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Abstract

This paper presents an integrative case-study examination of Chile's national strategy of research, development, and innovation (R&D+i) for disaster resilience and the progress towards developing the institutional conditions for its successful implementation. The article covers the period between 2016-2021, focusing on the work of the Chilean Commission of R&D+i for Disaster Resilience to Natural Hazards (CREDEN). Through an analysis of the official records of the initiative at all its stages and 29 semi-structured interviews with CREDEN's members and stakeholders, we aim to show a successful case of strengthening the role of science and technology in disaster risk reduction. The Chilean experience is particularly interesting because the Strategy focused on the role of R&D+i and proposed developing an industry of scientific-based technological solutions for disaster resilience. The case study also illustrates how the strategic interaction between academia, state, and industry can be a key factor for aligning knowledge production to tackle current socio-technical challenges.

Keywords: Disaster Risk, Science, Public Policy, Academia, Case Study

Introduction

The global agenda on disaster risk reduction (DRR) has increasingly highlighted the importance of integrating science into both policymaking and disaster management (STAG, 2013; UNISDR, 2015a). The UNDRR Scientific and Technical Advisory Group (STAG) was created in 2012 to link researchers with the most pressing problems posed by DRR (STAG, 2013, p.5). As a result, research was declared "key" to the post-2015 framework (UNISDR, 2015a, p.4), and the importance of increasing knowledge about disasters was stated clearly in the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015b). Sendai explicitly calls for efforts to understand disaster risk in all its dimensions—vulnerability, capacity, exposure, and hazards—urging researchers to ensure findings are not only useful but usable for decision-makers and different stakeholders.

Moreover, Sendai stresses the need for researchers of all disciplines to work closely with decision-makers, creating opportunities for collaboration, integrating knowledge, and ensuring findings reach broader audiences. This is not to say that other types of knowledge should not be considered for comprehensive disaster risk management (DRM), nor that every element of risk can be successfully quantified. What it shows is a consensus that risks should be assessed and mapped, "in broad terms at least" (UNDRR, 2019) as the first step towards effective DRR.

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/disa.12533](https://doi.org/10.1111/disa.12533).

Given this global agreement, several countries have tried to strengthen the relationship between science and disaster policy by encouraging outreach activities, including academics in the work of their national platforms for DRR, or incorporating scientists in their offices for emergency management. Yet, several case studies show that such initiatives are mostly project-based, focusing on one type of hazard, and involving scientists of one or two specific disciplines (STAG, 2013; 2019; DRMKC, 2017). Although these initiatives are very useful, there is a clear need for stronger and more permanent partnerships among disaster risk science, policy, and practice to tackle systemic challenges related to DRR with a transdisciplinary and comprehensive approach (DRMKC, 2017).

In this context, this paper presents an analysis of the rather unique experience of Chile, a country that has recently developed a strategy to strengthen the role of science and technology in DRR/DRM (from now on, the Strategy). The Strategy was developed in 2016 by the Chilean Commission of Research, Development, and Innovation (R&D+i) for Disaster Resilience to Natural Hazards (CREDEN) and has been recently institutionalized in the form of a public Institute for Disaster Resilience (Itrend).

The Chilean case is particularly interesting for several reasons. Firstly, CREDEN focused exclusively on the role of R&D+i in disaster resilience. Initiatives such as the *National Strategy for Disaster Resilience* developed by the Council of Australian Governments (COAG, 2011), for example, have included science and research as an important pillar of their strategy, but are not solely focused on this issue.

Secondly, CREDEN adopted a multi-disciplinary and multisectoral perspective. It was formed by about 80 experts from academia and the public and private sectors who worked together for a common goal. The so-called “Triple Helix model” has been deemed crucial for enhancing innovation (Leydersoff and Etzkowitz, 1998; Cai and Etzkowitz, 2020), but little is known about how these spheres can work together for linking research and innovation with complex public challenges such as DRR.

Thirdly, the Chilean Strategy addresses the problem of resilience from a multi-hazard perspective, looking to improve the role of science and technology on the whole DRR ecosystem. Similar initiatives such as the *National Earthquake Resilience* strategy developed by the U.S National Research Council (NRC, 2011) focus on one hazard only. Fourthly, CREDEN was innovative in aspiring to develop an industry of R&D+i solutions for DRR that could position the country as a regional leader in resilience (CREDEN, 2016).

Finally, the Chilean Strategy is worth studying because it managed to produce important outcomes, the most relevant being the creation of Itrend to support and oversee its implementation. We argue that the institute is not only the direct heir of CREDEN but also a venue where the lessons learned at the commission are constantly tested.

In the following sections, we present an integrative examination of this case. The question guiding this research is: what can we learn from this case study that can be replicated by other groups and countries facing similar challenges and looking to undergo a similar endeavour? In doing so, we must consider that both authors of this paper have been actors, participants, and witnesses of this process. Therefore, by producing this research we are also committing to an exercise of self-reflection, acknowledging that our own experiences and perceptions cannot be completely excluded from the analysis.¹ However, our

views have been complemented and contrasted with a methodological exploration of the case study, as explained in the next section.

Methods

Case studies have become increasingly important, as researchers realize their power to understand the relationship between decisions made at the micro-level and specific outcomes at the macro-level (Feagin, Orum and Sjoberg, 1991; Ragin and Becker, 1992; Becker, 2014). As Becker (2014) has masterfully explained, sometimes it is enough to show a connection between A (e.g., the existence of a strategy) and B (its outcomes), but sometimes we need to understand the practices that produced the results as they are. Aiming to gather these fundamental insights, the research for this article involved the in-depth analysis of an institutional history, combining documentary sources and interviews in different moments in time. The objective is not only to reconstruct the story of the Chilean Strategy but mainly to reason from this case about good practices to include R&D+i in DRR.

In terms of documentary evidence, different kind of primary documents were collected and analysed comprehensively. This includes public documents such as the Strategy itself and its Annexes, and internal documents such as previous drafts of the Strategy and meeting minutes (see Appendix). These documentary sources were gathered with the authorization of the institution or person involved. The analysis of documents is particularly relevant for reconstructing institutional history because they are both a record of what happened and an “enactment” of social dynamics in their original setting (Ritchie and Lewis, 2013, p.45; Mogalakwe, 2009).

The second set of qualitative data was obtained through 29 interviews with 23 participants and stakeholders of the Strategy (see Appendix). Interviews were semi-structured, guided by open-ended pre-defined questions but allowing interviewees to respond freely (Arthur and Nazroo, 2003). Fourteen interviews were conducted in 2017, a few months after CREDEN was over, aiming to gather the main impressions of the process from the point of view of its participants. These interviews lasted from one to two hours, were made in-person, and covered the topics of what the interviewees valued about CREDEN, what they would have done differently, and specific issues about what happened during the meetings (see full interview guide questions in Appendix). A second set of 15 shorter interviews were conducted in the period 2019-2021 to collect information on how participants perceived the legacy of CREDEN in perspective. Due to the current pandemic, nine of these interviews were done via Zoom. We included some of the previous interviewees and new stakeholders of the Strategy such as Itrend’s director and three of its board members, some of which were also part of CREDEN.

