

Article

Reconstruction as an Opportunity to Reduce Risk? Physical Changes Post-Wildfire in Chilean Case Studies

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Abstract

Post-wildfire reconstruction processes offer an opportunity to implement structural risk reduction measures and develop wildfire resilience; however, these efforts often lack comprehensiveness. Focusing on Chile, this research addresses the need for increased and nuanced understanding of the implementation and subsequent modifications in wildfire risk reduction actions in the built environment during post-wildfire reconstruction processes. Accordingly, this study aims to identify the physical changes associated with implementing structural wildfire risk reduction measures in Chile's reconstruction efforts from their establishment to the present, organized based on two secondary objectives: (1) document the physical changes that have occurred following the disaster, and (2) distinguish and categorize the reconstruction interventions. A mixed-methods multiple case study approach was employed, analyzing four post-wildfire reconstruction processes (Valparaíso, 2014; Santa Olga, 2017; Castro, 2021; and Punta Lavapie, 2023) through spatial analysis of physical changes and qualitative content analysis of documents to identify and categorize interventions. The research found that structural wildfire risk reduction measures and wider settlement improvements have been implemented in all case studies with varying emphasis and comprehensiveness. However, the results also suggest that these reconstruction efforts have not improved settlements' long-term wildfire resilience. This study contributes to the theory and practice of reconstruction and risk reduction by showing that the post-disaster period often fails to lead to lasting systemic change.

Keywords: disaster risk reduction; reconstruction; wildfire; resilience



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1. Introduction

Wildfires can pose significant risks at the wildland-urban interface (WUI) and peri-urban areas where settlements are in proximity to vegetated areas and humans' lives and material goods are more exposed to fire [1]. Wildfire risk can be understood as the function of: (a) the wildfire hazard, associated with the vegetation or available fuel, topography, weather/climate conditions, ignition likelihood and suppression capabilities; (b) the exposure, which relates to population, economic and built assets, and ecosystem services exposed to the hazard; and (c) the vulnerability, which refers to socio-economic factors, building conditions, and demographics of the population and assets exposed to the hazard [2]. Accordingly, international wildfire frequency and intensity are increasingly [3] associated with worsening weather conditions that support extreme fires [4–6]. Even more

so, settlement patterns in WUI areas, such as growing low-density urban sprawl and rural-residential developments that encroach upon fire-prone areas, can also affect the frequency and severity of catastrophic wildfires, increasing the risks for humans, properties, and the environment [7–9]. This implies that the development and management of settlements need to consider wildfires.

In Chile, wildfire events that impact WUI areas are a relatively new and growing challenge. Chile's fire regime is dominated by frequent low-intensity fires, with exceptionally intense events concentrated in the south-central territory [10,11], which also corresponds with the most populated areas of the country. Even more so, climate change is increasing the occurrence of fire weather [12] and projections suggest a slight rainfall decrease by 2100, but a significant temperature increase [13]. Within this context, wildfire events that impact settlements are becoming more common, and there is growing awareness of the need to address this risk in relation to the design and management of the built environment [14–17].

Taking into consideration the Chilean wildfire context, it is critical for Chile to reduce wildfire risk by addressing the physical aspects of wildfire disaster risk reduction (DRR) through structural measures, complementing them with non-structural ones such as community awareness and behavioural change. Structural measures refer to any physical constructions and built environment actions to avoid or reduce the hazard impact, and engineering techniques to resist the hazard [18]—the road network, managing vegetation, and increasing the fire resistance of structures. Structural measures implemented via architecture, building, urban design, spatial planning, and forest regulations and management are widely acknowledged as a way to treat disaster risk [19–21] and wildfire risk [2,22–25], and there is increasing evidence that they can contribute to wildfire DRR [14–16]. Furthermore, there is a growing body of international academic literature [25–28] and Chilean prevention guidelines [29,30] that provide guidance about common structural measures that can contribute to wildfire DRR. These physical actions can focus on: (a) avoid wildfire exposure, by directing new settlements to suitable locations and limiting development in areas where risks are considered unacceptable (giving particular attention to sensitive infrastructures); or by relocating people or assets away from high wildfire-prone areas; (b) reduce wildfire exposure, by clearing or modifying vegetation near structures; developing wildfire buffer zones; or by other fuel management strategies; (c) increase the resistance of structures to wildfires, including retrofitting existing buildings through improved construction, landscape, and infrastructure to better withstand a wildfire attack; and designing new developments that are better prepared to withstand a wildfire; and (d) improve the response to wildfires, by facilitating response of emergency services via the provision of water, fire truck access, among others; and by enabling civilian response via multiple evacuation routes. Thus, actual disasters resulting from wildfires could often be avoided if appropriate DRR measures are set in place to guide settlements' development and to manage them over time.

After a wildfire, there is a window of opportunity to Build Back Better and implement structural measures that can contribute to wildfire DRR, together with other measures that can improve wider living conditions in impacted communities. At certain critical times, separate streams of problems, policies, and politics come together, joining solutions to problems—the window of opportunity—suggesting that favourable contexts are created by compelling problems, such as a catastrophe, or by political events [31]. Considering that much public attention and political will are given to disasters' impact and to relief and recovery actions after an event, the idea that disasters provide a window of opportunity for transformative potential is prevalent in the DRR literature [32–34]. Reconstruction processes could offer the opportunity for Build Back Better, an approach to the recovery and reconstruction aiming to increase the resilience of communities by integrating

DRR and reducing vulnerability to future hazards [35]. Likewise, the period following a destructive wildfire can provide a ‘hot moment’ for changing and creating fire-adapted communities [36]. This is important because it implies reconstruction processes could allow for the implementation of measures for wildfire DRR by avoiding or reducing wildfire exposure, increasing wildfire resilience of structures, and improving the conditions that facilitate response actions. Even more so, they could also allow for wider improvement of living conditions in communities affected, especially in areas poorly serviced, such as ensuring access to clean water, reliable electricity, and better healthcare facilities and public spaces. Despite reconstruction’s potential and for implementing structural measures to treat wildfire risk, in practice, the window of opportunity after a disaster often does not lead to the implementation and maintenance of comprehensive systems of physical actions for wildfire DRR. The international literature highlights that built environment systems of decisions and actions can often struggle to integrate and act on wildfire DRR comprehensively [37–40].

Disasters in Chile have led to changes in governance and regulation. The origins and amendments of spatial planning in Chile are directly tied to post-disaster contexts, and there is evidence of attempts to integrate wildfire DRR and spatial planning better after major events [41,42]. Furthermore, in recent decades, the 2010 Chilean earthquake and tsunami, along with subsequent disasters, have highlighted significant shortcomings in the country’s disaster management strategy. The Office of National Emergency of the Interior Ministry (ONEMI), a primarily reactive and emergency response-focused institution, was found to be inadequate in a rapidly changing environment. The lessons learned from these events, particularly the need for a more comprehensive and proactive approach, became the primary motive for the change from ONEMI to the National Disaster Prevention and Response Service (SENAPRED) implemented in 2023 [43]. Similarly, after recurrent wildfires that challenged the governance around them, in 2025, the new National Forestry Service (SERNAFOR) replaced the former National Forestry Corporation CONAF, with an enhanced focus on the sustainable management of forests, prevention of wildfires, and the authority to enforce regulations.

From the perspective of physical changes for DRR in Chile, the literature suggests that some efforts have been made to take advantage of the post-wildfires window of opportunity; however, the impact of these initiatives on long-term DRR requires further assessment. In the context of Valparaíso’s reconstruction after the 2014 wildfires, official sources indicate early implementation of DRR measures [44] and the use of an existing program for neighbourhood improvement—the program ‘I like my neighbourhood’—to develop a pilot proposal to integrate risk reduction and management strategies in four Valparaíso neighbourhoods [45], although this pilot initiative was not subsequently sustained as a core objective of the programme. Similarly, the reconstruction of Santa Olga after the 2017 wildfire considered DRR measures [46,47]. Drawing a comparison between the reconstruction efforts following the 2010 earthquake and tsunami, and the 2017 wildfires, research argues that there have been considerable improvements post-2017, as the government adopted a more integrated and supportive role for affected communities, guided by principles of safety, quality, inter-sectoral collaboration, and public participation, encapsulated by the strategic aim to Build Back Better [48]. Despite these advancements, the study also identifies persistent systemic challenges within the institutional framework, the dynamics between key actors, and the efficacy of community engagement [48]. Ultimately, detailed characterizations of the implementation and maintenance of these structural measures are scarce [47,48], especially in more research cases such as reconstruction post-wildfire in Castro 2021 [49,50] and Punta Lavapie 2023 [51]. This highlights the need for increased understanding of post-wildfire reconstruction processes as a window of opportunity to

implement positive systemic change for reducing disaster risk. Accordingly, the problem addressed by this proposal is the need for increased and nuanced understandings about the implementation and maintenance of comprehensive wildfire DRR actions in the built environment in Chile, as a relevant case that can illustrate these processes internationally. Thus, this research aims to identify the physical changes associated with the implementation of the structural measures for wildfire DRR in reconstruction processes in Chile from their execution to the present.

The paper follows to describe the mixed-methods approach used in the four case studies (the reconstruction processes initiated after destructive wildfires in the Chilean localities of Valparaíso 2014, Santa Olga 2017, Castro 2021, and Punta Lavapie 2023) to identify the physical changes associated with the implementation of the structural measures for wildfire DRR. Next, the results for each case study are outlined, showing that structural measures for wildfire DRR and settlement improvements have varying focuses. The Section 4 also argues that reconstruction efforts have not increased long-term resilience and may raise risk in some areas. The conclusion highlights that post-disaster periods often fail to cause lasting systemic change, thereby adding to the reconstruction and risk reduction theory and practice.

