.

2.5 AVAILABILITY AND ACCESS TO INFORMATION

Chile has **extensive risk-related information**, but **fragmentation across formats and databases limits interoperability**. Even so, there are gaps with respect to specific information on the specific actions and management structures taken by each institution. Each ministry and service is responsible for collecting, managing, and sharing data within its jurisdiction. Also, the historical lack of transparent access mechanisms to such information has recently been reduced by **improving public accessibility** to geospatial information and data on public and private infrastructure through specific platforms and new information management systems. However, inconsistent capacities, inadequate supporting documentation, and insufficient safeguards for personal data limit inter-ministerial information sharing **across ministries and internal units**. In addition, mechanisms for measuring user satisfaction do not specifically address risk, disaster or resilience issues.

PART IV.
MOVING TOWARDS A MORE RESILIENT INFRASTRUCTURE: IMPLEMENTATION PLAN

In this last chapter, an analysis of governance gaps and strengths to promote a resilient infrastructure is carried out. Based on this, an Implementation Plan is presented with short, medium and long term actions to respond to the challenges and priorities identified, **in order to strengthen governance and move towards a more resilient infrastructure in Chile.**

The chapter is structured in **two parts**. In the first part (IV.1), findings and recommendations of a **cross-cutting** nature are presented to strengthen governance towards a coordinated and effective action on DRR. Most of these actions should be coordinated or promoted by SENAPRED in collaboration with sectoral counterparts and other key stakeholders. In addition, the second part (IV.2) presents **sectoral** priorities and actions to be promoted by the Ministries and authorities of each sector with the collaboration of SENAPRED.

The drafting of this implementation plan included the validation, refinement and prioritization of the recommendations, in writing and in the workshops developed, by sectoral and cross-cutting entities.

1. Priorities and Cross-cutting Actions

As previously mentioned, Chile is moving towards a more integrated, proactive and effective infrastructure resilience governance. Particularly, the establishment of SINAPRED (and SENAPRED as its coordinating entity), the National Land Use Planning Policy, the Framework Law on Climate Change, as well as different sectoral policies and regulations and the effort towards decentralization of competences, allow **moving towards a more articulated and capillary DRR system.**

Table 6 summarizes the main strengths and gaps, as they emerge from the previous chapters of this report.

TABLE 6. SUMMARY OF THE OPPORTUNITIES AND CHALLENGES IDENTIFIED

STRENGTHS	GAPS
SINAPRED coordination: Promotes intersectoral coordination and cooperation.	**Regulatory dispersion and sectoral fragmentation:** Key sectors work under autonomous and dispersed regulations. There is high fragmentation and disarticulation within critical sectors, especially water.
National Land Use Planning Policy (PNOT) and Territorial Management: Integrates climate change, DRR, and sustainable development.	**Reliance on private stakeholders** such as infrastructure owners and operators (limits to regulation).

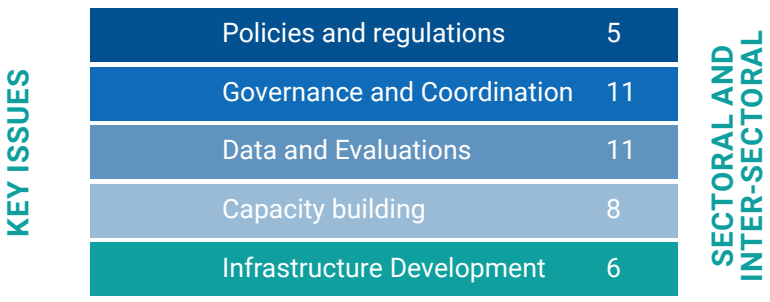
SENAPRED in Regulations: SENAPRED plays a crucial role in coordination.	**Variability in definitions:** Significant differences in definitions of "resilient" and "critical" infrastructure between sectors.
Roles of MOP, MINVU and MIDESO: Oversee critical infrastructure and promote common standards.	**Incipient implementation of DRR:** Proactive disaster risk management is in its initial phase; SENAPRED acts as an intermediary.
LMCC: Assigns a specific role to SENAPRED.	**Limited DRR approach:** DRR in Chile focuses mainly on people and goods, which omits productive infrastructure.
Advances in sectoral policies: Promote integrated governance.	**Delays in rural areas:** Greater lag in infrastructure beyond the agricultural sector in rural areas.
Decentralization of competencies can bring them closer to local contexts.	**Lack of transparency and information:** Lack of detailed and accessible information on institutional structure and conflict resolution.

One of the cross-cutting priorities to promote infrastructure resilience is greater **cross-sectoral** coordination. Cross-cutting strategies should promote coordination between public entities, organized civil society and productive private sectors. This means, on the one hand, **strengthening the National System for Disaster Prevention and Response (SINAPRED)** by deepening the integration of climate change and land use planning policies (e.g., National Land Use Planning Policy, Risk, Emergency and Climate Change Adaptation Plans). These should be binding for all infrastructure stakeholders (owners, concessionaires, operators, supervisors, regulators, etc.). It is also essential **to promote collaborative governance and coordinated infrastructure management,** as it ensures the harmonization of open standards, improved information sharing channels and data security, which are key aspects for achieving resilience. **Adaptive transformation**, another important principle, requires the choice of manageable and flexible solutions that enable adaptation and continuous transformation in the face of new challenges, including climate change and technological emergencies.

To achieve this, measures were identified in **five action areas (Figure 10)**:

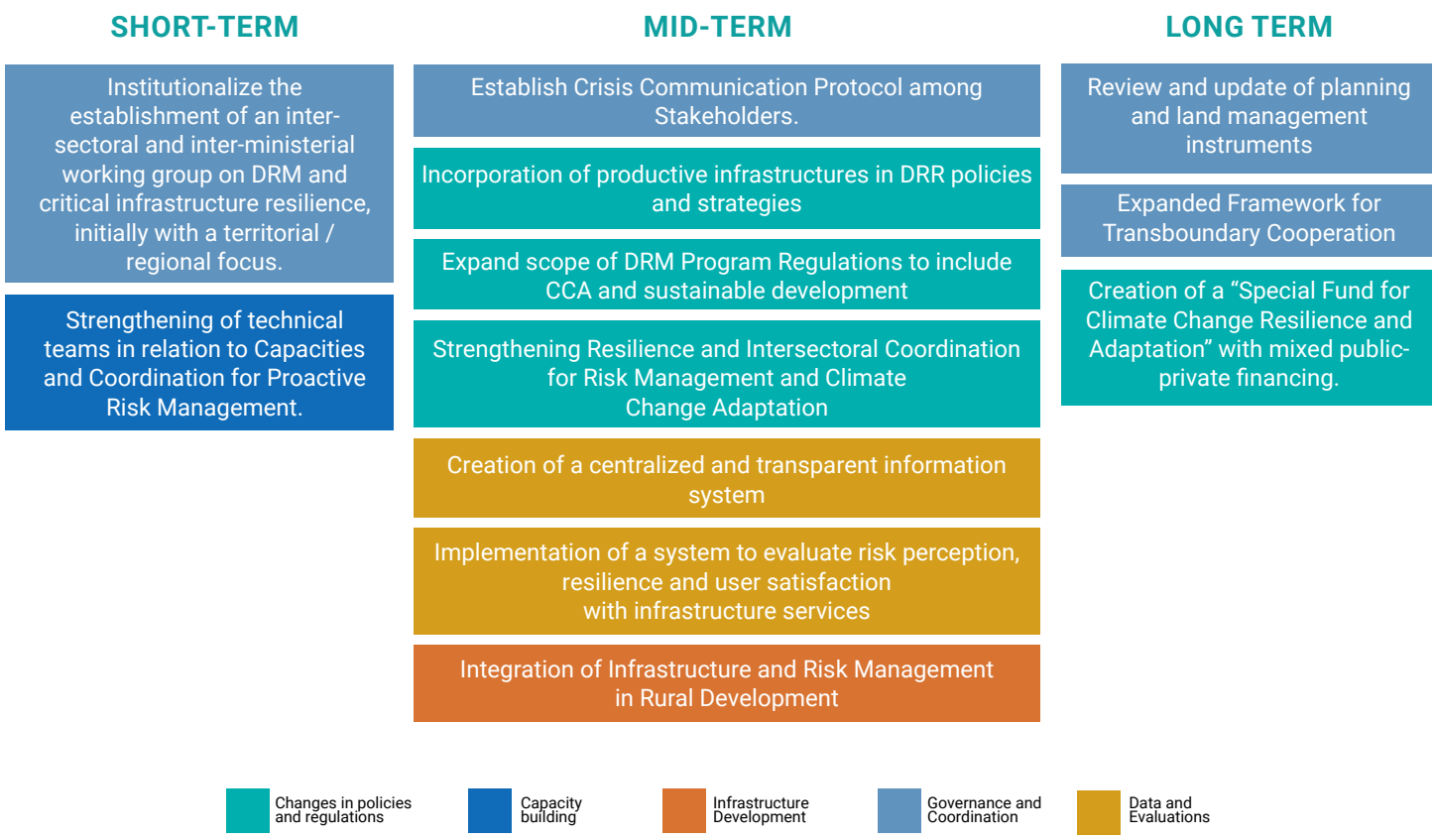
- Enactment, revision or improvement of **policies, laws and their respective regulations**.
- Establishment of more effective inter-sectoral **governance and coordination mechanisms.**
- **Enhancing the availability and accessibility of risk data and assessments.**
- **Development** of human and institutional **capacities** in DRR and resilience.
- **Development of infrastructure projects** that respond to identified gaps and move towards greater resilience.