In the following sections, we combine the documentary analysis and interviews to analyse the Strategy, the process that created it, and its outcomes. Examination of interviews was done through thematic analysis (Schmidt 2004) following a topic guide constructed from the questionnaires. Relevant quotes have been included throughout the article to summarize ideas and present part of the richness of collected data.

Building Disaster Resilience in Chile

Due to its location within the Pacific Ring of Fire and the adverse impacts of climate change, Chile is among the countries most exposed to natural hazards worldwide. However, the country is in a good position in terms of disaster risk relative to other countries with similar exposure due to its relatively low vulnerability and reasonably high institutional capacities (Mucke et al., 2021).

In terms of vulnerability, literature shows that high-income countries are less vulnerable to disasters (Kellenberg and Mobarak, 2011; Loayza et al., 2012) and Chile is today the country with the highest GDP per capita in Latin America (USD 25,000). Regarding institutional capacities to cope with disasters, Chile ranks third in Latin America (Mucke et al., 2021) and has historically gained experience in dealing with disasters, increasing its institutional capabilities in the process. Still, out of a population of about 18 million, at least 800 died and 4 million people were left homeless due to disasters in the decade of 2008-2019.² From an economic perspective, these events have caused an annual average loss of 1.2% of the GDP (UNISDR, 2015c). From a social perspective, impacts have remained mostly unaccounted for, but case studies show significant impacts on different sectors such as education and healthcare (see e.g., García et al., 2012; Oyarzo et al., 2012; Díaz et al. 2012; Palmeiro-Silva et al., 2018).

Undoubtedly, the most relevant recent disaster is the magnitude 8.8 earthquake and tsunami of February 27, 2010 that killed at least 525, affected 69% of Chile's territory, and caused total damage of about USD 30 billion, equivalent to 18% of the country's GDP (de la Llera et al., 2017). This event was a turning point for the Chilean state, not only because of the large destruction generated, but also because the disaster exposed critical problems in terms of urban planning, technological development, protocols, and human expertise (Farias, 2014; Kane and Medina, 2015).

As a response, a National Plan for DRM was developed in line with Sendai and the advice of a United Nations commission. This Plan specified the "development of the scientific capacities of the country" (ONEMI, 2016, p.97) and "to encourage scientific research in terms of DRM" (ONEMI, 2016, p.109) as two important tasks for the period 2015-2018. Thus, the National Emergency Office (ONEMI), the National Seismological Center (CSN), and the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) underwent important reforms, including the creation of a new Tsunami Early Warning Center and a new seismographic network. Also, the government promoted scientific research related to disasters funding three major research centres in the areas of natural hazards and disaster risk (*CIGIDEN*), climate change and resilience (*CR²*), and sustainable urban development (*CEDEUS*). Each of these centres includes about 50 researchers from several national universities and disciplines that range from natural to social sciences and humanities. Finally, a national platform for DRR was organized by ONEMI in 2012 to enhance coordination between different public institutions.

The creation of CREDEN results from this increased attention to DRM together with the recommendations for enhancing R&D published by the Chilean National Council of Innovation for Development (CNID) in 2015. Without explicitly identifying them, CNID advised defining priority areas to guide future national R&D+i efforts (CNID, 2015). However, DRR was prevalent among the possibilities discussed by the commission that wrote the document (Government official, 2017). When receiving CNID's report, President Michelle Bachelet announced two priority areas: management of water

resources and “prevention and management of natural disasters (sic).”³ To address the latter, a commission later known as CREDEN was formed to develop the national strategy of R&D+i for disaster resilience. This commission is the focus of this article which aims to show that the most relevant aspect of the Chilean case is not the Strategy itself, but the reflections and networks developed or strengthened at the commission.

The Chilean Commission of Research, Development, and Innovation for Disaster Resilience to Natural Hazards, *CREDEN*

Following the presidential mandate, CNID made a broad call by the end of 2015 to experts from academia, government, and industry to discuss disaster resilience. According to CNID officials, experts were chosen based on their trajectory in disaster research, their role in DRM, or their leadership in strategic industries such as infrastructure and communications, “trying to maintain an equilibrium between different sectors, and also the different research centres and universities” (Government official, 2021).

Twenty-seven experts formed CREDEN’s Central Committee, 13 of them representing academia (covering natural sciences, social sciences, and engineering), eight from the public sector, and six from industry. Overall, members were high-ranked academics, officials, and executives with expertise in disasters. Several had multisectoral and interdisciplinary backgrounds having worked in more than one sphere of the Triple Helix. For example, two government officials were scientists representing the National Seismological Center and the National Geology and Mining Service. CNID appointed an academic and entrepreneur as president of the commission due to his multiple roles in the resilience ecosystem, which included advising CNID (Government official, 2017). Overall, the commission’s focus on R&D+i meant that academia stood out in CREDEN’s composition and discussions.

Simultaneous to the work of the Central Committee, four subcommittees worked on the different dimensions of the Strategy: Social Resilience, Innovation for Development, Response and Risk Assessment, and Physical Processes and Exposure. Each subcommittee was formed by an average of 15 permanent members and a variable number of guests. Most members of the Central Committee were also part of one subcommittee, taking leading roles in these groups. Additionally, the work of CREDEN was accompanied by two assistant teams from CNID and P. Universidad Católica de Chile (UC-Chile). Convening such high-level participants for an 8-month endeavour carried the fear of decreasing participation with time, as had happened with similar commissions organized by CNID in the past. But “the fact that CREDEN was a request from the President was important to ensure engagement”—claims CREDEN’s president (2021)—“it was not easy to say no.” Overall, 76 experts representing different sectors, disciplines, and stakeholders participated in the development of the Strategy (plus guests who participated in only one meeting).

To organise the work of such a large group of experts from different sectors and disciplines was a big challenge. To do so, CREDEN committed to the idea that connecting the different spheres of the Triple Helix is crucial to solving complex societal problems, but the commission did not follow any specific

methodology. According to Cai and Etzkowitz (2020, p. 7), it is common to see that “the Triple Helix is sometimes used as a flag, a guiding heuristic” by several projects that many times fail to accomplish their objective. However, even without a clear model, CREDEN achieved a successful dynamic, focusing on bringing research and academia closer to other actors in DRM.

In the next subsections, we explore the most relevant characteristics of CREDEN’s multisectoral and interdisciplinary model *in practice*, looking for the main lessons learned at the commission that can help illuminate other similar endeavours. These sections correspond to the themes emerging from the interviews, complemented and contrasted with documentary analysis in order to assess their relevance in the Strategy.