2. Materials and Methods

In order to address the research aim, the research design considers two secondary objectives. The first objective is to document the physical changes that occurred in the case studies following the disaster, considering the initial reconstruction and its subsequent evolution up to the time of data collection. The second one is to distinguish and categorize the reconstruction interventions previously documented. It is important to point out that we refer to these interventions in a broader way as ‘physical measures’ because they encompass structural measures for wildfire DRR, as well as other wider physical changes introduced during the reconstruction. Accordingly, a mixed-methods approach was employed, incorporating spatial analysis of settlement physical change and qualitative content analysis of documentation to distinguish the types of interventions implemented.

2.1. Selection of Cases

The research was approached as a multiple-case study [52] of four case studies: the reconstruction processes initiated after destructive wildfires in (1) Valparaíso 2014, (2) Santa Olga 2017, (3) Castro 2021, (4) Punta Lavapie 2023 (see Figure 1 and Table 1). The temporal scope of case selection is inherently limited to the post-2014 period, as the Valparaíso 2014 event marks the beginning of the recent series of large-scale wildland-urban interface fires in Chile. All case studies chosen are from Chile because of the requirement to perform in situ observations. The selection intentionally spans four different administrative regions of the country to capture potential variations in governance and environmental context (Figure 1), from long-term organic recovery to recent, highly planned interventions.

The cases were selected to capture a spectrum of post-wildfire reconstruction approaches across different temporalities and scales in Chile. This approach allows for a unique analysis of how reconstruction mechanisms have evolved over time, reflecting lessons learned from earlier events. Valparaíso 2014 was chosen for its decade-long, organic, and resident-led recovery process resulting in densification in a high-risk area characterized by a history of socio-economic vulnerability and high levels of preexisting housing informality. In contrast, Santa Olga 2017 represents a state-led, top-down ‘refounding’ of a settlement, featuring a completely new urban layout and managed relocation. Castro 2021 exemplifies a reconstruction explicitly governed by a risk-based zoning plan designed to reduce density. Finally, Punta Lavapie 2023 was selected to analyze a recent and mixed gov-

ernment response model, which includes temporary housing, a transitional settlement, and industrialized permanent solutions in a remote community where doubled-up households are a common socio-economic reality.

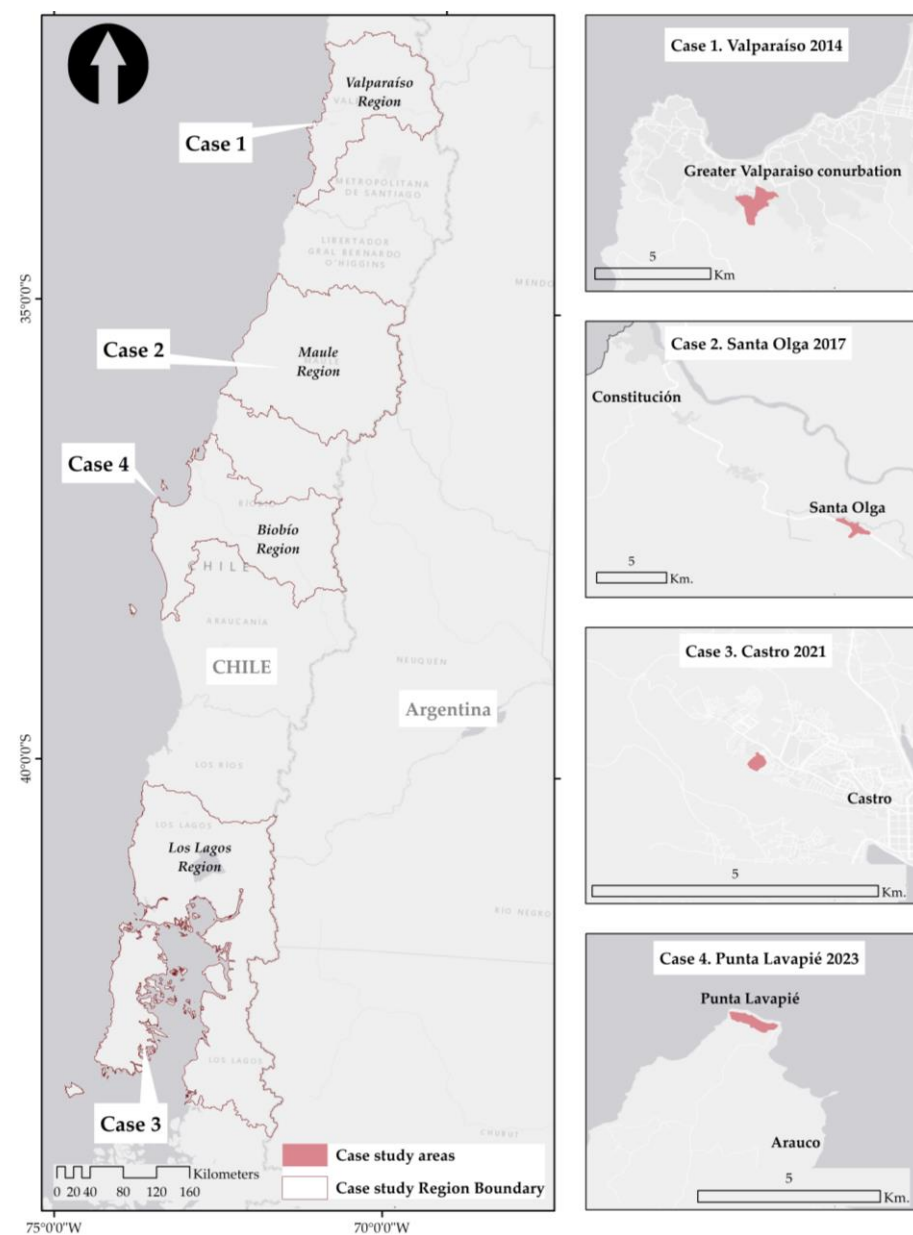


Figure 1. Regional location of the case studies within Chile.

Table 1. Summary and Rationale for Case Study Selection.

Case Study	Fire Event Context	Impact	Key Reconstruction Characteristic
Valparaiso 2014	Large-scale urban interface fire in an area with high informality.	3226 Constructions destroyed 15 Fatalities 1042 Burned hectares	Long-term (10-year) organic and resident-led reconstruction process leading to densification.

Table 1. *Cont.*

Case Study	Fire Event Context	Impact	Key Reconstruction Characteristic
Santa Olga 2017	Near-total destruction of a town during a national megafire event (“Tormenta de Fuego”).	2831 Constructions destroyed 11 Fatalities 183,946 Burned hectares	State-led, planned “refounding” of the settlement with a new urban layout and managed relocation.
Castro 2021	High-impact fire in a dense, formal urban neighbourhood.	129 Constructions destroyed. No fatalities 5.4 Burned hectares	Reconstruction is explicitly governed by a post-disaster, risk-based zoning plan to reduce density.
Punta Lavapie 2023	Destruction in an isolated coastal community during a regional megafire event.	88 Constructions destroyed. No fatalities 1822 Burned hectares	Recent mixed-model response combining temporary housing, a transitional settlement, and industrialized solutions.

Source: Author’s own elaboration.

Governance Context of the Case Studies

Chile functions within a national system of overarching national institutions and regulations that are implemented in a decentralized way at the regional or local level.

In terms of emergency management, the National Disaster Prevention and Response Service (SENAPRED) [43] (ONEMI before 2023) is responsible for disaster prevention, immediate response, and coordinating recovery efforts. After a disaster, its primary goal is to manage early recovery [53] by providing temporary dwellings to affected families.

From the perspective of the long-term reconstruction, a sectoral approach is employed, based on the different ministries.

The Ministry of Housing and Urbanism (MINVU) oversees temporary housing reconstruction management, urban planning, and provision of permanent housing solutions. It is important to distinguish between the national MINVU and its Regional Ministerial Secretariat (SEREMI) offices. The regional offices directly represent the ministry in each region. They are responsible for implementing and adapting national policies and programs to the specific realities and needs. They coordinate the execution of housing and urban development projects within their respective regions, collaborating directly with the Regional Housing and Urbanization Services (SERVIU) and local municipalities. The reconstruction of permanent housing is performed through different subsidies, most noticeably:

- On-Site Construction Subsidy (CSP)

Program that provides financial assistance for families to build a new house on land they already own.

- Construction on New Land Subsidy (CNT)

Collective subsidy program for groups of families to build housing projects with multiple units on a new plot of land, so families are relocated to a new place.

- Subsidy for the Acquisition of Already Built Housing (AVC)

Financial subsidy for families to acquire an existing house or apartment, either new or used.

- Material Bank Subsidy (BM)

Program that focuses on repairs and maintenance for existing homes. It provides a financial subsidy that includes a digital gift card, allowing families to buy construction materials at authorized stores.

Other entities that participate in reconstruction processes include the Ministry of Public Works (MOP), which is responsible for the reconstruction of the critical infrastructure, including roads, bridges, water systems, and other essential public assets. Furthermore, Non-Governmental Organizations (NGOs) and private companies also play an important complementary role in Chile's post-disaster reconstruction plans.

2.2. Data Collection

To address the study's two objectives of documenting physical evolution and categorizing interventions, data were collected through two primary streams: documentary sources and spatial datasets.