FIGURE 10. CROSS-CUTTING AREAS OF ACTION



An **implementation plan** with **short-, medium-, and long-term actions** in each of these areas is suggested below (**Figure 11**). The proposed actions follow a progressive approach, laying short-term foundations for broader medium- and long-term initiatives.

FIGURE 11. IMPLEMENTATION PLAN TRANSVERSAL MEASURES

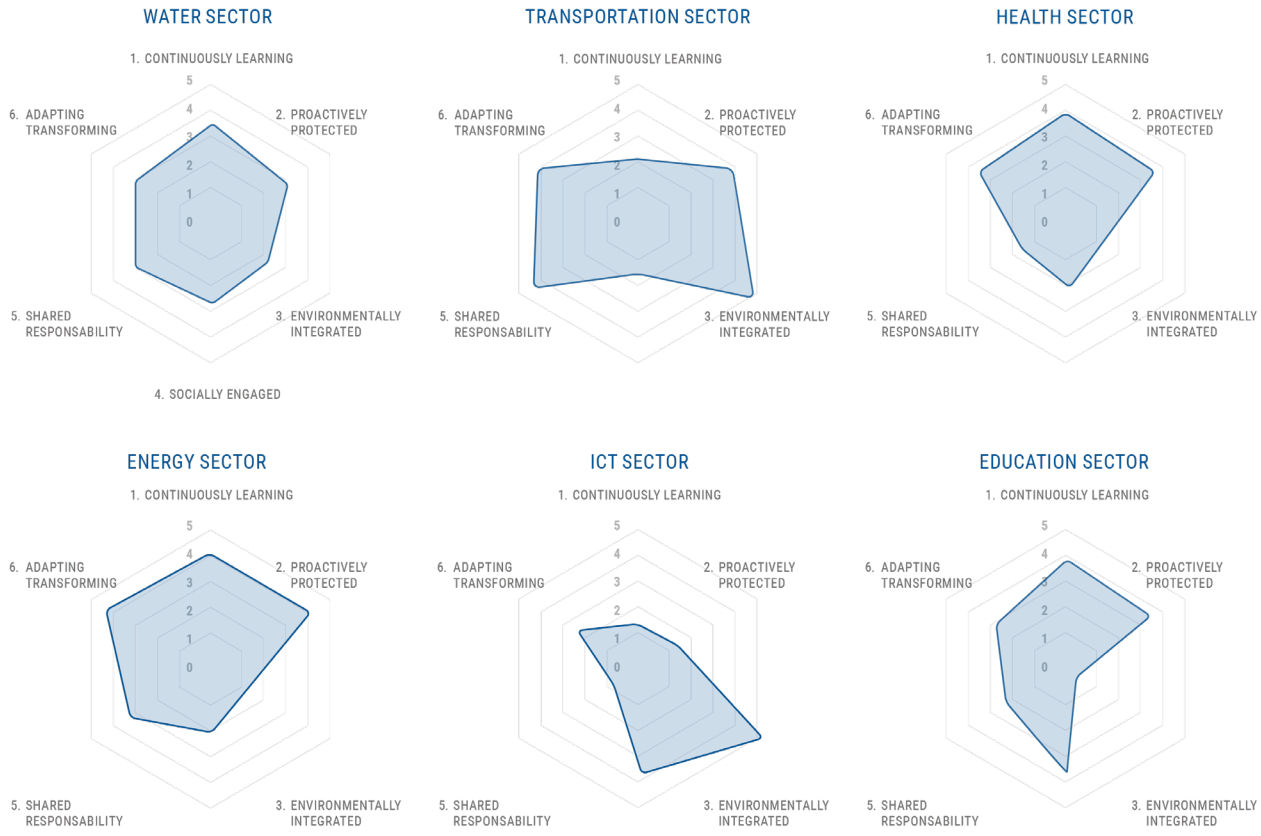


In the **short term**, the establishment of a formal and structured working group to promote initiatives that overcome fragmentation and improve coordination at regional and national levels is prioritized. In the **medium term**, communication protocols between stakeholders and a centralized and transparent information system are established, which should be closely linked to the National System for Access to Information and Citizen Participation on Climate Change (SNAIPCCC), provided for in the Framework Law on Climate Change and currently in the initial stages of design. Lastly, in the **long term**, it is recommended that planning and land use instruments be reviewed and updated, as well as the creation of a Special Fund for Climate Change Resilience and Adaptation with mixed public-private financing.

2. Sectoral Priorities and Actions

As already mentioned, there is a remarkable variability in the governance conditions of the different sectors analyzed, **leading to uneven infrastructure resilience performance in terms of infrastructure resilience**. This is attested by the results of the participatory assessments conducted with sectoral stakeholders (**Figure 12**).

FIGURE 12. GRAPHS FROM THE SCORING SYSTEM REGARDING SECTORAL COMPLIANCE WITH THE RESILIENT INFRASTRUCTURE PRINCIPLES (UNDRR-CDRI) [21]



Some sectors, such as **Health and Energy**, generally show higher compliance across most of the indicators associated with the Resilient Infrastructure Principles, especially in Continuous Learning and Adaptive Transformation, although both have points to strengthen in Environmental Integration and, to a lesser extent, Social Engagement (to which is added in the case of Health a deficiency also

[21] *These results are derived from documentary and secondary information analysis complemented by the assessment of resilience by sectoral actors through the scoring system based on the infrastructure resilience principles*

in Shared Responsibility). The **Transportation** sector also has a positive performance in most of the principles, with the exception of Continuous Learning and Social Commitment, while **Education** performs fairly well in most areas, but not in Environmental Integration. **ICTs** shows strengths in Social Engagement and Environmental Integration, while it lags in other areas, especially Proactive Protection and Continuous Learning. Finally, the Water sector scores at moderate levels in all dimensions.

Across the board, sectors tend to perform **less well in resilience literacy and fostering community participation, as well as in cultivating collaborative management and providing information on risk and cost-effectiveness of actions.**

These results highlight the need for **balanced approaches** that in addition to efficiency and safety, also encompass sustainability, social responsibility, and adaptability. Continuous improvement in these dimensions is essential to ensure the long-term resilience and effectiveness of critical infrastructures.