A legitimate host

The presidential mandate was important for CREDEN’s success because it gave the project relevance and legitimacy. According to the interviewees, a second source of validation was given by CNID, which hosted the commission. As a public institution aiming to strengthen R&D+i in the country, the Council had the advantage of being considered a highly “technical” and “non-political” organization by most actors (several interviews). For public organizations, the fact that CNID is a state organization gave assurance about the public role of the Strategy. Still, it was difficult at the beginning to convince actors closer to DRM, such as the National Emergency Office (ONEMI), that the commission should be held at CNID. “At the beginning, the differences between CREDEN and the national platform [for DRR], functioning since 2012, were not clear to us”, claimed a government representative (2021), “but eventually the puzzle was cleared up, it was made clearer that the focus was bringing academia to the table.”

CNID was considered a privileged host to do so, since academics perceived that its mission is “linked with science” (Academic, Nat. Sci., 2017) although CNID neither directly funds nor participates in academic research projects in Chile. CNID is an institution that constantly works with scientists on different projects and has a board where many academics participate. Industry, on the other hand, was also familiar with the work of CNID, understanding its mission as to “increase development” (Industry leader, 2017). This multifaceted interpretation of CNID’s role allowed the Council to be seen as a legitimate host for the commission.

A clear objective and well-defined workflow

The objective of CREDEN was to develop a national strategy for strengthening the role of R&D+i on disaster resilience. One of the first things highlighted by interviewees is that the scope was clear from the beginning. “When we started, I was a little worried. It seemed like a broad task, and we were all over the place”—claimed a government official (2017)—“but the fact that it was focused on science and research really helped.” Document analysis shows that members were constantly asked to focus on issues related to the role of R&D+i on resilience, leaving aside other relevant topics such as operational concerns for DRR/DRM. The main assumption was that better knowledge about disaster risk and its components is required to reduce it. In the words of CREDEN, “the objective [of this work] is to prevent

‘chance’ to play a role in future extreme natural events, and to anticipate their consequences using the maximum possibilities given by research, technology, and innovation” (2016, p.20).

Together with the importance of focus, the methodical and systematic organization of the work to be done was one of the most salient topics. “I have participated in several commissions”—claimed an academic (2017)—“but CREDEN stands out in terms of methodology and organization.” Certainly, since our interviewees are members of CREDEN themselves, they are partially evaluating their own work. However, they felt that credit for organizing the workflow should be given to the executive team and CNID, since the structure, goal, and activities of CREDEN were defined before they were invited to participate. In the words of another participant, “when we arrived at the meetings it was not just to talk, you know... to talk about disasters, no. There were tasks and activities already planned. That really helped” (Government official, 2019).

Documentary analysis shows that the executive team looked for other relevant experiences worldwide to organize CREDEN. Even though they could not find something that completely resembled the work ahead, the NRC’s earthquake strategy (2011) stood out as a reference because of its organization around tasks. Thus, this document was used to design an outline for the Strategy. This outline consisted of two main components: a vision for a future resilient Chile, and a roadmap of research tasks. As the work of the commission advanced, this pre-defined outline suffered several changes. However, interviewees agree about the importance of having a starting point: “The path we had to walk through was already settled, and that was mostly good” (Academic, Eng., 2017).

When asked about downsides to this organization some participants claimed that they would have liked to have more influence in the early definitions of CREDEN. “Sometimes I felt that it was too pre-fabricated”—claimed a government official (2017), adding that “we had little to say about the fundamentals of our work.” A representative from academia reflects on the same issue: “there was a clear management, and little time to talk freely or maybe question CREDEN assumptions” (Soc. Sc., 2017). However, these interviewees seemed to conclude that having a clear path for the work to be done was necessary to finish the Strategy. “It is obviously very hard to move forward with a large group and restricted time. So, I get it, I get the need for this work dynamic” reflected the mentioned government official. In the words of the academic: “Still, the methodology worked, it was a successful exercise, both in a practical and a cognitive sense. I ended up appreciating it at the end.”

Summarizing, this theme addresses the importance of well-defined goals, tasks, activities, and the overall organization of the work to be done to properly engage participants in a task of great magnitude. The pragmatism and practicality of the meetings made the time devoted to CREDEN feel well invested. “This kind of thing needs to be productive, and participants need to feel that they are learning something, gaining something” (Academic, Soc. Sci., 2017). Still, improvements could be done in increasing participation in the design of the workflow and outline.

Reconciling epistemologies and common definitions

One of the main challenges of CREDEN was the diversity of backgrounds among its members. Besides working in different sectors, they were also trained in very different disciplines across engineering,

natural sciences, and social sciences. In the interviews, this was presented as both beneficial and challenging. On one side, the multiplicity of worldviews allowed CREDEN to analyse disasters in complex ways, “adding layers and layers of knowledge” to improve the ideas being discussed (Academic, Soc. Sc, 2017). However, this was also a challenge for the commission because people did not know each other, and even academics of the same institution felt they belonged to different worlds: “we were a community, but we could not recognize each other as such” (Nat. Sc., 2017).

Furthermore, this myriad of scientists needed to converse with practitioners, and this was a challenge both ways. For a government official (2017), “the state and industry sectors do not have the capacities to take advantage of the work of academia. Industry plainly does not understand them, and therefore sees no benefits” (2017). A representative of the private sector described the same issue from his point of view “[in Chile] a lot of knowledge is being produced in universities, but only a little is useful for decision-making” (2017). For another government official (2017), the core of the problem is that “scientists simply do not know how to talk in plain language and therefore knowledge stays in the classroom.”

A social scientist who participated in CREDEN representing an NGO summarizes this many interpretations of the problem claiming that “several epistemologies were at the table, even with a different understanding of the same concepts” (NGO, 2017). Interviews give credit to this description of the problem. According to several interviewees, communications challenges were greatly solved by the development of common language and definitions.

The first issue was the use of the term “natural disaster” in the original name of the commission, a concept that was labelled as a misnomer by various members. “What I first learned at CREDEN is that disasters are not natural, but events from nature that become catastrophic because of human exposure and vulnerability” (Government official, 2017). After repeated discussions, it was agreed that the term “disaster of natural origin” would be used in all official documents and the name of the commission.

Another important definition discussed at CREDEN was the understanding of disasters as events, instead of focusing on the permanent conditions that allow for natural hazards to become catastrophic. According to the original definition, the commission was to consider earthquakes, tsunamis, volcanic eruptions, landslides, firestorms, and extreme climatic events intensified by climate change. This left aside other threats such as terrorism and pollution. Several members thought this scope was too restrictive, and that CREDEN should better focus on prevailing conditions of vulnerability and exposure. However, others thought that an emphasis on disasters themselves was justified because the challenges posed by extreme events are different than those at regular times, even if both are connected. They feared that a focus on “times of peace” would delude the work of the commission and that “no one was taking extreme events seriously. In a highly seismic country, that is serious” (Academic, Eng., 2017).