First, the documentary information used in this study was obtained from various secondary sources, including official documents (N = 61), transparency data (N = 10) [54], official website (N = 14), academic papers (N = 1), and media (N = 8). (see Appendix A for a detailed list per case). These sources were used to quantify the extent of damage and details of reconstruction projects, considering dwellings, equipment, infrastructure, and services.

Second, spatial data were obtained from four primary sources. First, foundational GIS base cartography, including administrative boundaries, topography, and other vector layers, was obtained from the official Chilean Spatial Data Infrastructure. Second, high-resolution orthophotographs were captured via drone during the project's fieldwork campaigns to obtain detailed, up-to-date imagery of the reconstruction status. Third, a time series of historical and current satellite imagery was sourced from Google Earth to provide a temporal overview of the affected areas. Finally, systematic in situ observations and photographic records were gathered during fieldwork campaigns for each case, conducted between December 2023 and August 2024: Santa Olga (December 2023); Castro (January 2024); Valparaiso (April 2024); and Punta Lavapie (March and August 2024). This fieldwork included a comprehensive photographic inventory to systematically document the operational status and physical condition of key DRR infrastructure.

2.3. Data Analysis

A dual approach to the data analysis was also employed in correspondence with the two sources of data.

First, the collected documentary information was synthesized and organized within a categorized database of structural measures for wildfire DRR. Information about the reconstruction projects codified using Excel (version 2507). The file comprises 150 rows, primarily codifying the purpose of the measures for each case study. An initial categorization was used and then expanded inductively from the preliminary results. The initial codification was based on categories identified in the literature review [25–30], all of which are related to wildfire DRR measures:

- (a) Avoid wildfire exposure, by directing new settlements to safe areas and restricting development in high-risk areas, particularly around sensitive infrastructure. This also includes relocating people and assets from zones prone to wildfires.
- (b) Reduce wildfire exposure, by clearing or modifying vegetation near buildings to create a buffer zone.
- (c) Increase resistance to wildfires, improving construction, landscape, and infrastructure to better withstand a wildfire attack.

- (d) Improve response to wildfires, by facilitating the response of emergency services to answer with better access for fire trucks and water supplies, and providing multiple escape routes for residents.

During the analysis process, new categories were created by an inductive process; these categories were related to physical changes associated with measures implemented during the reconstruction processes that address wider settlement recovery or improvements, distinct from wildfire DRR:

- (e) Facilitate early recovery, by building emergency dwellings for affected families and other temporary facilities for the initial reconstruction process.
- (f) Reduce other risks, focused on slope stabilization and retaining walls.
- (g) Improving other liveability aspects, by building facilities for communities, including public squares, community centres, sports centres, and sanitary improvements.
- (h) Restore preexisting conditions, to rebuild housing and facilities without additional improvements beyond the minimum standard.

It is important to note that these categories (e–h) that emerged from the case studies' observations and analysis do not necessarily represent an ideal of any kind, unlike categories (a–d), which do aim to showcase the range of wildfire DRR applicable and desirable structural measures for DRR.

Complementary to the primary codification of the purpose of the projects and measures, other variables were considered to complement the analysis, including execution date, financial, and maintenance management, along with the budget associated with each project. It is important to understand the conversion process. Budgets, originally expressed in Chilean Pesos (CLP) and Unidad de Fomento (UF) (UF is Chile's inflation-adjusted unit), were converted to their equivalent in US dollars. To ensure consistency, this conversion to US dollars used the average annual exchange rate for the year in which each project's budget was reported or executed. For amounts specified in CLP, they were first converted to UF using the average UF rate for the year. As a general rule, when different sources reported different budgets for one project, the highest amount was recorded in the budget cell. At the same time, any additional details were specified in the description table.

Second, the spatial analysis began with the co-registration and correction of all time-series imagery in ArcMap 10.8 to ensure a reliable basis for comparison. The core analysis involved the manual georeferencing of constructions, an approach chosen over automated algorithms as the academic literature indicates that such methods perform poorly in dense and morphologically informal settlements, where irregular patterns and material heterogeneity limit their accuracy [55,56]. To maintain consistency, all digitization was conducted by a single analyst following a standardized protocol, thus minimizing inter-rater variability. Through systematic visual interpretation, each construction was classified and tracked across key temporal snapshots—including pre-disaster, immediate post-event, and subsequent intervals—with the specific timing for each case detailed in Table 2. It is important to note that the terminology used for post-disaster modifications intentionally varies between case studies. This reflects the finding that the non-standardized nature of each reconstruction process led to distinct morphological outcomes, and using specific terms preserves this analytical precision, especially utilizing the categorization system obtained in the codification process (data analysis). The resulting spatiotemporal dataset of the built environment was integrated via a spatial join with the categorized database of structural measures for wildfire DRR and other measures for wider settlement improvements. This integrated analysis forms the basis of the study's outcome assessment method, where the long-term effectiveness of the reconstruction is evaluated, leading to several cross-case findings that are systematically presented in the Results Section. Finally, the positional accuracy of this dataset was validated through triangulation, using in situ observations

and cross-referenced with official initial damage assessments from the Basic Emergency Form (FIBE), Chile’s governmental post-disaster data collection instrument, where these data were available.

Table 2. Temporal Framework of the Reconstruction Process for Each Case Study.

Case Study	Pre-Fire Observation	Immediate Post-Fire Observation	Early Reconstruction Observation	Formal Reconstruction Observation	Reconstruction Evolution Observation
Valparaíso (April 2014)	March 2014	April 2014	August 2014	April 2017	February 2024
Santa Olga (January 2017)	December 2016	February 2017	March 2018	March 2020	October 2023
Castro (December 2021)	December 2021	December 2021	N/A	December 2022	November 2024
Punta Lavapie (February 2023)	October 2022	February 2023	September 2023	February 2025	N/A

Source: Author’s own elaboration based on the georeferencing methodology and preliminary results. “N/A” (Not Applicable) is used for recent cases where distinct stages have not yet occurred or are part of an ongoing process.

3. Results

This section presents a summary of cross-case results, followed by individual case study findings, organized into four sections that correspond to each case study. The results reveal a central tension: while all reconstruction processes implemented a wide range of structural DRR measures and wider settlement improvements, the overall analysis points to three consistent cross-case findings that ultimately undermine long-term wildfire resilience. The following paragraphs first detail the scope of the implemented measures and their corresponding budgets (see Tables 3–5), before presenting these three key findings in detail.

Table 3. Number of projects and Budget (USD).

	Valparaíso 2014		Santa Olga 2017		Castro 2021		Punta Lavapie 2023	
	Projects	Budget (USD)	Projects	Budget (USD)	Projects	Budget (USD)	Projects	Budget (USD)
Wildfire DRR								
Avoid wildfire exposure	2	58,115,163	2	24,436,510	2	2,736,703	0	0
Reduce wildfire exposure	16	16,940,026	12	130,065	2	111,074	0	0
Increase resistance to wildfires	0	0	2	7,621,354	1	2,621,973	2	79,362
Improve response to wildfires	86	151,287,731	2	6,096,567	2	22,677	1	562,717
Wider Measures								
Facilitate early recovery	1	2,314,981	0	0	0	0	5	54,640
Reduce other risks	62	2,927,048	2	18,004,766	1	N/A	1	N/A
Improve other liveability aspects	15	1,988,127	17	14,965,358	2	22,677	3	350,469
Restore preexisting conditions	9	52,023,492	3	18,058,143	1	17,130	3	2,277,051

Source: Author’s own elaboration.

In general terms, Valparaíso 2014, Santa Olga 2017, and Castro consider seven out of the eight categories, whereas Punta Lavapie 2023 considers only five. Furthermore, Table 3 describes the measures per category in terms of the quantity of projects and their budget per case; and Table 4 lists the projects by category, providing a nuanced illustration of the initiatives undertaken per case.

Distinguishing wildfire DRR measures from other initiatives, the cross-case results show that structural measures for wildfire DRR have been implemented in all cases (see Table 4) in at least two of the four categories for wildfire DRR: ‘Reduce wildfire exposure’; ‘Improve response to wildfires’; ‘Avoid wildfire exposure’; and ‘Increase resistance to wildfires’. It stands out that in Santa Olga 2017 and Castro 2021, measures in all four categories were implemented; conversely, in Punta Lavapie 2023, the least comprehensive reconstruction, only measures for ‘Improve the response’ and ‘Increase the resistance to wildfire’ were implemented. It also stands out that in all case studies, measures for

‘Improve the response’ were considered. In terms of budget (see Table 3), one of the lowest allocations is for implementing measures to ‘Reduce wildfire exposure’ (4.5% of the total budget), such as removing illegal dumps, clearing ravines, or building mitigation parks. Furthermore, ‘Improve the response’ initiatives, which include measures such as enhancing car, pedestrian, or maritime connectivity, and implementing fire suppression systems, among other actions, is one of the categories with the highest budget allocation (41.2% of the total budget). Within this category, most of the budget (97.6% of the total budget) is directed towards road connectivity improvement projects. The next category with the highest budgetary allocation is ‘Avoid wildfire exposure’ (22.2% of the total budget), which covers subsidies for the Acquisition of Already Built Housing (AVC) (29% of the category budget) and Construction on New Land (CNT) (71% of the category budget) in other areas. These reconstruction solutions strategically aim to relocate families away from areas with high wildfire risk. Lastly, initiatives for increasing the resistance of buildings, including public buildings and houses rebuilt, incorporate improvements in fire resistance that exceed the minimum standards by law. This category allocated 2.7% of the total budget. In Santa Olga 2017, this category represented 9% of the case’s total budget. In Castro 2021, it represents 47.4% of the case budget, because the On-site Construction Subsidy (CSP) provides an improvement on the minimum required construction standards. In Punta Lavapie, the budget for this category accounted for 2.4% of the total budget, which included two educational buildings.