An aspect of concern is that **there are more statements related to the Principles than concrete practices for their implementation** (e.g., in the sectoral documents analyzed, there were several mentions of concepts and principles consistent with resilience, but few concrete actions to implement them; these aspects also emerged from the workshops with sectoral stakeholders). Thus, progress towards the alignment of regulations with these principles leaves effective and concrete implementation pending. Many of the policies and regulations for integrated and proactive approaches in DRR are incipient, so their effective implementation is still at an early stage and often only at the normative or strategic policy level, which needs to be complemented with regulations, technical guidelines and concrete programs or projects to become effective. This **gap between policies and their operation** highlights the importance of integrated and coordinated strategies to improve the effective enforcement of existing regulations and advance projects and initiatives that strengthen infrastructure resilience. Strengthening resilient infrastructure thus requires **improving regulatory capacity and regulatory implementation**. This includes incentives, certifications, financing, regulations and adequate oversight, as well as collaboration between the public and private sectors, given the role of private entities in infrastructure management.

Furthermore, the prioritization carried out with sectoral stakeholders has underscored the urgency not only of effective administration and alignment between policies, regulations and stakeholders in emergency management, but also of strengthening the country's capacity to manage and mitigate risks over the long term. In line with this, strategies are identified that seek a **comprehensive and proactive approach to risk management and resilience in Chile**, coherence between sectors, and alignment between technological responses and community participation.

In the following sections, the gaps, priorities and specific actions for each sector will be discussed in more detail.

2.1 WATER SECTOR

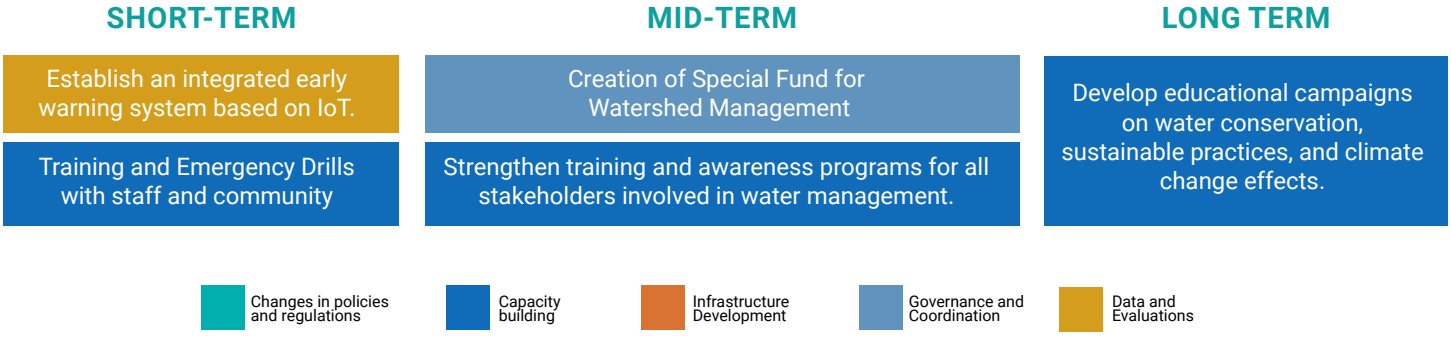
As already mentioned, the water sector is one of the most vulnerable to disasters in Chile, especially considering the projections associated with climate change. Its main strengths and gaps are summarized in **Table 7.**

TABLE 7. MAIN GAPS AND STRENGTHS OF THE WATER SECTOR

MAIN GAPS	MAIN STRENGTHS
1. Reduced capacity to adequately monitor and intervene, especially combined chain risks, which limits its ability to respond quickly to emerging problems.	1. Legislative reforms and sectoral policies that promote proactive and articulated management with a focus on sustainability, resilience and innovation (e.g., Law 21.435, reform of the Water Code)
2. There is a need to strengthen education and community engagement.	2. The implementation of integrated basin management (Strategic Basin Water Resources Plans, PERHC), as it improves the planning and use of water resources.
3. Fragmented sector, with private and public stakeholders in need of greater cooperation.	3. Desalination plants are emerging as an attractive solution.
4. There is a need to strengthen continuous learning processes in risk.	4. Greater focus on irrigation technology and the use of treated wastewater, which enables a more sustainable management of the resource.
5. Insufficient implementation of strategic water resources plans and storm water master plans, which limit coordination and effective response.	5. In rural areas, the Sanitation Services Law of 2020 has provided a regulatory framework for drinking water committees and cooperatives to operate and receive technical support.

In this context, a plan is proposed that **combines advanced technology, ongoing training, and public education** to advance resilient and sustainable water resource management, better prepared to face present and future water-related challenges (**Figure 13**).

FIGURE 13. IMPLEMENTATION PLAN WATER SECTOR MEASURES



Short-term actions focus on improving rapid response and preparedness for water emergencies. Along these lines, a key action is to establish an integrated early warning system based on Internet of Things (IoT) technology for monitoring water quality and levels in critical reservoirs, and for more efficient detection and response to critical events. This information, collected and sent in a timely manner to the responsible authorities (Dirección General de Aguas (DGA), Dirección de Obras Hidráulicas (DOH), and other key stakeholders such as local communities and end-user organizations), would ensure a rapid and effective response to any anomaly detected, strengthening resilience and sustainability in water resources management.

As for the **medium term**, the creation of a Special Fund for Watershed Management is a crucial measure for financing and supporting specific projects in water resources management. This fund would support the implementation of Strategic Water Resources Plans and could finance pilot projects for climate resilient infrastructure and environmental impact studies. This fund could be financed by governmental sources, international donations and private sector contributions (e.g., Santiago-Maipo Water Fund[22]).

Finally, these measures should be accompanied by educational and capacity building campaigns with **short, medium and long term actions**. These campaigns would include, on the one hand, regular training (professional and community) and drills to strengthen the reaction capacity of personnel and the community, in order to promote a culture of prevention and adequate response. On the other hand, the campaigns would include education and awareness-raising on water conservation, sustainable practices, and the effects of climate change to promote responsible water management at the community and national levels.

[22] *Collaborative platform that brings together various actors in the water sector in the Metropolitan Region.. It aims to ensure water security through effective and coordinated actions based on science, benefiting the inhabitants, organizations and ecosystems of the Maipo river basin. The fund promotes conservation, water efficiency and risk management through a long-term approach.*

2.2 ENERGY SECTOR

Critical energy infrastructure in Chile faces key challenges that affect its resilience and capacity to respond to socio-natural hazards and emergencies. **Table 8** details the gaps and strengths of the energy sector, which provides an overview of the areas that require improvement and highlights the strengths that can be leveraged to improve risk management and preparedness for adverse events.