Thus, it was decided that the Strategy would be discussed under the framework of sustainable development, and members were encouraged to think beyond the emergency phase and consider the role of science and technology in the full DRM cycle. Still, a focus on intensive disasters triggered by low-

frequency hazards with potentially large human, social, physical, environmental, and economic impacts was maintained as a guide for defining the R&D+i priorities in the Strategy.

Finally, a central epistemological debate was about the concept of resilience and its many definitions across disciplines (see e.g., Davidson et al., 2016). One of the subcommittees took the task of working a definition that suited CREDEN considering its goals and diversity. Their starting point was the definition of resilience from Sendai.⁴ After many sessions discussing the issue, CREDEN's definition of resilience was set as the following:

“Resilience refers to the capacities of a system, person, community, or country exposed to a hazard of natural origin, to anticipate, resist, absorb, adapt, and recover from its effects in a timely and effective manner, and to achieve the preservation, restoration, and improvement of its structures, basic functions, and identity” (CREDEN, 2016, p.4) [translated by the authors].

Note how this definition differs from Sendai's approach in some important points. First, CREDEN acknowledges that resilience can be achieved at different levels, including whole countries, while Sendai's only explicitly names communities and societies. Second, CREDEN highlights natural hazards, leaving aside crises caused by e.g., biological agents or terrorist attacks. Third, CREDEN adds the capacity to anticipate the effects of extreme natural events to the ideas of “resist, absorb, accommodate, and recover” included by Sendai. This was important considering the focus on science and technology. Overall, these changes or additions reflected CREDEN's goals and were considered crucial by interviewees because it allowed the commission to have a common ground.

This and other terms discussed at the Central Committee and several subcommittees were compiled as a glossary and included in the Annexes of the Strategy. This work took significant time, especially at the beginning of CREDEN, but it is regarded by the interviewees as crucial for the development of the Strategy.

Disasters as an opportunity

An innovation of the Chilean Strategy is that it presents a view on disasters that some participants describe as “hopeful” (Government official, 2019). This is partly because CREDEN was born from the confluence of two national agendas, DRM and R&D+i. Congruently, the Strategy had to serve two purposes: to use knowledge for mitigating the effect of disasters by increasing physical and social resilience, and to boost knowledge for creating an industry of scientific-based technological solutions for DRR (CREDEN, 2016, p.53). “In this, CREDEN was truly innovative”, claims a representative of industry; “it invited us to think beyond prevention and to dream about using disasters for innovation” (2017).

CREDEN thus proposed that Chile could become a regional leader in disaster science, taking advantage of its problematic geography and defying common views of hazards as an obstacle to development. Presenting Chile as a *natural laboratory* for disaster resilience was discussed at the meetings, an idea used previously by the Chilean government in relation to astronomical observation (Aguilera and Larraín, 2018).

This approach was important for participants, as the interviews reveal that many felt that their experience at CREDEN completely changed the way they approached the challenges associated with DRM. According to a government official (2017), “for a while now, other countries see us as a reference in disaster response. Developed countries see us as a possible partner, not just a ‘subject’ [of study]. But to be a leader in resilience is something different.” This challenge was included in the final version of the strategy as part of the vision: “to make the challenges of natural hazards an opportunity, as water risks are to the Netherlands” (CREDEN, 2016, p. 22).

Work on real local problems and concrete tasks

Another arising theme is the orientation of the Strategy towards what the interviewees referred to as “concrete” and “practical” challenges, as opposed to discussing philosophical questions. As mentioned, the initial structure of the Strategy consisted in a roadmap of R&D tasks. “Otherwise, the Strategy had a high risk of becoming just an intellectual exercise”—claimed a representative of CNID (2017).

In the words of a geoscientist: “in Chile, research topics depend completely on the curiosity of researchers. And that is ok for disciplinary development, but it also presents problems. Research questions are not always useful” (2017). A government official (2017) claimed something similar when expressing that “there is a scientific logic that tries to influence globally, to ask questions from the German school, or the American school or the Japanese school. They become agents of that frame, and do not try to answer the questions posed by their own country.” These challenges were spotted and tackled early on by the executive team and some of CREDEN members. Documentary analysis of meeting minutes shows that scholars were repeatedly invited to listen to all stakeholders on the table rather than generating research questions from literature reviews or an exclusively scientific drive. When asked about this, CREDEN president stated that “at CREDEN, we pushed for something different, we needed to address real problems, real pains” (2021). Emphasis was thus placed on understanding current challenges in public policy and the resilience of communities and strategic industries, and how R&D+i could help solve these problems.

This theme appears most prominently among academics and government officials who were part of the subcommittees. Whereas the Central Committee met once a month to work on the big epistemological questions of the Strategy, the subcommittees met fortnightly for five months to work on the tasks. For each task, the subcommittees had to produce a comprehensive description, identify current local capacities and knowledge in the topic, and imagine the R&D+i actions or projects to be developed in the next 20 years. Additionally, they had to calculate an estimated budget and the requirements, inputs, and considerations for their implementation.

Consequently, the subcommittees were inherently more specific than the Central Committee. This also increased the risk of falling into siloed work, since some tasks were better related to specific disciplines or sectors. To avoid this, each subcommittee was interdisciplinary in its core, with experts from different sectors and disciplines, and the freedom to invite guests for specific topics. From this space, subcommittees questioned some of the assumptions made by the Central Committee when defining the topics for each group. For example, no representatives of civil society were initially considered in the

commission, which the Social Resilience subcommittee addressed by incorporating two representatives from NGOs (one of them interviewed for this article).

Overall, what the interviewees highlight most about the work at the Subcommittees is the awareness academics got from other actors about current challenges in different areas and the knowledge that was needed to address them. “Working on tasks make me realize all that we were not doing. We do a lot of science, important science, but there is a lot that we are missing,” concluded an academic (Nat. Sci., 2017).

Defining the enabling conditions for the Strategy

Early on, the discussion about the resources needed to complete the tasks showed gaps or structural concerns common to several of them. In other words, while a roadmap of tasks was practical and important, some things should be addressed systemically and urgently for this roadmap to be completed. In the words of CREDEN’s president “this led to the realization that every strategy needs to create the conditions for its success” (2017).