From the perspective of wider settlement improvements, the results also show that in all case studies there have been significant efforts to address other broader issues distinct from wildfire DRR through the reconstruction processes, in at least two of the four categories of wider measures: reduce other risks, restore preexisting conditions, improve other liveability aspects, and facilitate early recovery (see Table 4). The results show that in all case studies a significant number of projects and budgets (see Table 3) are destined for restoring preexisting living conditions (18.9% of the total budget). This is mainly associated with housing reconstruction based on the On-site Construction Subsidy (CSP) (97.7 per cent of the category budget) and the Material Bank Subsidy (BM) (0.65% of the category budget), with no consideration of wildfire DRR (see Table 5). Furthermore, in all case studies, reconstruction processes have been used to ‘Improve other liveability aspects’ and to deliver other liveability aspects, including improving sanitary conditions, and building public facilities previously needed in the community, such as creating a medical centre. Noticeably, reconstruction processes in two cases triggered the implementation of land containment measures such as retaining walls to reduce landslide risks. Acknowledging the social and political needs and forces that influence reconstruction processes, it is important to point out that restoring preexisting conditions and improving other liveability aspects without thorough consideration of wildfires can challenge DRR. Especially, restoring previous conditions without serious mitigation actions might not be desirable from the perspective of risk reduction.

Overall, the analysis of the reconstruction measures—classified across the eight established categories—reveals three consistent cross-case findings that suggest that long-term resilience has been compromised. First, a consistent outcome was the trend towards densification and risk-prone development in affected areas. In Valparaíso 2014, for instance, the total number of constructions within the fire-affected, high-risk area grew from 4273 pre-fire to 4740 a decade later.

Table 4. Projects by Category.

	Valparaiso 2014	Santa Olga 2017	Castro 2021	Punta Lavapie 2023
Wildfire DRR	Avoid wildfire exposure			
	Subsidy for Acquisition of Already Built Housing (AVC)	1	1	1
	Construction on New Land Subsidy (CNT)	1	1	1
	Reduce wildfire exposure			
	Mitigation Park	3	1	
	Removing illegal dumps	10		
	Waste Management		1	
	Clearing ravines	2		
	Vegetation Management	1		
	Reforestation		11	
	Riks Zone and Non-buildable Zone		1	
	Increase resistance to wildfires			
	Fire Station		1	
	Educational Establishment	1		2
	On-site Construction Subsidy (CSP)		1	
Wider Measures	Improve response to wildfires			
	Signs and Demarcations	1	1	
	Maritime/Port Connectivity Improvement			1
	Road Connectivity Improvement	10	2	
	Pedestrian Path Improvement	18		
	Alarm and Siren Systems	9		
	Fire Extinguishing Systems	39	1	
	Safe Zones	9		
	Facilitate early recovery			
	Temporary Public Restrooms			1
	Primary School			1
	Kinder garden			1
	Playgroup			1
	Emergency Housing	1		1
	Reduce other risks			
	Land Containment and Security	62	2	1
	Improve other liveability aspects			
	Sport Facilities	2	1	1
	Medical Centre		1	
	Community Spaces		7	
	Sanitary improvements	10	2	2
	Murals		1	
	Bus Stop		1	
	Square	3	4	1
	Bus Station		1	
	Restore preexisting conditions			
	Sports Facilities	3	1	
	Community Spaces	4		
	Material Bank Subsidy (BM)	1	1	1
	On-site Construction Subsidy (CSP)	1	1	2

Source: Author's own elaboration.

Second, the proliferation of informality emerged as a prominent finding across all cases. The time-series analysis reveals a significant number of informal extensions added to formally reconstructed houses, which compromise their fire-resistant integrity and increase the risk of structure-to-structure fire propagation.

Third, a notable decline in the operational readiness of response measures due to inadequate maintenance was a common finding. Fieldwork in Valparaíso confirmed that critical infrastructure, such as dedicated water storage tanks and the early warning siren system, suffer from neglect, rendering them ineffective.

Table 5. Affected dwellings and Subsidies provided.

	Valparaiso 2014	Santa Olga 2017	Castro 2021	Punta Lavapie 2023
Houses: Total Damage	2516	1122	129	58
Houses: Unaffected structures	1757	34	11	8
Emergency housing	1600	0	0	75
On-site Construction Subsidy (CSP)	1184	527	67	31
Construction on New Land Subsidy (CNT)	617	270	5	0
Subsidy for the Acquisition of Already Built Housing (AVC)	1087	322	56	0
Material Bank Subsidy (BM)	21	37	7	12
Avoid wildfire exposure	Increase resistance to wildfire	Facilitate early recovery	Restore Preexisting conditions	

Source: Author's own elaboration.

3.1. Valparaiso 2014 Case Study

The spatiotemporal analysis of the Valparaiso 2014 case reveals a complex and largely informal reconstruction process following the April 2014 wildfire, which destroyed 2516 constructions within the study area (see Figure 2). The initial response, observed four months post-disaster, was dominated by the installation of 1600 emergency houses [44] (see Table 5) alongside the emergence of 259 informal houses. By the three-year mark in April 2017, the urban landscape had hybridized recovery pathways, with 760 formal state-subsidized homes and 206 ongoing informal houses [57] coexisting with 248 modified emergency houses and 156 new informal extensions. A decade after the event, in February 2024, this trend toward informal development had intensified significantly. While official records noted 1182 formal on-site reconstructions through the CSP subsidy [58], this study's spatial analysis revealed a significantly higher number of informal houses (1801), dwellings that evolved from emergency housing (594), and additional informal extensions (362). This demonstrates a straightforward process of densification, as seen in Figure 2, with the total number of constructions on-site growing from 4273 pre-fire to 4740 ten years later, not including the 1704 families who were relocated out of the area through CNT and AVC subsidies (see Table 5).

The spatial distribution of post-wildfire projects in Valparaiso 2014 shows interventions across seven of the eight established categories, as detailed in Figure 3. The reconstruction strategy prioritized community-scale resilience over the hardening of individual buildings. Efforts concentrated on improving emergency logistics ('Improve response to wildfires') and mitigating geohazards ('Reduce other risks'). While this included extensive road and pedestrian connectivity upgrades, it also incorporated innovative solutions such as a public dry riser system and dedicated water storage tanks (Fire Suppression Systems–Australian tanks). However, subsequent fieldwork reveals these systems now suffer from a significant lack of maintenance, undermining their long-term effectiveness. The housing deficit was addressed through a dual strategy of on-site reconstruction and subsidized relocations. Moreover, fuel management projects were strategically targeted at high-risk ravines. A critical finding is the complete absence of identified measures aimed at 'Increasing the fire resistance' of individual homes, marking a significant gap in the recovery strategy.

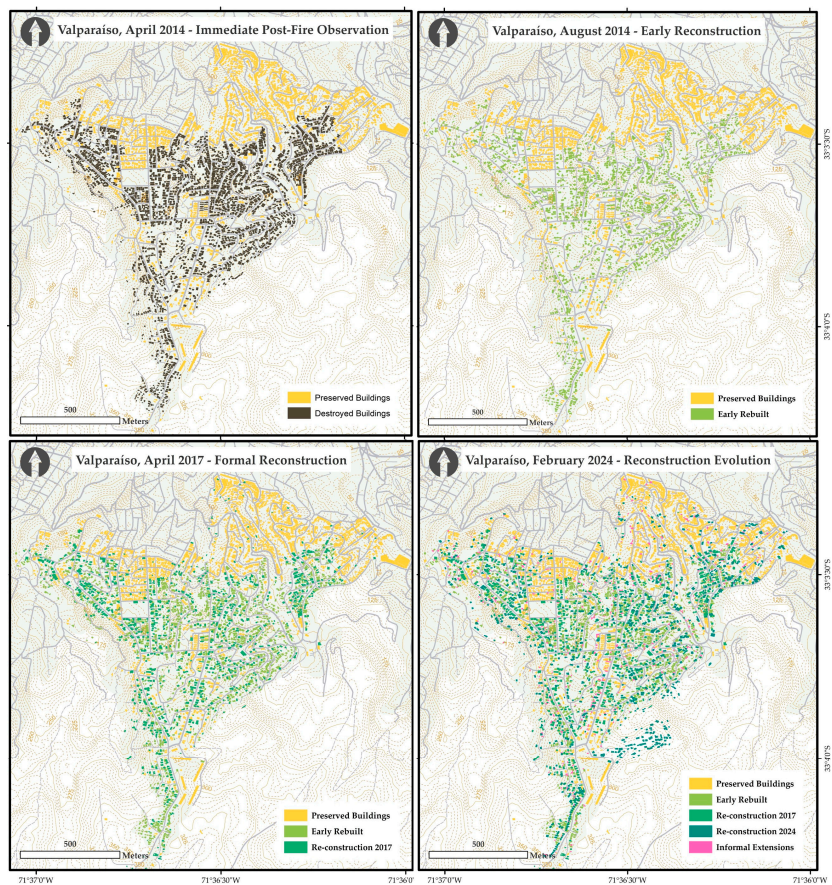


Figure 2. Spatiotemporal Evolution of the Built Environment in Valparaíso (April 2014–February 2024).