TABLE 8. MAIN GAPS AND STRENGTHS OF THE ENERGY SECTOR

MAIN GAPS

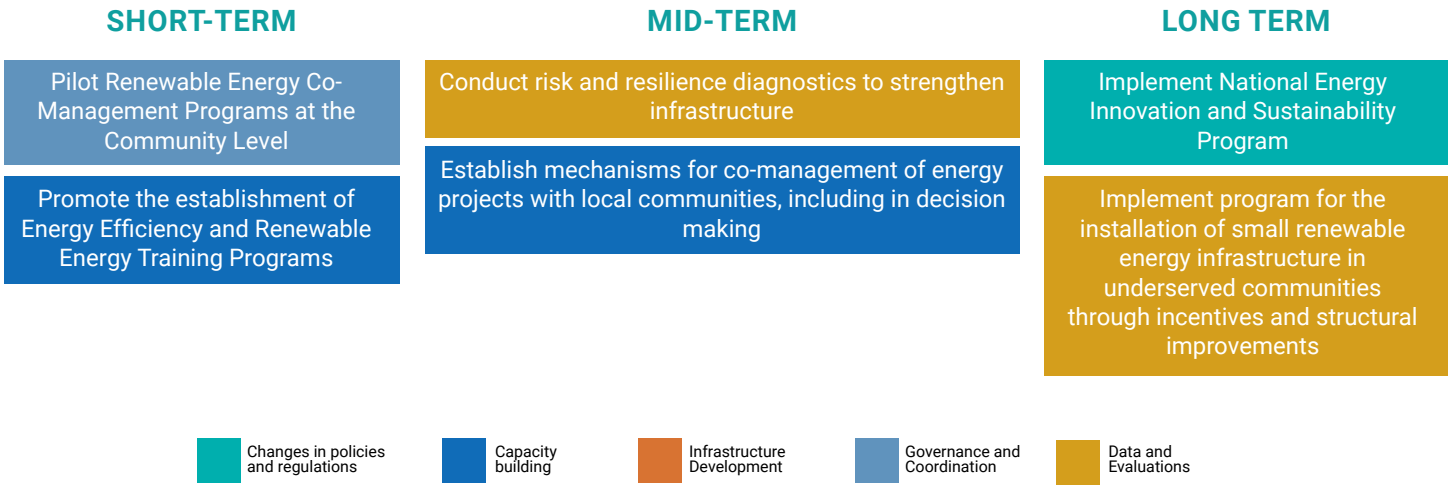
1. Unequal distribution of infrastructure, coverage and access to renewable energies.
2. Infrastructure needs to be improved in the face of climate change
3. Education and awareness-raising in energy efficiency needs to be improved.
4. Deficiencies in energy storage infrastructure.
5. Insufficient emergency preparedness and response.
6. Low community involvement in energy projects.

MAIN STRENGTHS

1. Technological innovation capacity: continuous investment in technology.
2. Resilient infrastructure: investment in infrastructure capable of withstanding extreme weather events.
3. Commitment to sustainability: efforts to reduce dependence on fossil fuels and minimize environmental impact.
4. Renewable energy integration: source of adoption and integration of renewable energy into the energy matrix.
5. Development of smart grids: there is a process of implementing smart grids to optimize energy consumption and distribution.
6. Cross-sector collaboration: active participation in alliances and agreements for the sustainable development of the sector.
7. The Ministry of Energy has developed policies and strategies focused on integrating DRR in the energy sector, as it highlights its commitment to resilience in the face of various threats. The National Energy Policy for 2050 and the Tariff Equity Law stand out.
8. The Ministry of Energy has also adopted a proactive approach across all instruments to ensure a secure and stable energy supply, minimizing interruptions and risks.

In view of the above, a comprehensive strategic plan is proposed with short, medium and long term actions to address the identified gaps and capitalize on its strengths, and thus **contribute to transforming the energy landscape** by implementing educational initiatives, improving infrastructure and integrating new technologies (**Figure 14**).

FIGURE 14. ENERGY SECTOR IMPLEMENTATION PLAN AND ACTIONS



Short-term actions seek to engage communities and promote energy efficiency education through pilot co-management and training programs. These programs seek to increase community participation and address the lack of awareness, providing tools for more sustainable practices. In the **medium term**, suggestions are aimed at strengthening energy infrastructure in the face of climate change through risk and resilience diagnostics. Co-management mechanisms are also established with local communities to ensure their role in decision-making, promoting acceptance and shared responsibility. In the **long term**, it seeks to boost innovation and equity through a National Energy Innovation and Sustainability Program that promotes advanced technologies and reduces dependence on fossil fuels. In addition, the implementation of renewable infrastructure in underserved communities is recommended to ensure equitable access to renewable energy for sustainable and inclusive energy development.

2.3 TRANSPORTATION SECTOR

In the transportation sector in Chile there is also a **good degree of progress** in relation to several of the Resilient Infrastructure Principles, with the dual leadership of the MOP and the MTT in providing coordination on this matter. Nevertheless, **key areas** are identified **that still require more work**, as well as the need for **further progress in the implementation** of existing instruments and in the coverage and integration of the system. This is summarized in **Table 9**.

TABLE 9. MAIN GAPS AND STRENGTHS OF THE TRANSPORTATION SECTOR

MAIN GAPS

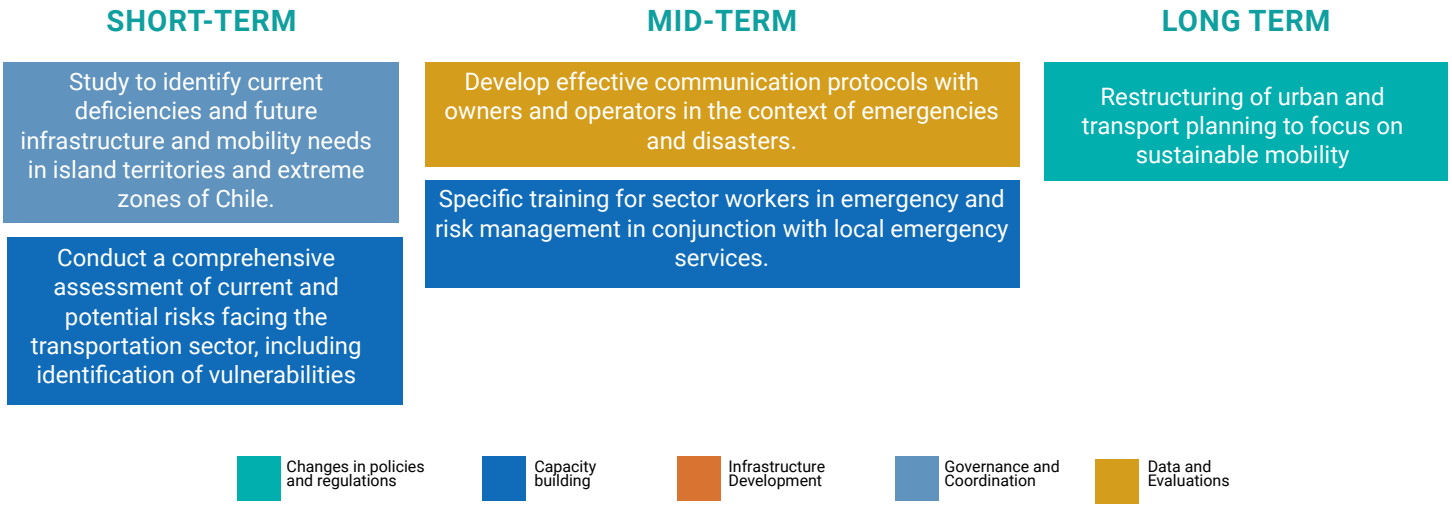
1. The sector requires strengthening continuous learning processes.
2. Challenges in risk management and operational resilience.
3. Risk response needs to be strengthened in different sectoral areas.
4. Improvement needed in key areas on disruptions and Encouraging appropriate demand behaviors, which is essential in a sector that affects a large number of people on a daily basis.
5. Presents discrepancies linked to principle N°1, associated with criteria such as “Monitor and intervene appropriately” and “conduct stress tests”, which suggests challenges in risk management and operational resilience.
6. Insufficient integration of sustainable transportation systems.
7. Vulnerability to climate change and disasters.
8. Lack of accessibility and connectivity in rural areas.
9. The need to update some communal regulatory plans is identified.
10. There is a need for a more effective and coordinated implementation of the National Transportation Policy to ensure a resilient and safe infrastructure.