The first issue that came out in the meetings as common to several challenges across different subcommittees was the lack of reliable data for R&D+i. In the words of one interviewee: “We agreed that in Chile, today, information is not systematized, and there are no protocols to share information among institutions, not even among public institutions” (Government official, 2017). At CREDEN, participants were able to share their experiences about this topic, realizing that some relevant data is never produced due to a lack of measurement and monitoring instruments, methodologies, or protocols. Moreover, some data is collected by multiple sources with different purposes and in different formats, and it is not always available for research or innovation activities. This problem was very present for industry representatives: “there is good information about some risks but it is really dispersed and difficult to obtain, and as such, it is not usable for us” (Industry leader, 2017). Thus, generation and integration of data was considered a base condition for the implementation of the Strategy.

Similarly, the need for advanced human capital was repeatedly considered a problem at different subcommittees. Data from CNID (2015) showed that Chile had 0.9 people engaged in R&D per one thousand workers when the OECD average is 7.6. This lack of researchers affects several areas of knowledge but is especially relevant for disaster research because of its interdisciplinary nature. As one academic stated, “Most scientists in the country do not devote themselves to disasters but work on broader topics such as geology or climate. Thus, many people serve in too many projects and too many boards” (Nat. Sc., 2017). Social scientists agreed with this idea, especially since many do not identify themselves as “disaster scholars,” even though they have researched one or two cases during their academic careers. “From the point of view of social sciences, we are only a few [disaster scholars]. But we do our best to influence” (2017).

A third common aspect was the need for world-class infrastructure for research. “You do not have a strategy without facing the brutal facts”—says an academic—“and the brutal fact is that there is a huge gap of infrastructure development in science and technology in the country” (Engineering, 2019). At the

Social Resilience subcommittee, a similar problem appeared when discussing possibilities for research: the lack of methodologies to assess many of the topics that were being discussed.

These transversal issues were presented to the Central Committee. After two meetings, including one where a complete analysis of the links between tasks was presented, it was decided to add a set of *enabling conditions* to the outline of the Strategy. The enabling conditions are defined as major structural concerns that hinder the development of high-impact R&D+i in the country and should be addressed immediately for the tasks to be completed in the 20-year period of the Strategy (CREDEN, 2016). Their inclusion as a separate section was a major innovation from the initial outline, and it will prove to be crucial for the Strategy's success.

Importantly, the first draft of the Strategy included only three enabling conditions: Data and Information, Advanced Human Capital, and Infrastructure for R&D+i. However, two more enabling conditions were added later. One came from the concerns repeatedly raised at the different meetings of the Central and subcommittees about the continuity of the network formed within CREDEN. The multisectoral and multidisciplinary composition of the project was considered successful and useful by its members, and meeting minutes show how many felt that it was the greatest outcome of their work: "for us, CREDEN is nothing more than a first step; the impulse must go on" (Academic, Nat. Sc., 2017). Several other members repeated this idea in the interviews: "there is a concern in the subcommittee of how [CREDEN] is going to go on after the Strategy is published" (Academic, Soc. Ss., 2017). Thus, the development of permanent institutional capacities for R&D+i in the resilience ecosystem was included as enabling condition.

Finally, a repeated concern at CREDEN was that current developments in terms of R&D+i in the country fail to reach decision-makers in the public and private sector, as well as communities and society in general. Additionally, the notion of "knowledge transfer" that was initially present in many documents was questioned by some members. Eventually, this idea evolved towards a different model, one where knowledge is co-produced by different stakeholders. Awareness about the role of other actors such as communities and civil society not only changed the wording of some tasks but also stands out as the most important challenge that the Strategy had to address in the future. Therefore, the final enabling condition to be included in the Strategy was enhancing outreach and scientific communication among different actors, incorporating civil society and communities.

The Chilean R&D+i Strategy for Disaster Resilience

The final document of the Strategy, entitled *Toward a Disaster Resilient Chile: An Opportunity* (CREDEN, 2016), was presented to the Chilean President in a public event on December 20th, 2016. In this section we provide a glance of the Strategy's content. A broader English summary can be found at de la Llera et al (2018). After an introduction with a historical analysis of disasters in Chile and their connection with scientific developments in the country, the core of the Strategy consists of the description of the five enabling conditions and a list of 14 tasks that describe a route for strengthening the role of science and technology in disaster resilience (Table 1).

Table 1: Structure of the Strategy.

Objective	To make Chile more resilient to the impacts of extreme natural events through original R&D+i solutions that will have a positive impact on the country's development			
Dimensions	Resilience	Innovation for Development	Response and Risk Assessment	Physical Processes and Exposure
Tasks	T1: Social resilience to disasters of natural origin T2: Resilience of lifelines and critical infrastructure T3: Projects on community resilience	T4: Public goods and policies to activate the demand for innovation in disaster resilience T5: Next-Generation of technologies, sustainable materials, components, and systems T6: New applications of ICCT* and other technologies	T7: Scenarios for disasters of natural origin T8: Simulation of losses and risk assessment T9: Assessment and improvement of the built environment	T10: Physics of processes related to natural hazards T11: National monitoring and reporting system for natural hazards T12: National models of natural hazards T13: Early warning systems T14: Predictive models for disaster response operations
Enabling conditions	Institutional framework Integration of data and information Advanced human capital Infrastructure for science and innovation Outreach and scientific communication			

Source: summarized and translated by the authors from CREDEM 2016, p.55

*ICCT: *Information, Control, and Communication Technologies*

Each task proposes the thematic basic, applied, associative, and interdisciplinary knowledge that needs to be generated and used to achieve the overall objective of increasing Chile's resilience through R&D+i solutions. Each task comprises a brief description of what it entails, a vision of the expected situation 20 years on, once the task is completed, a set of three to six specific R&D+i projects to achieve it, and the resources and requirements needed for its implementation (see an example in Table 2).

Table 2: Example of a Task.

TASK 1	Social Resilience to disasters of natural origin			
Description	To understand how and why systems, people, communities, and regions are able to organize and effectively practice resilience			
Vision	R&D+i in different fields allows to develop new strategies to enhance resilience and improve the conditions of vulnerable people and communities			
Projects	<u>Project 1</u>	<u>Project 2</u>	<u>Project 3</u>	<u>Project 4</u>
	To develop and implement protocols for generating and sharing data and information about different territories in order to compare and comprehend resilience	To determine the different characteristics of resilient communities, in different ecological and sociocultural context, identifying critical factors	To identify good examples of community practices related to disaster risk	To identify good practices in education and risk communication that enhance resilience in different levels
Resources	Identify and support researchers and centres whose work relates to social resilience Identify, generate, and make data and information on vulnerability and capacities of the different communities in the Chilean territory available Specific outcomes of enabling conditions ii, iii, and iv			

Source: Summarized by the authors from CREDEN (2016)

The enabling conditions were an innovation that resulted from the work of CREDEN, perceived by the interviewees as crucial for its success. Apart from including a diagnosis of each structural gap, the Strategy contains specific proposals to address them in the short term as follows:

- i. *Institutional framework.* Different ideas such as more funding for research and new commissions to deal with specific R&D topics were discussed at the Central Committee aiming to ensure that the network formed with CREDEN survived and expanded. In the end, a proposal for creating a new public technological institute for disaster resilience was included in the Strategy.
- ii. *Integration of Data and Information.* The Strategy proposes the development of a major platform of data and information useful for R&D+i in disaster resilience. This digital infrastructure should centralize all new and historical data related to disaster risk and make it publicly available.
- iii. *Advanced Human Capital.* The Strategy proposes to develop double-doctorate degree programmes devoted to disaster resilience in partnership with international institutions, and a postdoctoral program of applied research on resilience in connection with strategic industries.

iv. *Experimental infrastructure for science and innovation.* CREDEN proposed the creation of a national grant to develop and consolidate laboratories to advance research on five topics: resilient infrastructure, extreme climatic events, tsunamis, an advanced manufacturing laboratory, and an observatory of social resilience.

v. *Outreach and scientific communication.* It was established that research funded in the context of this Strategy should produce public goods that go beyond academic publications, emphasizing the transfer of knowledge to industry, civil society, communities, and especially government and public policy.

Budget and expected returns

The cost of implementing the Strategy was estimated at an annual average of USD 45.7 million, for a total cost of USD 914.2 million in twenty years (US dollars of 2016). Of this total, USD 315 million would be allocated to the enabling conditions and the rest to the 14 tasks. CREDEN's research team calculated the estimated benefit/cost ratio (B/C) of implementing the Strategy following the comprehensive analysis made by the Multihazard Mitigation Council for the United States to quantify the B/C of resilience "knowledge" or "process" programs (MMC, 2005). These are defined as R&D+i activities leading to policies, practices, and programs aiming to reduce risk. The Strategy's B/C was estimated at 2.32, meaning that for each dollar invested in the Strategy, it is expected that Chile will save 2.32 dollars in future disaster-related losses.⁵

Calculating the cost of implementation and expected returns of the Strategy is identified by the interviewees to be very important in the success of CREDEN. Compared with other similar initiatives that have not prospered as the Strategy has, a government official (2021) is clear: "the resilience strategy had a clear budget, and that changes everything."

Assessing the Impact of the Strategy

We have repeatedly claimed that CREDEN and the Chilean R&D+i Strategy is a case of successfully enhancing the role of science and technology on DRM. In this last section, we support this statement with examples of how CREDEN and the Strategy have impacted the Chilean resilience ecosystem.

The first outcome of CREDEN came immediately after the Strategy was published. The Chilean National Commission for Scientific and Technological Research (CONICYT, now ANID), which actively participated in CREDEN and co-led one of the subcommittees, launched a new scholarship program to fund master's degrees abroad related to disaster resilience. The creation of this program is directly linked to the conversations within CREDEN, especially those about the gap in human capital (Government official, 2017). According to data from Itrend (2020), since 2017, a total of 20 grants have been awarded, covering topics in natural sciences, social sciences, and engineering.

The foremost conclusion of the interviewees, however, is that the main impact of the Strategy was not the document itself, but the networks generated or strengthened during the year of CREDEN's

functioning. In the words of an academic, “now we have a community [of disaster experts] that recognizes itself as one, and it is broader and more diverse than I once thought” (Nat Sc. 2017). Most of the interviewees highlighted how much they learned from each other and how they started to see disasters as a common field. In the words of another researcher, “we came from different places but, once created, the commission started to have a life of its own” (Eng. 2019). Thus, it can be said that all other outcomes of the Strategy result from the conformation of this intersectoral and interdisciplinary group.

CREDEN both provided a much-needed space to reflect on the importance of R&D+i on DRR and filled an institutional gap, strengthening links between government, industry, and academia within the disasters ecosystem. The value of enhancing these networks was rapidly understood by CREDEN members, leading to high engagement throughout the process, and a push for maintaining the initiative in the long run. This impulse was expressed in the creation of the Chilean Institute for Disaster Resilience, Itrend, in 2019. As proposed by the Strategy, Itrend aims to help Chile become more resilient through the development of public goods and services based on R&D+i. To do so, the institute looks to help the resilience ecosystem thrive, generating the conditions needed for Chile to become a regional leader in science-based solutions to disaster risk (see www.itrend.cl). “In practice”—claims Itrend’s Director—“this means to promote and monitor the Strategy. It means to make sure that the science and knowledge that is produced in the area of disaster risk ends up being useful, both for public policy and also for the development of new technologies or services” (2021).

The institute was made possible by the efforts of several CREDEN members at different institutions. CORFO, the Chilean development corporation, played a crucial role by providing a grant to formally assess the necessity and feasibility of such an institution. For almost a year, an advisory board of former CREDEN members worked with CNID to identify and shape the legal and institutional arrangements of Itrend and apply for long-term funding from CORFO. It is important to notice that, during this time, the Chilean government changed its administration, and a new coalition took over the Presidency. However, the continuous support of CORFO, CNID and two of the most prominent universities in the country (UC-Chile and University of Chile) meant that the project survived the turmoil. CORFO approved Itrend by late 2018 with a total budget of approximately USD 7.6 million for 10 years.

Since 2019, Itrend has embodied the continuity and legacy of CREDEN. The institute works with different stakeholders on a project-based scheme to generate the enabling conditions defined by the Strategy. In this line, Itrend has created several online platforms to connect and share information among stakeholders. Mainly, an open data platform with information about disasters and resilience for researchers in different disciplines (<https://www.plataformadedatos.cl/>). Also, the website *Conecta Resiliencia* (<https://conectaresiliencia.cl/>) focused on practitioners where different actors can share knowledge and learn from each other. Finally, the project *Aprende Resiliencia* (<https://aprenderesiliencia.cl/>) shares material for schoolteachers to discuss resilience in the classroom. Several of the material comes from different research projects developed in the country.

Itrend has also learned from CREDEN's work with the Triple Helix, generating numerous working tables where academia, government, and industry collaborate in addressing issues related to DRM. Topics covered by these working tables include the risk of urban fires, operational continuity of lifelines, DRM at the local level, and risk governance of water resources. In these workshops, the lessons learned at CREDEN are constantly tested, hoping to improve intersectoral and interdisciplinary work around resilience. In 2020, Itrend cooperated with the International Development Bank to apply the Index of Governance and Public Policy in Disaster Risk Management (*iGOPP*) in the country, where the experience of Itrend to develop the intersectoral workshops was included as an innovation to the methodology.⁶ Also, it shows Itrend's recognition and legitimacy in resilience ecosystem nationally and abroad.