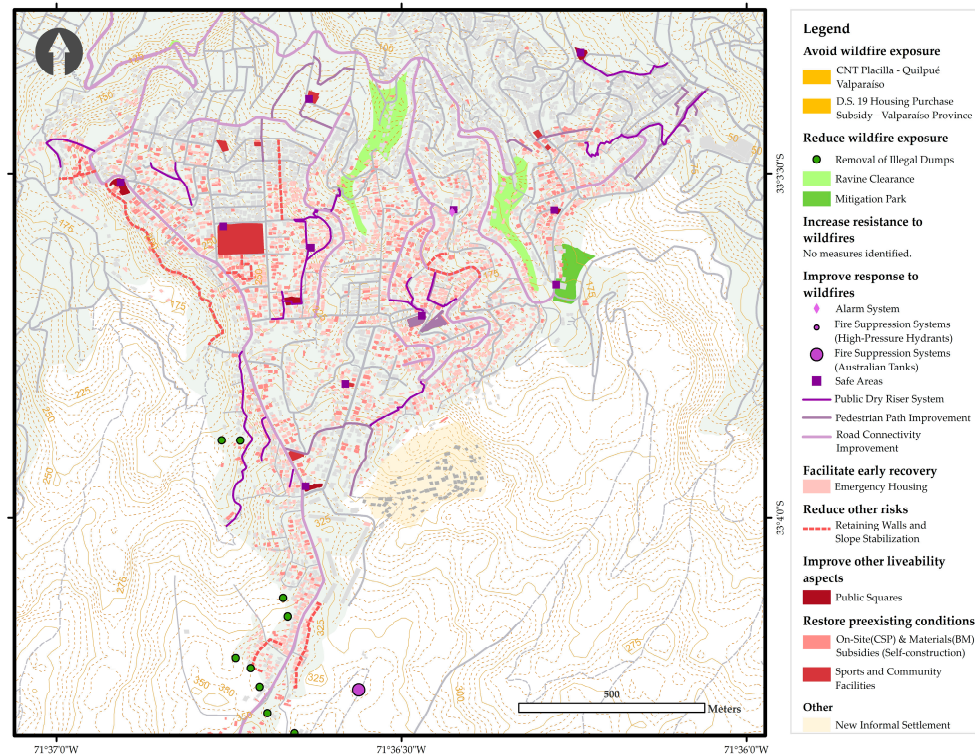


Figure 3. Classification and Spatial Distribution of Post-Wildfire Reconstruction Measures in Valparaíso (2014–2024).

3.2. Santa Olga 2017 Case Study

In contrast to Valparaiso 2014, the reconstruction of Santa Olga 2017 was characterized by a highly planned, state-led process of urban refoundation. This followed the near-total devastation caused by the 2017 “Las Maquinas” fire [59], part of the larger “Tormenta de Fuego” event, which destroyed 1122 (see Table 5) of the 1156 existing constructions in the locality [47], as seen in Figure 4. One year post-disaster, the analysis showed an orderly start with 244 formal houses and only 11 informal dwellings, a rate significantly lower than that observed in Valparaiso’s 2014 initial phase. This formal approach was consolidated by the three-year mark with the delivery of 761 formal dwellings [60] and the implementation of a new, planned road layout that reconfigured the settlement’s structure. At the same time, informal houses remained limited to 60 dwellings. However, the six-year analysis in October 2023, a total of 834 formal housing solutions had been delivered through various subsidies (see Table 5). Although the number of formal houses reached 834 [61], informal houses increased to 193 and 421 informal extensions had appeared on the formal houses built during the earlier phases. This evolution highlights a planned reconstruction that, over time, still experienced significant informal modification, ultimately resulting in a reordered settlement with 1030 dwellings rebuilt on-site and 322 families who were relocated via the AVC subsidy.

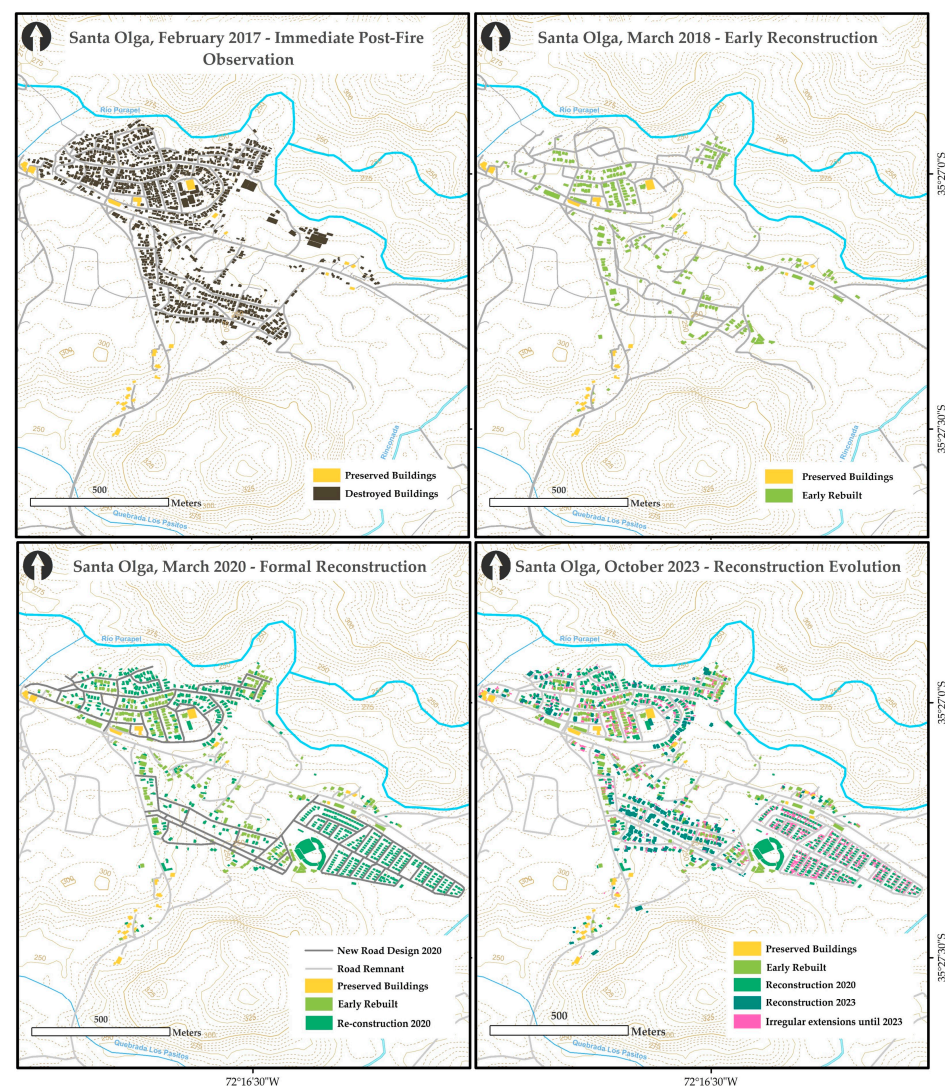


Figure 4. Spatiotemporal Evolution of the Built Environment in Santa Olga (February 2017–October 2023).

The reconstruction of Santa Olga 2017 represents a comprehensive, state-led refoundation of the settlement, with interventions across seven of eight categories as detailed in Figure 5. This planned approach implied the complete redesign of the road network and installation of new hydrants to ‘Improve response to wildfires’. Housing solutions were twofold: large-scale On-site Construction Subsidies (CSP) (‘Restore preexisting conditions’) and the creation of a new, relocated neighbourhood, Villa Renacer, under the Construction on New Land Subsidy (CNT) (‘Avoid wildfire exposure’) (See Table 5). Crucially, the strategy explicitly included measures to ‘Increase resistance to wildfires’ through the construction of resilient public facilities, including a new fire station and improvements to the health centre. The new urban layout is buffered by a mitigation park and native reforestation zones designed to ‘Reduce wildfire exposure’ (Figure 5). Furthermore, significant efforts were made to ‘Improve other liveability aspects’, which included new community sports facilities, public squares, and a critical upgrade to the rural potable water system.