MAIN STRENGTHS

1. Overall good performance is evident in the following Principles for Resilient Infrastructure: P2 (Proactive Protection), P3 (Environmental Integration), P5 (Shared Responsibility), and P6 (Adaptive Transformation).
2. Raise essential security requirements.
3. Design of multiple scales.
4. The transportation system, by having a coordinated structure, can be an advantage in the implementation of disaster prevention and response policies.
5. The MOP is highlighted as a key actor, since it has been implementing various guidelines in this area, especially through its General Directorate of Concessions, since it specifies that concessioned transport constructions must be integrated with regional and local urban development plans.
6. The Ministry of Transportation and Telecommunications has implemented transportation safety measures, including vehicle safety requirements and health protocols during the pandemic.

A series of **strategic initiatives** designed to address current and future deficiencies, improve resilience and operational efficiency, and promote sustainable mobility are proposed in response to this (**Figure 15**). These actions are aimed at strengthening infrastructure, improving risk management and emergency response capacity, and fostering the integration of sustainable practices in urban and transportation planning to promote the transportation sector becoming more equitable, safe, and prepared to meet future challenges.

FIGURE 15. IMPLEMENTATION PLAN AND MEASURES IN THE TRANSPORT SECTOR



In the **short term**, Studies are recommended to identify infrastructure and mobility needs in insular and extreme zones of Chile, along with a comprehensive assessment of transport sector risks and vulnerabilities. These actions set the stage for informed and strategic improvements. In the **medium term**, actions include the development of effective communication protocols with transport sector owners and operators in emergency and disaster situations, and specific training for sector workers in emergency management. These measures will strengthen crisis preparedness and response, ensuring a coordinated and efficient response. In the **long term**, the restructuring of urban and transportation planning is proposed to focus on sustainable mobility by promoting the use of public transportation, bicycles and walking. This restructuring seeks to reduce dependence on private vehicles, reduce carbon emissions and improve the quality of urban life.

2.4 INFORMATION AND COMMUNICATION TECHNOLOGIES SECTOR

The Information and Communication Technologies (ICTs) sector is **fundamental** for economic and social development in the digital era. By understanding these aspects, it is necessary to develop effective strategies that strengthen the resilience, security and efficiency of the sector, ensuring its capacity to adequately respond to present and future challenges. **Table 10** summarizes some of the critical areas that require attention and the capabilities that stand out in the ICT sector.

TABLE 10. KEY GAPS AND STRENGTHS OF THE ICT SECTOR

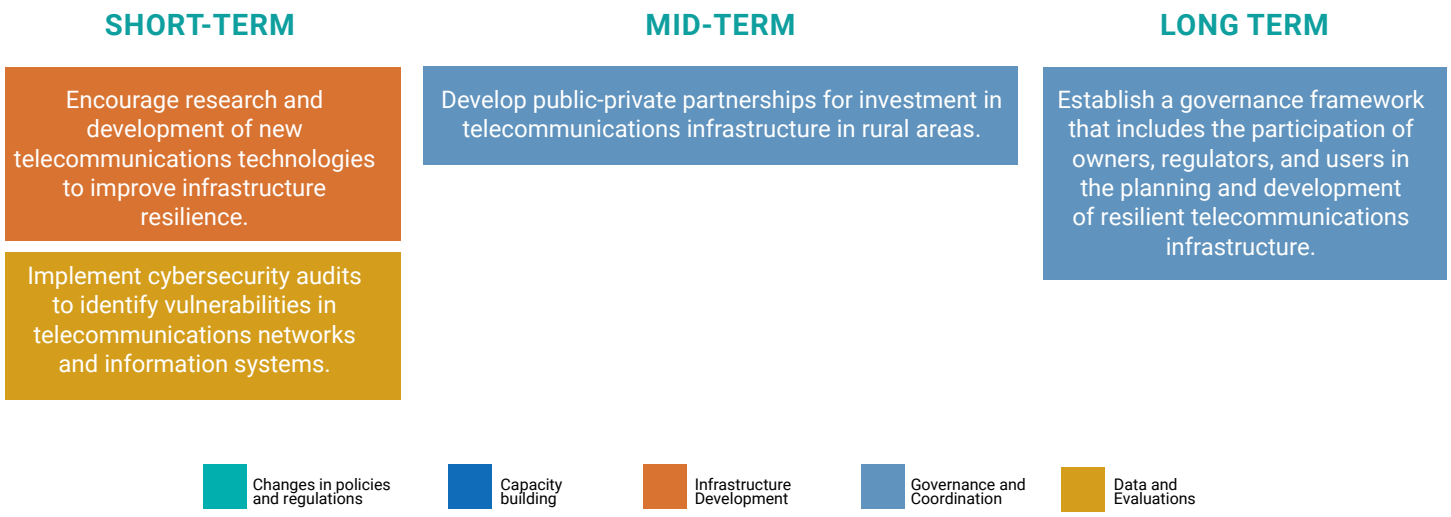
MAIN GAPS	MAIN STRENGTHS
1. Requires significant improvements in Principles 1 and 2, especially in “Conduct stress tests”, “Set essential security requirements” and “Design long-term investments”, which points to a potential vulnerability in both the capacity to respond to crises and the ability to carry out	1. Environmentally friendly infrastructure. 2. Strengths are highlighted in Principles 3, 4 and 6, especially in “harmonize open standards” and “choose manageable solutions. 3. Proactive measures have been taken to strengthen resilience and protect the sector's

ambitious policies with a long-term outlook.
2. There is a need to strengthen continuous learning processes on risk.
3. Risk response needs to be strengthened in different sectoral areas.
4. There is no evidence of a commitment to users.
5. Vulnerability to cyber-attacks.
6. Limited access in rural areas.
7. Preparedness to socio-natural hazards.

own critical infrastructure, as well as to improve response capacity and coordination in emergency situations.
4. Carabineros de Chile's General Information Security Policy and the work of the Chilean Institute of Law and Technology advance contingency plans designed to safeguard information security and continuity of public service in emergency situations.
5. Telecommunications companies are obliged to cooperate with the government in emergency situations, conflicts and disasters.

Based on the above, **Figure 16** presents a set of recommendations designed **to strengthen infrastructure resilience, strengthen cybersecurity and promote equity in access to telecommunication services**. These actions are aligned with the need to prepare the sector to face current and future technological and security challenges to ensure that ICTs can continue to be a driver of development and sustainability.

FIGURE 16. IMPLEMENTATION PLAN FOR MEASURES IN THE ICT SECTOR



As we can see, in the **short term**, the aim is to promote research and development of new telecommunications technologies, as well as the implementation of cybersecurity audits to identify and mitigate network vulnerabilities. As we can see, in the **medium term**, the aim is to promote research and development of new telecommunications technologies, as well as the implementation of cybersecurity audits to identify and mitigate network vulnerabilities. These partnerships combine public and private sector resources and expertise to improve connectivity and socioeconomic development in these regions. In the **long term**, the proposal is to establish an inclusive governance framework that incorporates the participation of owners, regulators and users in the planning and development of resilient infrastructure.

2.5 HEALTH SECTOR

The main challenges and current capacities identified for the Health sector are illustrated below (**Table 11**).