The institute is currently attempting to assess the impact of the Strategy on research about disasters and resilience. According to data provided by Itrend (2021), funded research projects related to resilience doubled the two years after the 2010 earthquake. By 2015, however, the numbers were slowly returning to previous levels. After 2016, the year of CREDEN, the numbers rose again, reaching in 2018 levels above those of 2012. A similar effect can be seen in the number of papers published about disasters in Chile, where earthquakes continue to be the main topic (Itrend, 2020). None of this data alone can prove that the tasks had the impact that CREDEN wanted them to have, but show a tendency.

It is clear that the work of Itrend has focused on the enabling conditions, and in particular, the coordination of the resilience ecosystem. Several stakeholders highlight the important role that Itrend has for their work today. For example, many academics have joined the work of the National Platform for DRR. As highlighted by a representative of ONEMI (2021), "all this work we do, it is all voluntary. People do it if it makes sense to them, or if they think is important. And there is where Itrend's work articulating actors becomes most important." In the words of Itrend's director: "From CREDEN we inherited a leitmotif, and this is to focus on the gaps or failures of the system that hinders coordination. That is what Itrend does every day, to help coordinate actors, languages, goals, always maintaining the spirit of CREDEN alive, and that spirit is to work together for a vision of a more resilient Chile" (2021).

Final Remarks

There is a global agreement on the need to enhance the role of science on DRR. However, only a few successful strategies have managed to do so. Among these, the Chilean Strategy stands out for its impacts on the whole resilience ecosystem. The case study shows that its success is mostly due to the networks created and enhanced during the time that CREDEN worked discussing a vision of resilience, the contributions of science and technology to such purpose, and the strategic tasks needed to achieve it. Our integrative case-study analysis of the inner workings of CREDEN shows that several factors influenced its success.

In this final section, we briefly discussed the limitations of this project. The first limitation of CREDEN's work was the relative absence of representatives from civil society. This issue was not only highlighted in the interviews but part of CREDEN's discussion as well. Hence, the Strategy may be lacking tasks that are

real and concrete problems for communities and civil society. This can be addressed by including members from this sphere in upcoming similar endeavours. Itrend has tackled the issue by constituting a Council of Civil Society in 2021.

Secondly, a major challenge for the Chilean Strategy comes from its ambition to include the goal of creating a market of knowledge-based technologies from resilience. The impact of CREDEN on science, and the relationship between academia and the public and (some strategic) private sectors is something that stakeholders notice today. However, using the produced knowledge for technological development and innovation has proven to be more difficult than expected.

Overall, assessing the impact of the Strategy beyond Itrend is elusive. We intended to do so by inquiring retrospectively to those involved in this institutional story about what they see as the main contribution of CREDEN's endeavour. The creation of a new institution (Itrend) with the explicit mandate of implementing the Strategy is an evident outcome. However, Itrend is just starting its functioning and several challenges remain. In particular, several interviewees highlighted that while Itrend has inherited CREDEN's mission and work model, it has not completely received the relevance and urgency that the presidential mandate gave CREDEN.

The institute has managed to engage universities, the state, and strategic industries in the discussion of disaster resilience in new, innovative, and productive ways. But relying completely on coordinating the system has also shown limitations. Some actors see that the institute is not strong enough to enforce the Strategy, because it cannot directly fund projects (several interviews) nor mandate public institutions to implement the results of the working groups (several interviews). This is important because it directly relates to the possibilities of expanding the success of the Strategy and should be addressed in the future.

the main conclusion of this case study is that the most important development of the Strategy was generating a space where different sectors and stakeholders gather to think strategically about the contributions of R&D+i for disaster resilience. CREDEN's workflow model has been constantly referred to as fruitful (several interviews), creating a positive precedent from the disaster resilience ecosystem in multisectoral initiatives. Finally, we believe that case studies like the one show how disaster resilience provides a relevant space where practices for tackling complex societal challenges can be tested and eventually replicated in other spheres.

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Data Availability Statement

The data that support the findings of this study are available upon reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Acknowledgements

This case study examination was possible because of the involvement of many people. First of all, we want to thank the 23 experts who agreed to be interviewed for this article, some of them more than once. Special thanks to Juan Carlos de la Llera from P. Universidad Católica de Chile, Catalina Undurraga from the Chilean Institute of Disaster Resilience (Itrend), and Katherine Villarroel from the Chilean National Council of Innovation for Development (CNID) for allowing us access to the material and contacts needed to complete our research. Many thanks to Diego Cárcamo who helped us with fieldwork and analysis. This research was partially funded by the Research Center for Integrated Disaster Risk Management (CIGIDEN) [ANID/FONDAP/15110017] and the National Agency of Research and Development (ANID) through Becas Chile programme, scholarship #72190127. The study sponsor and collaborators had no role in the study design, analysis, or interpretation of data.

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¹ Both authors were part of the UC-Chile's team supporting CREDEN's work. At the time, Dr. Gil was a graduate student at Columbia University and Mr. Rivera was working at UC-Chile and CIGIDEN. Professor Gil is today part of Itrend's expanded network of experts and has collaborated with the institute in several projects. Mr. Rivera is finishing his PhD at University College London.

² Calculations made by the authors based on data from EM-DAT (2019) and reports from Chile's National Emergency Office (ONEMI). See: <https://www.emdat.be/>

³ 'Discurso de la Presidenta Michelle Bachelet al recibir el informe de la Comisión «Ciencia para el Desarrollo de Chile»'. <http://archivospresidenciales.archivonacional.cl/index.php/discurso-de-michelle-bachelet-al-recibir-informe-de-comision-presidencial-ciencia-para-el-desarrollo-de-chile> (last accessed 27 January 2022)

⁴ "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR 2015b, p. 9)

⁵ The methods for calculating the budget and its expected returns are fully described in the Annex of the Strategy. An English summary of the budget calculation can be found in de la Llera et al. (2018)

⁶ Information about these workshops can be found at <https://conectaresiliencia.cl>

APPENDIX

A. INTERVIEW TOPIC GUIDES

Interviews 2017

- How do you see the role of research, development, and innovation on disaster risk management?
- How do you see the current state of research, development and innovation related to resilience in Chile?
- After your work in CREDEN, has this vision changed? How so?
- After the work of CREDEN, what are—in your opinion—the major gaps for strengthening the role of research, development, and innovation in disaster resilience in the country?
- How do you evaluate the work of CREDEN?
- What lessons do you take from the work of CREDEN?
- Do you think other countries can learn from the experience of CREDEN? How so?
- How was the work with people from industry/public/private sector, from your perspective?
- What do you think that (academics/public officials/private sector representatives) should do better in order to improve industry/public/private sector communication around resilience?
- To finish, what should be the country's priorities for Chile to move forward with the Strategy?

Interviews 2019

- What is the legacy of CREDEN?
- Why do you think that CREDEN was successful in creating an institution—Itrend—to move forward with the strategy and other similar strategies developed in the country have failed to do so?
- If other countries were looking to develop similar strategies, what would you recommend based on your experience in CREDEN?