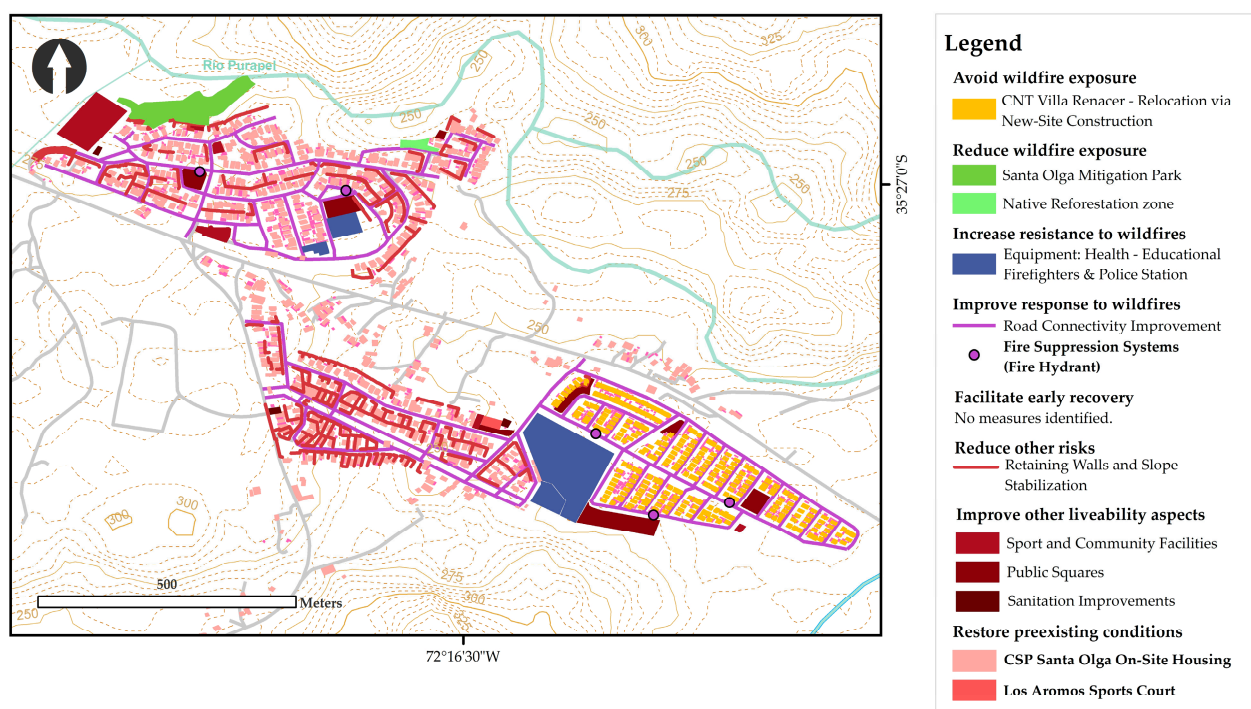


Figure 5. Classification and Spatial Distribution of Post-Wildfire Reconstruction Measures in Santa Olga (2017–2023).

3.3. Castro 2021 Case Study

The reconstruction process in Castro 2021, following the severe urban impact of the “Camilo Henríquez” fire [62], was approached as a state-controlled, risk-based process. After the fire destroyed 129 constructions in a high-density area (see Table 5), MINVU commissioned a risk assessment that influenced the reconstruction’s evolution. The assessment defined the ravine itself as Risk Zone (Zone A), and the area to its east—formerly Yungay neighbourhood—as Non-Buildable (Zone B1), prohibiting residential use due to severe fire and landslide risk (see Figure 6) [50]. Consequently, reconstruction was concentrated on the western side of the ravine, in the Camilo Henríquez neighbourhood. The process was highly formalized: the one-year analysis revealed 54 new formal houses constructed on the western side and, in contrast to other cases, a complete absence of informal houses on both sides of the ravine. By the three-year mark, while the number of formal dwellings had increased to 70 and informal houses remained at zero, a new phase of informality emerged with 59 informal extensions on these new dwellings, as seen in Figure 6. This top-down

approach successfully resulted in a deliberate reduction in urban density, with only 74 of the original 119 pre-fire building lots being reconstructed on-site. Nevertheless, the process remained incomplete, with 56 housing solutions still pending for displaced families via the AVC subsidy (see Table 5).

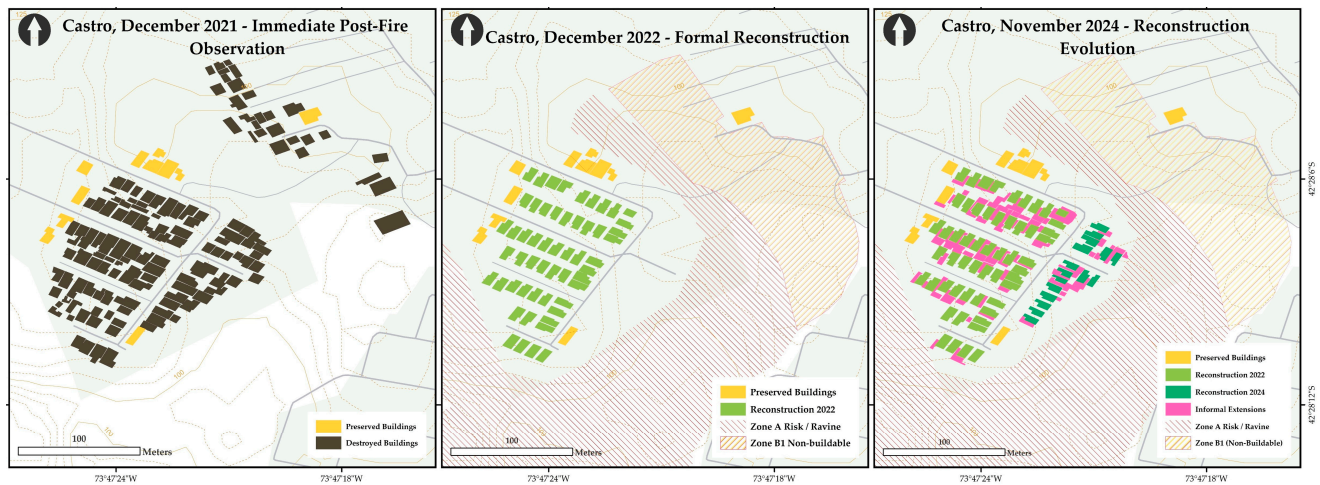


Figure 6. Spatiotemporal Evolution of the Built Environment in Castro (December 2021–November 2024).

The reconstruction in Castro 2021 was explicitly governed by a post-disaster risk assessment from the Ministry of Housing and Urbanism (MINVU), resulting in a strategy centred on risk-based zoning, as detailed in Figure 7. The primary intervention was to ‘Avoid wildfire exposure’ by designating hazardous areas: Zone A (Risk zone) and Zone B1 as non-buildable for residential use due to severe fire and landslide risk, facilitating the relocation of families through Construction on New Land Subsidies (CNT) in another area of the city. For areas deemed suitable, the strategy shifted to ‘Increasing resistance to wildfires’ through the on-site reconstruction of homes (On-site Construction, CSP), which were built with enhanced fire protection measures exceeding standard building codes. However, this study’s spatiotemporal analysis revealed that the long-term effectiveness of this resistance strategy is compromised by the subsequent emergence of informal extensions on these new dwellings. These additions reduce the fire-resistant integrity of the structures, decrease the separation between buildings, and increase the risk of structure-to-structure fire propagation. These primary strategies were complemented by localized measures to ‘Improve response to wildfire’ through a new fire hydrant, to ‘Reduce other risks’ with new retaining walls, and to ‘Improve other liveability aspects’ with the construction of a public square and bus stop (see Figure 7).

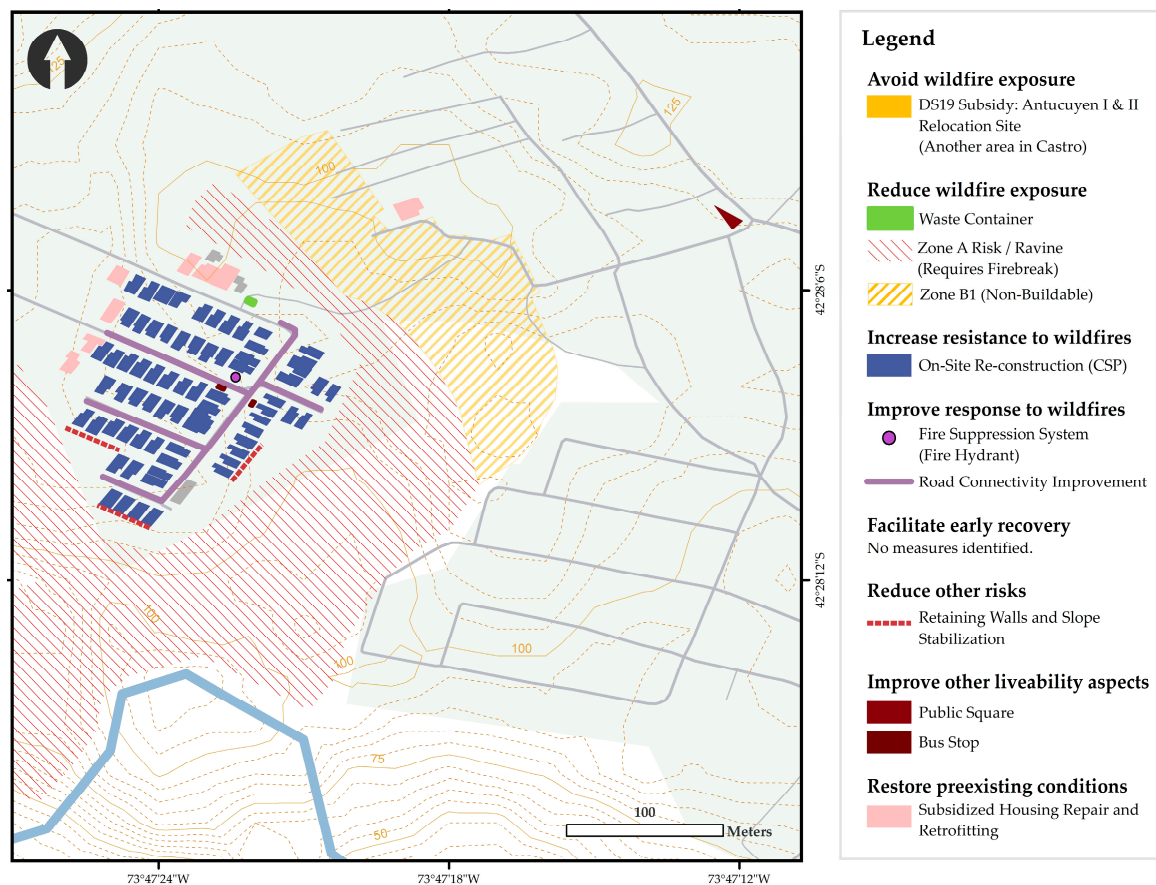


Figure 7. Classification and Spatial Distribution of Post-Wildfire Reconstruction Measures in Castro (2021–2024).