TABLE 11. MAIN GAPS AND STRENGTHS OF THE HEALTH SECTOR

MAIN GAPS

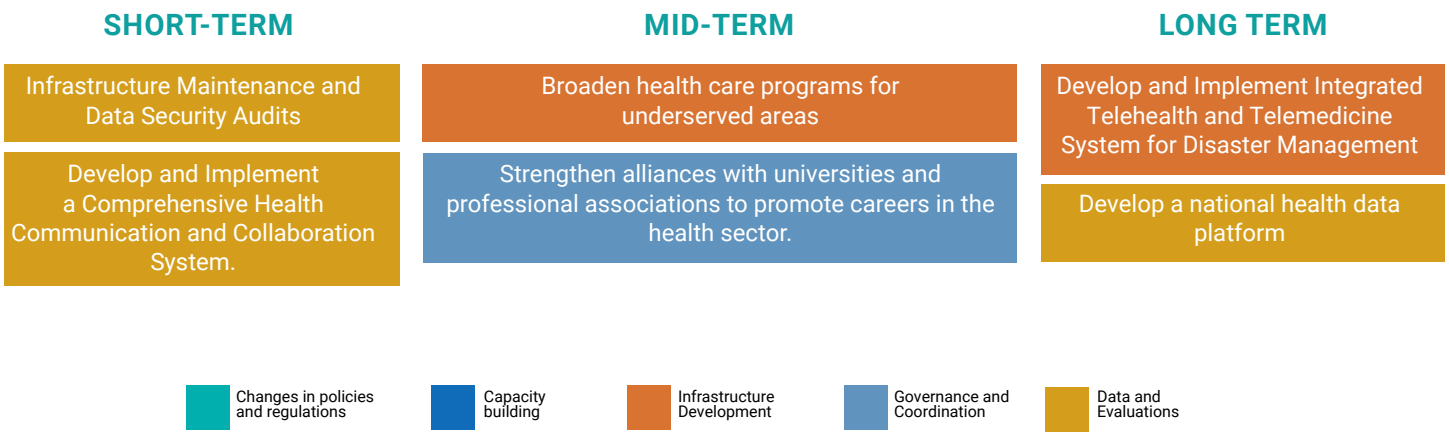
1. Needs to address additional aspects of infrastructure maintenance, data security, and risk communication, to improve cooperation and trust, as well as in achieving a more coherent and committed environmental approach.
2. Does not clearly specify cross-sectoral collaboration or facilitation of information sharing.
3. Insufficient infrastructure for primary care.
4. Lack of trained medical staff.
5. Limitations in health data management.
6. The sector lacks specific policies and regulations that actively promote disaster risk management and the promotion of infrastructure resilience.
7. Insufficient integration of Information and Communication Technologies (ICTs) in Disaster Risk Management and Climate Change Adaptation: While there is a focus on preparedness and adaptation, there may be a gap in the full utilization of advanced technologies and information systems to optimize disaster response and recovery.

MAIN STRENGTHS

1. It stands out for its performance in Principles 1, 4 and 6, with high scores especially in "Conduct stress tests" and "Monitor and intervene appropriately",
2. Reflects a balanced approach to emergency preparedness and response, which is essential in such a sensitive sector, as well as to influencing user behavior and enabling transformation, which highlights its proactivity.
3. High emergency response capability: Effectiveness in rapid response to health crises.
4. Healthcare innovation: Continued investment in technology and innovative practices to improve patient care.
5. Strong commitment to research and development: Active collaboration in research to advance public health treatments and solutions.
6. There is a growing awareness of the risks and vulnerabilities that can affect this sector and, in turn, the need to incorporate risk reduction and climate change adaptation measures into its management and planning.
7. It is immersed in a context of adaptation and preparedness for disaster risks and the challenges of climate change, with a special focus on the sector's infrastructure.

In view of the above, **Figure 17** suggests short-, medium- and long-term strategic initiatives aimed at addressing the main gaps identified and taking advantage of the sector's strengths. These actions are designed to **improve infrastructure, data security, communication and collaboration, as well as to expand health care coverage and develop integrated systems to strengthen emergency response and disaster management**. The goal is to promote the health sector to become increasingly efficient, resilient, and accessible to all communities.

FIGURE 17. IMPLEMENTATION PLAN AND ACTIONS IN THE HEALTH SECTOR



Short-term actions are focused on conducting infrastructure and data security audits, and developing a comprehensive communication and collaboration system. These measures seek to identify deficiencies and improve the protection of sensitive information, thus ensuring better coordination and response to emergencies. In the **medium term**, the proposals are aimed at expanding health care programs in underserved areas and strengthening alliances with universities and professional associations to promote health careers. These actions are essential to improve access to health services and address the shortage of trained medical personnel. Finally, in the **long term**, the development of an integrated telehealth and telemedicine system for disaster management and a national health data platform are proposed. These initiatives seek to improve accessibility and continuity of medical care in emergency situations and optimize health information management.

2.6 EDUCATION SECTOR

Table 12 illustrates the gaps and strengths identified for the sector, and evidences the need for efforts to strengthen infrastructure, data security and collaboration, and thus move towards a more resilient, efficient and equitable education system.

TABLE 12. MAIN GAPS AND STRENGTHS FOR THE EDUCATION SECTOR

MAIN GAPS

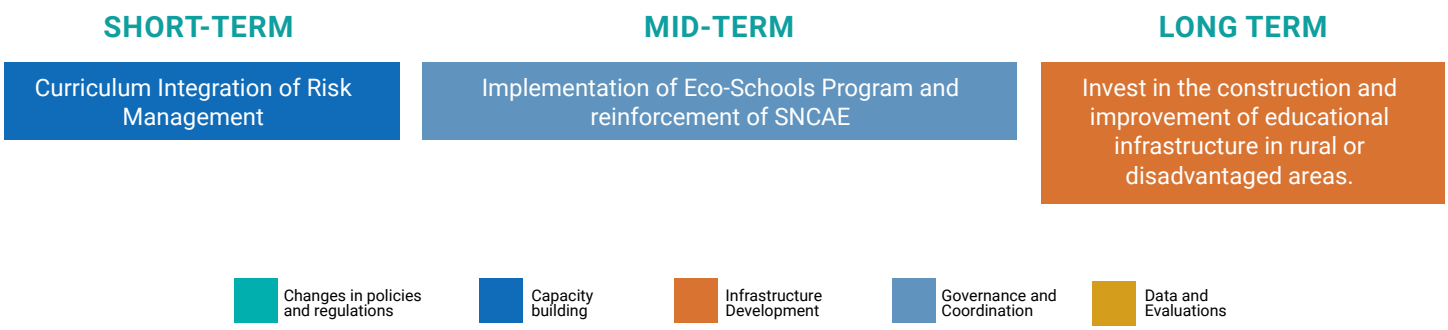
1. Weaknesses in designing long-term investments" (P2), which could affect the basis for future strategies and policies; in community involvement and resilience literacy (P4), as well as in collaborative management and shared responsibilities (P5), elements that are crucial in a sector that is fundamental for social development.
2. There is a need to strengthen continuous learning processes on risk.
3. Risk response needs to be strengthened in different sectoral areas.
4. Requires areas for improvement, mainly in "Minimizing its environmental impact and maintaining the natural environment".
5. Lack of integration of educational technologies in the curriculum.
6. Limited access to education in rural or disadvantaged areas.
7. The sector lacks specific policies and regulations that actively promote disaster risk management and the promotion of infrastructure resilience.
8. Although policies and measures related to DRR and CCA have been identified, specific information on the development of resilient educational infrastructure in the face of these challenges is limited.

MAIN STRENGTHS

1. The "stress testing" are presented as a strength for the sector.
2. It stands out for complying with "raising essential security requirements".
3. It excels in "designing infrastructure with fail-safe mechanisms".
4. It excels in "risk communication".
5. "Flexible management" practices are identified as a strength for the sector.
6. Growing awareness of sector risks and vulnerabilities demonstrates the need to incorporate risk reduction and climate change adaptation measures into planning and management.
7. Progress has been made in incorporating DRM as a topic in the formal curriculum, thus promoting greater preparation of teachers in this area and encouraging the active participation of students.

Based on the above, **Figure 18** provides strategies to address identified gaps, strengthen capacities, **improve risk management, promote sustainability, and ensure quality education accessible to all communities, particularly in rural or disadvantaged areas**. Using comprehensive planning and a collaborative approach, these initiatives aim to build an education system that is more resilient, equitable and prepared to face the challenges of the future.