Interviews 2020

- What is the legacy of CREDEN today, four years from its publication?
- Are you aware that Itrend was first concocted in CREDEN? (if needed)
- What is the role of Itrend in the ecosystem of research, development and innovation today for resilience today?
- In your opinion and experience, are some lessons learned at CREDEN perpetuated today in Itrend?
- In your opinion and experience, what decisions made in the history of CREDEN and Itrend that should be done differently looking backwards?

INTERVIEWEES' PROFILES

Total People interviewed: 23

Total Interviews: 29

Sector/Discipline	Role in the Strategy		Interview date
	CREDEN	Itrend	

	Central Committee	Subcommittee	2017	2019	2021
Academia, Engineering	x	Board	x	x	x
Academia, Social Sciences		x	x	x	
Academia, Natural Sciences	x	x	x	x	
Academia, Engineering	x	x	x		
Academia, Engineering	x		x	x	
Academia, Social Sciences	x	x		x	
Academia, Engineering	x	x		x	
Academia, Engineering	x	x	x		
Academia, Engineering	x	x			x
Industry		x	x		
Industry	x		x		
Industry	x	x	x		
Industry		Board			x
Public sector	x		x		
Public sector		x		x	x
Public sector	x	x	x		
Public sector	x		x		
Public sector	x		x		
Public sector	x			x	
Public sector		x			x
Public sector		Stakeholder			x
Civil Society		x	x		
Itrend		Director			x

B. Summary of documents collected and analysed

Public documents and institutional webpages

- CREDEN's Strategy. 'Hacia Un Chile Resiliente Frente a Desastres: Una Oportunidad'. <http://www.cnid.cl/wp-content/uploads/2016/12/CREDEN-27122016-2.pdf> (last accessed on December 7th, 2021).

- CREDEN Appendix A: “Marco Legal y Regulatorio para la Gestión de Riesgos de Origen Natural” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-1.pdf> (last accessed on December 7th, 2021).
- CREDEN Appendix B: “Biografía de los miembros de la Comisión Central ” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-2.pdf> (last accessed on December 7th, 2021).
- CREDEN Appendix C: “Actividades con el Panel Asesor Internacional ” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-3.pdf> (last accessed on December 7th, 2021).
- CREDEN Appendix D: “Actividades con la Industria” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-4.pdf> (last accessed on December 7th, 2021).
- CREDEN Appendix E: “Información Adicional Costos” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-4.pdf> (last accessed on December 7th, 2021).
- CREDEN Appendix F: “Brechas, experiencias y capacidades actuales para el desarrollo de las tareas de la Estrategia” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-4.pdf> (last accessed on December 7th, 2021).
- CREDEN Appendix G: “Glosario” Available at: <https://www.cnid.cl/wp-content/uploads/2017/02/CREDEN-apendices-4.pdf> (last accessed on December 7th, 2021).
- ITREND’s webpage. www.itrend.cl
- CREDEN Library at CONECTA RESILIENCIA Itrend’s knowledge hub. <https://conectaresiliencia.cl/estrategia-creden-2/>

CREDEN’s Internal Documents (access to documents granted by CNID)

- Documents sent to International Board of Experts
 - CREDEN. Executive Summary (in English). Document sent to International Board of Experts
 - “Enabling Conditions for a Successful Strategy.” Document sent to International Board of Experts
- Documents from Subcommittees
 - CNID “Subcommittees CREDEN”. Document defining CREDEN’s subcommittees
 - Final Report to Central Committee from Subcommittee 1: “Resiliencia: Resumen del trabajo de la subcomisión 1. Tareas” 12-septiembre-2016.
 - Final Report to Central Committee from Subcommittee 2: “Polo de Desarrollo: Resumen del trabajo de la subcomisión 2. Tareas” 12-septiembre-2016
 - Final Report to Central Committee from Subcommittee 3: “Respuesta y Riesgo: Resumen del trabajo de la subcomisión 3. Tareas” 12-septiembre-2016
 - Final Report to Central Committee from Subcommittee 4: “Procesos Físicos y Exposición: Resumen del trabajo de la subcomisión 4. Tareas.” 12-septiembre-2016
- Drafts of the final strategy sent to the Central Committee
 - “Outline Estrategia I+D+I”. Draft sent to Central Committee. July 15th, 2016
 - “Estrategia I+D+I. Borrador Comisión Central”. Draft sent to Central Committee, November 17th, 2016.
- Workflow documents

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- “Tareas y Proyectos CREDEN,” Official Gantt Chart of the project.
 - “CREDEN Budget”, developed by Ursula Schwarzhaupt. Collected with her permission.
 - Documents of Central Committee meetings
 - Power Point Presentations and meeting minutes. Dates: January 14th, March 7th, April 13th, May 16th, June 15th, July 13th, August 10th, September 29th, and November 24th 2016.
 - Exercise “Values and Purpose” (June 15th, 2016)
 - Exercise “Enabling conditions” (14th July, 2016)
 - Documents from meeting with Industry Leaders
 - Document: “Involucramiento de la Industria en la Estrategia CREDEN.”
 - Presentation of CREDEN to Industry Leaders. June 22nd.
 - International Seminary. “Natural Disaster Resilience: An urgent need and opportunity for Chile.” Thursday, August 25th, 2016, Avda. Libertador Bernardo O’ Higgins 227, Santiago
 - Program
 - Presentation President of CREDEN

Itrend’s Internal Documents

- First phase: Design (Proyect CORFO 16ITPS-67551)
 - Submission to CORFO’s call for application “Concurso Fortalecimiento y Creación de Capacidades Tecnológicas para Bienes Públicos. Etapa Perfil.”
 - Report: “Tendencias actuales para la difusión de bases de datos.”
 - Report: “Dimensionamiento del mercado de desastres naturales: Impacto y tamaño en Chile y el mundo” Research Study demanded by CREDEN. Produced by: IDOM.
 - Report: “Capacidades de Investigación, Desarrollo e Innovación en Materia de Desastres Naturales en Chile. Produced by: Cameron Consulting
 - Report: “Institutos Tecnológicos Públicos en Resiliencia: Benchmarking Nacional e Internacional”
 - Report: “Outreach, Difusión y Relación con la Comunidad”
 - Final Report: “Propuesta de Diseño del Instituto Tecnológico Público dedicado al I+D+i para la Resiliencia frente a Desastres de Origen Natural”
- Second Phase: Implementation
 - Submission to CORFO’s call for application “Concurso Fortalecimiento y Creación de Capacidades Tecnológicas para Bienes Públicos. Etapa Perfil.”
 - Itrend. Strategic Development Plan. 2019-2024
 - Itrend. Map of Stakeholders.
 - Itrend. Implementation Reports