3.4. Punta Lavapie 2023 Case Study

Shaped by its remote location, the reconstruction in Punta Lavapie 2023 after “Llico” fire [51], is distinguished by a mixed and phased response model that involved the simultaneous deployment of multiple recovery strategies: on-site emergency housing, a transitional settlement, traditional reconstruction, and industrialized solutions, reflecting a pragmatic yet complex response to urgent housing needs in a remote community. The initial recovery phase was characterized by the rapid installation of 75 emergency houses (Table 5); 67 were installed on-site for homeowners [63], while a dedicated transitional settlement of 8 dwellings was established for other residents from doubled-up households [64] affected by the fire. This strategy facilitated a faster re-housing process with temporary solutions compared to the initial delivery of permanent homes in the Santa Olga 2017 and Castro 2021 cases (see Figure 8).

The analysis at the two-year mark reveals a shift toward permanence, marked by the reconstruction of the local school and the replacement of emergency housing with permanent, industrialized housing solutions [51]. The subsequent shift toward permanence involves delivering 43 permanent housing solutions through 31 On-site Construction (CSP), comprising 12 industrialized and 19 traditional solutions, and 12 Material Bank (BM) subsidies (see Table 5). However, this later phase also revealed the consolidation of informality, with 10 new informal houses emerging in the transitional settlement and 20 temporary dwellings being modified by residents into more permanent structures (Figure 8).



Figure 8. Spatiotemporal Evolution of the Built Environment in Punta Lavapie (February 2023–February 2025).

The reconstruction in Punta Lavapie 2023 was characterized by a focus on immediate recovery and the hardening of critical infrastructure, with a notable absence of measures to ‘Avoid’ or ‘Reduce’ wildfire exposure (see Figure 9). The strategy was dominated by actions to ‘Facilitate early recovery’, such as installing emergency housing, and to ‘Restore preexisting conditions’ through on-site housing reconstruction. Significant investment was also directed at ‘Increasing resistance to wildfires’ by reinforcing key public buildings like the local school and kindergarten (critical community facilities) (see Table 5). Uniquely shaped by the community’s coastal location, the approach to ‘Improve response’ centred on upgrading the pier as a maritime evacuation route.

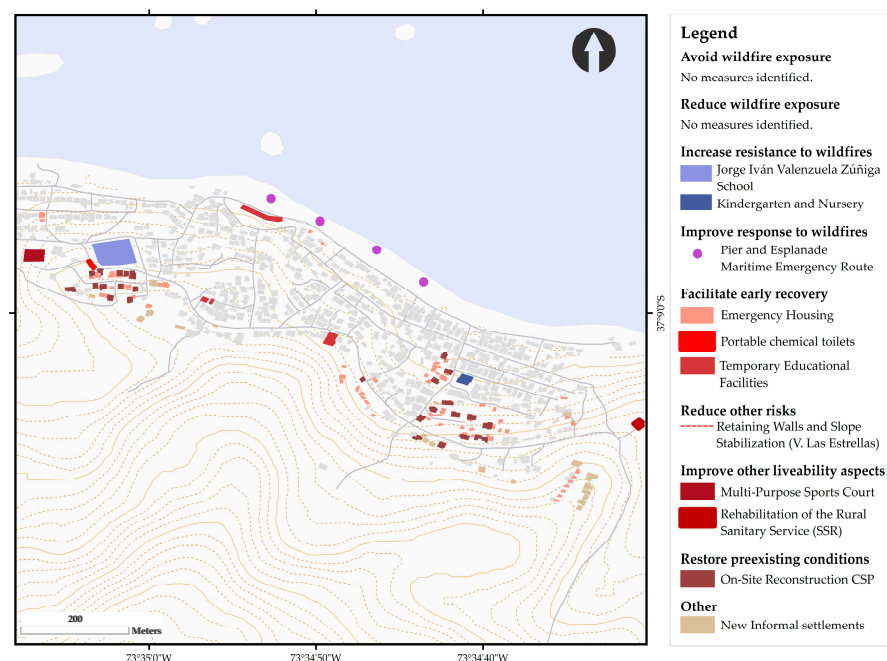


Figure 9. Classification and Spatial Distribution of Post-Wildfire Reconstruction Measures in Punta Lavapie (2023–2025).

4. Discussion

Using the example of four Chilean case studies, this research advances understanding of reconstruction processes as a potential opportunity to implement structural measures for wildfire DRR and create better, more resilient settlements. The results indicate that these reconstruction processes provide opportunities to implement wildfire DRR measures and other improvements, which have enhanced overall settlement conditions, albeit partially and incompletely. They overlook key aspects, suggesting they have not significantly contributed to making settlements more resilient to wildfires, especially in the long term.

From a general point of view, the results suggest that in these reconstruction processes, the intention is to Build Back Better, using this window of opportunity to improve wider living conditions in impacted communities. This supports the idea that communities and governments view these events as an opportunity to change [31–34] in line with the concept of Build Back Better [35]. In fact, essential liveability aspects were upgraded through these processes; for instance, sanitary improvements were implemented, new community facilities were built, and landslide risks were reduced.

Despite these intentions, our analysis suggests these reconstruction processes do not promote settlements that are more resilient to wildfires in the long run. As the cross-case findings presented in the Results Section demonstrate, outcomes such as the trend towards densification in high-risk areas, the widespread proliferation of informality, and the poor upkeep of critical infrastructure collectively undermine long-term resilience. This is particularly evident in the case of infrastructure maintenance, where fieldwork observations in Valparaíso confirmed that critical infrastructure, such as dedicated water storage tanks and fire hydrants, suffer from neglect and vandalism, rendering them ineffective. This indicates that while measures to ‘Improve response’ were implemented, their long-term contribution to resilience is not sustained.

The findings suggest that fire-prone behaviours are sometimes encouraged during these processes, which can increase wildfire risk in some instances. The results align with the literature that argues systems often struggle to implement wildfire DRR comprehensively [37–40]. Furthermore, these findings highlight the limitations of reconstruction processes in creating wildfire-resilient settlements, and they should be considered in the context of the literature that claims these moments provide a ‘hot moment’ [36] or a window of opportunity for improvement [31–33] and the development of fire-adapted communities [36]. Instead, the research findings support the view that the window of opportunity after a disaster often does not lead to systemic change, or if it does, the change following a large disaster can often be negative [34].

The results suggest that one of the main issues hindering the development of settlements more resilient to wildfires is that the structural measures for wildfire DRR are sometimes incomplete or poorly coordinated. This is critical, as the literature emphasizes that wildfire DRR measures need to be implemented as a system of complementary actions, and none of them is a failsafe mechanism [2,22]. In particular, Punta Lavapie 2023 stands out for the incompleteness of the measures implemented, focusing on only a few mechanisms. Moreover, the Valparaíso case study also illustrates the limited coordination of measures. For example, emergency housing was built in areas with significant exposure without integrating plans for future housing reconstruction projects, and response features such as water tanks, fire hydrants, safe zones, and alarms were installed without considering fire services requirements and management capacities.

It can also be inferred that another significant issue hindering the delivery of wildfire-resilient settlements is the considerable focus on restoring previous conditions as fast as possible. This policy choice, acting as a key ‘intervention’, directly led to the ‘outcome’ of encouraging risk-prone behaviours, a trend particularly evident in housing reconstruction.

For example, new homes are often rebuilt in the same exposed areas through on-site housing reconstruction programs. Furthermore, new housing solutions are established, increasing density in these exposed areas due to the provision of on-site housing for affected doubled-up households and new families settling in the area.

This issue of informality, introduced as a key indicator, warrants a deeper analysis. It is primarily associated with housing reconstruction and their extensions, and it is a practice that hinders the establishment of settlements that are more resilient to wildfires. Self-guided housing reconstructions and extensions are widely present in all cases. Even more so, these practices are frequently accepted and even encouraged with limited consideration for disaster risk reduction. This is especially evident in Valparaíso 2014, where the reconstruction process was dominated by informality. The spatial analysis identified 1801 new informal houses and 594 dwellings modified from emergency housing, which together significantly outnumber the 1182 formal, state-subsidized reconstructions (see Table 5 and Figure 2). Furthermore, the time series analysis of all case studies reveals a significant number of houses with extensions, most of which were constructed without considering their impact on fire resistance and the increased proximity of structures, thereby increasing the risk of structure-to-structure fire propagation. These examples suggest that the effectiveness of the measures initially implemented is compromised, and their efficacy is considerably diminished. This outcome points to an institutional failure: a tacit acceptance of non-compliant construction in exchange for rapid rehousing.

This challenge of poor upkeep and its evolution over time, noted previously, is a last key issue that limits the effectiveness of the implemented measures. This assessment is based on direct, verifiable physical evidence from our fieldwork. Structural measures for wildfire DRR typically require ongoing maintenance; roof seals need regular checks, vegetation must be managed, and so forth. During data collection, the systematic photographic inventory confirmed that many measures were poorly maintained, such as vegetation that was not consistently cared for, many water tanks were left unused because of neglect, fire hydrants were often vandalized, and the early warning siren system implemented in Valparaíso was largely non-operational, with only one of eight sirens found to be active, among others. This finding is further corroborated by our review of planning documents, which frequently lacked clear budgetary provisions for long-term maintenance. This widespread decay is a direct consequence of an institutional gap in planning: the failure to assign long-term maintenance responsibilities and budgets from the outset. The existing mechanism is defective in that national agencies fund and execute reconstruction works, but the subsequent responsibility for upkeep is often ambiguously transferred to local municipalities or communities that lack the dedicated financial and technical resources to sustain them.