FIGURE 18. IMPLEMENTATION PLAN AND ACTIONS IN THE EDUCATION SECTOR



In the **short term**, it is proposed to integrate risk management into the school curriculum by preparing students and teachers to handle emergencies and promote a culture of prevention and resilience. In the **medium term**, the measures suggest implementing an Eco-Schools program and strengthening the National System of Environmental Certification of Educational Establishments (SNCAE), in order to promote sustainable practices in schools. In the **long term**, investment in construction and improvement of educational infrastructure in rural and/or disadvantaged areas is suggested. These improvements would not only ensure a suitable environment for learning, but also add elements of resilience to ensure the continuity of education in adverse situations, thus reducing the inequity gap and improving the social and economic development of communities.

PARTE V.
PATHWAY TO IMPLEMENTATION

The UNDRR Resilient Infrastructure Principles **offer a comprehensive framework for managing critical infrastructure assets and functions with robustness and adaptability, supporting sustainable development**. By promoting a drive towards continuous adaptation, protection by design, environmental integration, social engagement, shared responsibility, and adaptive transformation, this approach emphasizes a multi-sectoral approach to strengthening governance for the implementation of more resilient infrastructure.

On this basis, the analyses and proposals in this document give a better understanding of the challenges, opportunities and gaps that exist in Chile to move towards a resilient infrastructure. In addition, **a pathway** is proposed **to strengthen national governance and promote more robust and adaptive management of critical resources and services in the country.**

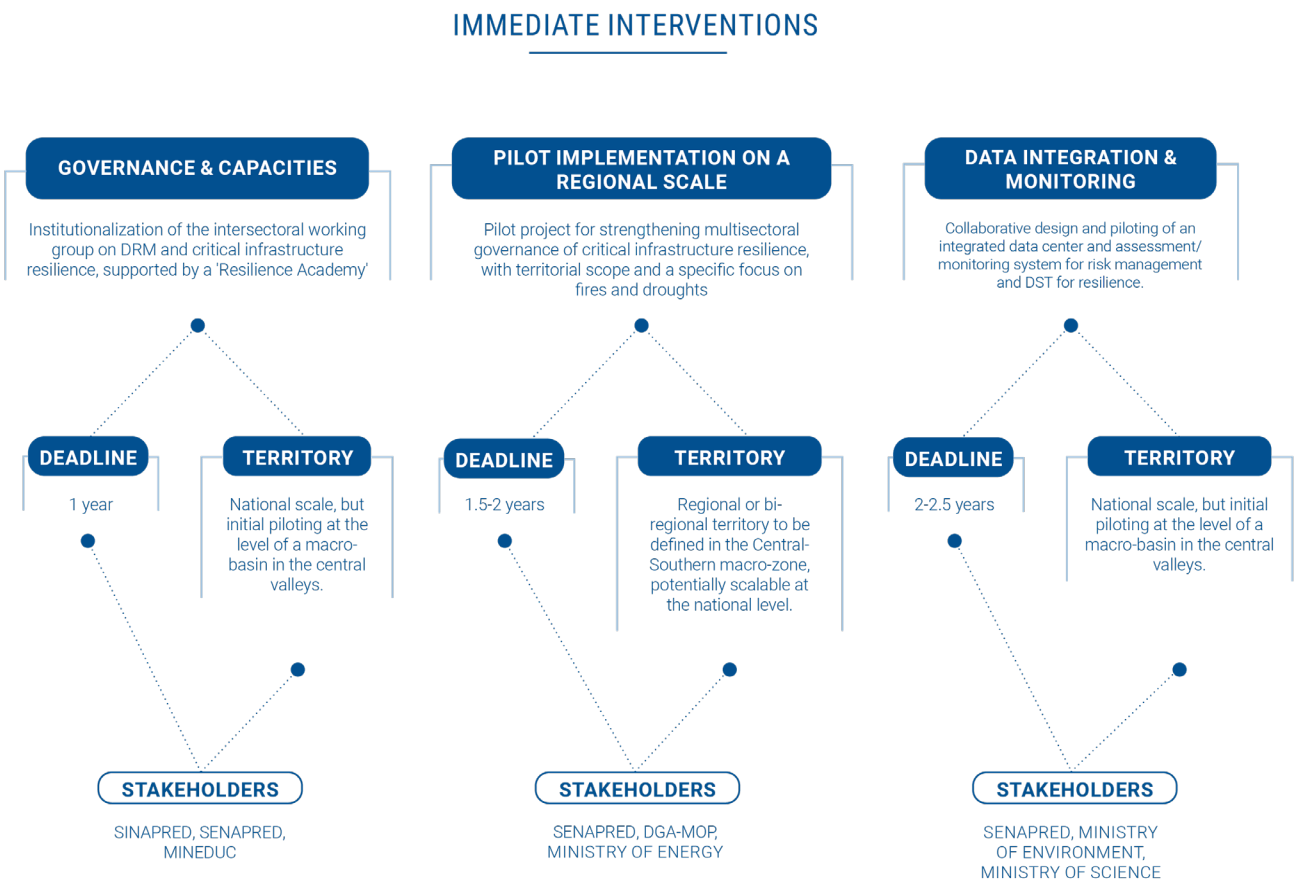
By bringing itself in line with international resilient infrastructure principles and adopting a proactive and collaborative approach, **Chile will be better positioned to face not only current but also future challenges to ensure that its infrastructure not only survives disasters, but also thrives in an ever-changing environment**. Continued collaboration between government, private and community sectors will be crucial to the success of these initiatives.

This last section highlights some **cross-cutting considerations** to be taken into account in carrying out the proposals and recommendations in this report:

- **Multi-sectoral vision:** Seffective coordination between different sectors is required for integrated and effective resilience management. This implies cooperation between government and private sectors and the participation of communities in the decision-making process.
- **Strategic and progressive actions:** The plan outlines specific actions for each sector, organized into short-, medium-, and long-term interventions, enabling phased implementation beginning with immediate measures and progressing toward comprehensive structural reforms. This approach not only addresses urgent needs, but also establishes a platform for long-term sustainable development and adaptation.
- **Comprehensive and inclusive solutions:** Implementation faces significant challenges such as the need for sustained funding, resistance to change within the organizations involved, and effective integration of all stakeholders. An inclusive approach that enables community involvement is key to overcoming these obstacles and to fostering a sense of ownership and commitment among stakeholders.
- **Importance of governance and adaptability:** Effective governance that integrates and coordinates policies and regulations across sectors and levels of government is important. In addition, the ability to adapt to new technologies and changing environmental realities is critical to maintaining the relevance and effectiveness of proposed interventions.

In conclusion, we present **some immediate actions** that, according to the work carried out and the discussions with key stakeholders of the system, should be urgently carried out as a matter of priority in order to give continuity to the work of this study and create spaces for institutional innovation in the area of resilient infrastructure. Specifically, immediate actions are identified in three thematic areas (**Figure 19**).

FIGURA 19. CONCEPTUAL MAP OUTLINING IMMEDIATE INTERVENTIONS, DETAILING PROPOSED ACTIONS, TIMEFRAMES, IMPLEMENTATION TERRITORIES, AND STAKEHOLDERS INVOLVED.



IMMEDIATE ACTION 1: GOVERNANCE AND CAPACITIES

The first area of action is associated with strengthening inter-sectoral governance instances, and especially the construction of shared definitions and guidelines among the different stakeholders of the system in terms of resilient infrastructure.

It is suggested that the intersectoral dialogue group created for this project be institutionalized and made permanent, ensuring the participation of all the necessary sectors and ministries. Likewise, in order for these stakeholders to act as leaders in their respective units, it is suggested to strengthen the working group through a capacity building instance in the form of a 'Resilience Academy'[23], involving both national and international experts in the field.

ACTION	Institutionalization of the cross-sectoral group on Disaster Risk Management (DRM) and critical infrastructure resilience, supported by a 'Resilience Academy'.
DEADLINE	1 year
TERRITORY	National scale, involving central government, regional governments (GORE) and selected municipalities.
STAKEHOLDERS	SINAPRED, SENAPRED, MINEDUC

[23] *Resilience Academy, based on the model currently implemented in SENAPRED to train national SINAPRED officials, but strengthened with the Resilient Infrastructure Principles and international support from UNDRR and CDRI.*

IMMEDIATE ACTION 2: PILOT IMPLEMENTATION ON A REGIONAL SCALE

The geographic and cultural diversity of Chile creates heterogeneity in the incidence of risks and vulnerabilities and in the governance and resilience of infrastructure in different contexts and regions. Therefore, a pilot implementation of this methodology at a subnational scale, preferably regional, would allow identifying and considering differences in sectoral interactions and resilience practices and policies. This would also allow to strengthen the linkage of local and regional stakeholders and authorities in this process, and should also have a stronger participation of the private sector, civil society and regional academia.

ACTION	Pilot implementation of a study that deepens the diagnosis at the regional level and advances in analyzing and proposing initiatives to improve the governance of resilient infrastructure relevant to the territorial context.
DEADLINE	1.5-2 years.
TERRITORY	Regional or bi-regional in the Central-South macro-zone, potentially scalable to national level.
STAKEHOLDERS	SINAPRED, DGA, Ministry of Energy.

IMMEDIATE ACTION 3: INTEGRATED DATA CENTER

Chile has important data, assessments and diagnostics on resilient infrastructure, however, they are fragmented among different sectors and agencies. Therefore, an integrated data center and a unified system for monitoring, reporting and verification (MRV) of actions and initiatives for infrastructure resilience would strengthen and provide transparency to infrastructure planning and DRR.

ACTION	Collaborative design and piloting of an integrated data hub that promotes the availability of information and a monitoring and evaluation system for risk management and decision-making (Decision Support Tools, DST) for resilience.
DEADLINE	2-2.5 years.
TERRITORY	National, but initial pilot at the level of a macrobasin in the central valleys.
STAKEHOLDERS	SINAPRED, Ministry of Environment, Ministry of Science.

These immediate actions are intended to establish a coordinated commitment between different sectors and levels of government to improve resilience and risk management in the country. It highlights the importance of cross-sectoral collaboration, as well as the need to have both national and regional approaches to address specific risks. The stated deadlines indicate an urgency for action, with projects expected to be completed within 1 to 2.5 years, and the actors involved are mainly government agencies and ministries, underscoring the role of the government as a catalyst and coordinator of these initiatives. Moreover, the need to produce robust data and monitoring systems is emphasized, suggesting an orientation toward evidence-based decision making and adaptability of policies as new information is gathered.

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Photo: Pexels by Marek Piwnicki

APPENDIX 1: BREAKDOWN OF METHODOLOGY STEPS AND REFERENCE MATERIALS

STEP	CONTENT	DATA USED	PERIOD
Stakeholder mapping	Involves identification and participation (mapping) of key stakeholders within various critical infrastructure sectors to ensure resilient disaster management.	Kick-off workshop held on September 26, 2023. Questionnaire sent to participating Ministries and services.	June - September 2023
Review of existing policies and regulations	Consists of the assessment of current policies and regulations that impact infrastructure resilience, paying attention to cross-cutting and cross-sectoral aspects that may influence disaster response	Documentary review, including 3 cross-cutting documents and 35 sectoral documents. The selection of documents was based on inputs from the previous kick-off workshop.	August - November 2023
Vulnerability Identification (Stress Test)	The vulnerabilities of the infrastructure and the existence of interdependencies between different risks to which the infrastructure system may be affected are identified, thus allowing the prioritization of actions and resources based on solid data.	Analysis of national and international indicators and databases. Workshop held on December 14, 2023	October 2023 - March 2024
Assessment of resilience practices (Principles)	Builds on evidence previously collected in Workshop 1, conducted with stakeholders identified earlier in step 1; current infrastructure practices were assessed using a scoring tool developed by UNDRR, based on the Principles for Resilient Infrastructure.	Results step 2 Questionnaires sent to participating stakeholders Workshop held on December 15, 2023[24].	October 2023 - March 2024
Development of an Implementation Plan	Consolidation of the analyses carried out, which are discussed and validated in Workshop 2, held on April 8, 2024, to establish an implementation plan, and the Final Report is drafted.	Validation questionnaire to all participating stakeholders. Workshop held on April 15, 2024.	February - May 2024

[24] *Three working groups were formed at the workshop: 1) Ministries of Energy, Defense and Public Works; 2) Ministry of Housing and Urbanism, Undersecretary of Telecommunications, SENAPRED and Ministry of Public Works; 3) Ministry of Education, Ministry of Health, Social Development and Public Works.*

APPENDIX 2: MAIN CONCEPTS USED

ADAPTATION
An adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

THREAT
A phenomenon, substance, human activity or hazardous condition that can cause death, injury or other health impacts, as well as property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

CLIMATE CHANGE
A change in the state of the climate that can be identified as a result of a change in the mean value and/or variability of its properties, and that persists over an extended period of time, usually decades or longer.

SUSTAINABLE DEVELOPMENT
Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

DISASTER
An event that causes serious disruptions in the functioning of a community or society and causes great human, material, economic or environmental losses, which exceed the ability of the affected community or society to cope using its own resources.

RISK ASSESSMENT
A qualitative or quantitative approach to determining the nature and extent of disaster risk by analyzing potential hazards and assessing existing conditions of exposure and vulnerability.

RISK MANAGEMENT
The systematic process of using management policies, procedures and practices for risk identification, analysis, assessment, evaluation, treatment and monitoring activities.

DISASTER RISK MANAGEMENT
The application of policies and strategies to reduce disaster risk in order to prevent new risks, reduce existing risks and increase resilience.

INFRASTRUCTURE
The physical facilities and organizational systems that provide essential services to society, such as transportation, energy, water and sanitation.

RESILIENT INFRASTRUCTURE
Infrastructure designed and built to withstand and recover quickly from disaster events, minimizing impacts on the functioning of society.

VITAL FACILITIES
Facilities that are essential for the continuity of critical services during and after a disaster.

STRUCTURAL AND NON-STRUCTURAL MEASURES
Structural measures are comprised of physical constructions to reduce or avoid the impact of hazards, while non-structural measures are based on knowledge, practices or regulations.

MITIGATION
Actions to reduce or eliminate disaster risk, including structural and non-structural measures.

LAND-USE PLANNING
The regulation and management of land use in an area to prevent and reduce disaster risk.

PLANNING
The process of setting objectives and determining the appropriate course of action to achieve them.

PRINCIPLES FOR RESILIENT INFRASTRUCTURE
Guidelines for designing, constructing and maintaining infrastructure that can effectively withstand, absorb, adapt to and recover from the effects of a disaster.

DISASTER RISK REDUCTION
The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causes of disasters.

RESILIENCE
The ability of a system, community or society exposed to a hazard to resist, absorb, adapt to and recover from its effects in a timely and effective manner.

INFRASTRUCTURE RESILIENCE
The ability of infrastructure to resist, absorb, adapt to and recover from the effects of a disaster in an efficient manner.

SYSTEMIC RESILIENCE
The ability of the system as a whole to adapt to and recover from the effects of a disaster.

RISK
The combination of the probability of an event occurring and its negative consequences.

ACCEPTABLE RISK
The potential loss level a society or community deems acceptable based on existing social, economic, political, cultural, technical, and environmental conditions.

RISK TRANSFER
The process of formally or informally transferring the financial consequences of a particular risk from one party to another.

VULNERABILITY
The characteristics and circumstances of a community, system or asset that make them susceptible to the damaging effects of a hazard.

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UNDRR UN Office for Disaster Risk Reduction

CDRI Coalition for Disaster Resilient Infrastructure