Based on this study's findings, it is advisable for post-wildfire reconstruction efforts to adopt a more comprehensive approach to risk reduction and management, recognizing that political will and direction are necessary to effect these changes. This means establishing comprehensive reconstruction approaches that go beyond merely replacing what was lost, focusing instead on long-term resilience. To achieve this, it is essential to balance the tension between rebuilding quickly and rebuilding better, prioritizing quality and safety over speed while also considering communities' struggles and their immediate and medium-term recovery needs. Furthermore, policymakers should acknowledge that self-construction of housing and extensions is common practice driven by underlying socio-economic needs, and work to improve guidance and oversight systems—for instance, by creating dedicated technical assistance programs or subsidies for safe structural extensions—to ensure these structures meet safe standards. Lastly, maintaining physical measures for wildfire disaster risk reduction—by clearly defining responsibilities, timelines, and budgets—is crucial

to preventing future disasters and safeguarding communities over the long run. This requires moving beyond the current model of unfunded responsibility transfers. Future reconstruction plans should be required to include legally binding maintenance agreements and dedicated, multi-year operational budgets, ensuring that responsibilities are clearly assigned and adequately resourced from the project's inception.

5. Conclusions

This research identified the physical changes associated with implementing structural measures for wildfire DRR and other wider improvements in reconstruction processes, categorizing the interventions undertaken in the case studies of (1) Valparaiso 2014, (2) Santa Olga 2017, (3) Castro 2021, and (4) Punta Lavapie 2023. The measures implemented in the reconstruction processes were categorized into four categories for wildfire DRR: (a) avoid wildfire exposure; (b) reduce wildfire exposure; (c) increase resistance to wildfires; and (d) improve response to wildfires. (Additionally, four other categories of measures aimed at broader settlement improvement, separate from wildfire DRR, were identified: (e) facilitate early recovery; (f) reduce other risks; (g) enhance other liveability aspects; and (h) restore preexisting conditions. The study found that all cases implemented structural measures for wildfire DRR, though the emphasis varied between cases. Santa Olga 2017 and Castro 2021 were the most comprehensive in wildfire DRR efforts, whereas Punta Lavapie 2023 was the least. The only set of measures common to all cases was aimed at improving wildfire response. Furthermore, the research showed that in every case, measures to enhance broader settlement conditions outside wildfire DRR were adopted, and all case studies included significant efforts to restore preexisting conditions and to improve liveability aspects.

Although wider settlement improvements and some disaster risk reduction measures have been implemented, the results indicate that these reconstruction efforts have not increased settlements' resilience to wildfires in the long run, and in some instances, may have even heightened the risk. Major obstacles to establishing more wildfire-resilient settlements include incomplete or poorly coordinated measures; a focus on restoring conditions as quickly as possible; acceptance and even promotion of informality, mainly related to housing reconstruction and extensions; and the inadequate upkeep of measures over time.

Using the example of wildfire disaster risk reduction, this research makes a significant and novel contribution to both the theory and practice of reconstruction and wildfire risk reduction. It also advances the understanding of the constrained ability to deliver improved settlements through post-wildfire reconstruction processes in Chile. The results provide detailed new information about the changes made in the four case studies. Additionally, the documentation and categorization of these interventions provide a novel empirical evidence base of structural measures implemented through architecture, building, urban design, spatial planning, and vegetation management in practice. Moreover, the interventions listed in Table 4 can serve as a preliminary guide for other wildfire post-reconstruction efforts in Chile and around the world. Ultimately, research's primary theoretical innovation is to provide robust, longitudinal evidence that challenges the 'window of opportunity' theory, showing that the post-disaster period often does not lead to positive long-term systemic change.

It is essential to point out that this research has several limitations. The shorter observation period for the more recent case studies is an inherent constraint, as large-scale wildland-urban interface fires are a recent phenomenon in Chile, limiting any longitudinal analysis to the post-2014 period. However, this comparative longitudinal design, including cases at different reconstruction stages, provides timely insights into the evolution

of recovery policies in an emerging field of study. The analysis focuses on the physical aspects of wildfire DRR; nevertheless, it is acknowledged that these must be accompanied by non-structural measures, such as community awareness, early warning systems, and behavioural change [29,30]. Furthermore, although protocols for data collection and analysis were established, the process may have inadvertently omitted some information or overlooked changes due to the dynamic and multifaceted nature of the unit of analysis of this research— the physical changes associated with the implementation of the structural measures for wildfire DRR in reconstruction processes. It is also important to point out that the case studies' results reflect contextual conditions that are not directly generalizable to reconstruction processes in other places or communities [52].

Future research can be suggested based on this work. More case studies that analyze the physical DRR measures implemented in post-wildfire reconstruction processes in various locations, like Portugal, France, or California, should be conducted to either confirm or expand on the exploratory findings of this research. While the need to address wildfire DRR based on a comprehensive system of complementary measures is acknowledged in this study, further research could also analyze the synergistic or conflicting relationships between different types of measures to clarify which combination of measures can more effectively improve resilience. Regarding the budget allocation for the different measures, a further analysis could be conducted in relation to it, for instance, evaluating the rationality of the budget in combination with the actual effect of the measures, or exploring whether insufficient budget or unbalanced allocation are key factors leading to incomplete measures and poor maintenance.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AVC	Subsidy for the Acquisition of Already Built Housing
BM	Bank Material Subsidy
CNT	Construction on New Land Subsidy
CONAF	former National Forestry Corporation
CSP	On-Site Construction Subsidy
DRR	Disaster Risk Reduction

FIBE	Basic Emergency Form
MINVU	Ministry of Housing and Urbanism
MOP	Ministry of Public Works
ONEMI	Office of National Emergency of the Interior Ministry
ONGs	Non-Governmental Organizations
SENAPRED	National Disaster Prevention and Response Service
SEREMI	Regional Ministerial Secretariat
SERNAFOR	National Forestry Service
SERVIU	Regional Housing and Urbanization Services
WUI	Wildfire-Urban Interface
CLP	Chilean Pesos
UF	Chilean inflation-adjusted unit

Appendix A

Appendix A.1. Valparaíso 2014

	Origin	Entity	Document Name	Date
1	Official document	MINVU	Reporte Plan de Reconstrucción, Incendio Valparaíso 12 abril 2014	30 September 2018
2	Official document	MINVU	Reporte Plan de Reconstrucción, Incendio Valparaíso 12 abril 2014	31 July 2019
3	Official document	MINVU	Reporte Plan de Reconstrucción, Incendio Valparaíso 12 abril 2014	13 December 2020
4	Official document	MINVU	Reporte Plan de Reconstrucción, Incendio Valparaíso 12 abril 2014	15 September 2021
5	Official document	MINVU	Reporte Plan de Reconstrucción, Incendio Valparaíso 12 abril 2014	31 December 2022
6	Official document	MINVU	Reporte Plan de Reconstrucción, Incendio Valparaíso 12 abril 2014	28 February 2023
7	Official document	MINVU	Resolución Exenta 3052. Llamado especial para el otorgamiento de subsidios habitacionales regulados por los Decretos N° 1 y 49, ambos de 2011, para los damnificados por el incendio del mes de abril de 2014 que afectó la comuna de Valparaíso. Fija el monto de recursos que se destinarán para el Subsidio Directo	2014
8	Official document	MINVU	Resolución Exenta 555. Llama a postulación en condiciones especiales para el otorgamiento de subsidios habitacionales del fondo solidario de elección de vivienda, regulado por el decreto N° 49, de 2011, en la alternativa de postulación colectiva con Proyecto Habitacional, tipología de construcción en nuevos terrenos, para los damnificados por el incendio del mes de abril de 2014 que afectó a la comuna de Valparaíso	2015

9	Official document	MINVU	MINVU. Subsidios del programa habitacional del fondo solidario de elección de vivienda, modalidades construcción en Sitio Propio y Densificación Predial, conforme al Artículo 27 del DS N°49 (V. Y U.) de 2021, cuyo texto fue reemplazado por el Artículo Primero del DS N°105 (V. Y U.) de 2014 a damnificados de la comuna de Valparaíso, en la región de Valparaíso–Resolución Exenta 10236. 2015.	2016
10	Official document	MINVU	MINVU. Subsidios del programa habitacional de vivienda, modalidad construcción en Sitio Propio y Densificación Predial, conforme al Artículo 27 del D.S. N°49, (V. Y U.) de 2011, cuyo texto fue reemplazado por el Artículo primero del D.S. N°105, (V. Y U.) de 2014, a damnificados de la comuna de Valparaíso, en la región de Valparaíso–Resolución Exenta N° 03488.	2016
11	Official document	MINVU	Resolución Exenta 000410. Subsidios habitacionales adicionales, conforme al Artículo 27 Familias pertenecientes al proyecto “Condominio Social Placilla” de la comuna de Valparaíso, región de Valparaíso	2018
12	Official document	Observatorio	Reconstrucción Gran Incendio de Valparaíso Reporte 1	2015
13	Official document	Senado	Informe de la Comisión Especial sobre catástrofe por incendio en Valparaíso	2015
14	Official document	SERVIU region Valparaíso	LP 17/2017. Programa Conservación conectividad de los barrios afectados por el incendio 2014, Conservación calle Lircay, Cerro La Cruz, comuna Valparaíso–Resolución Exenta N°155 1779	2017
15	Official document	SERVIU region Valparaíso	LP 75/2017. Programa conservación de muros para estabilizar terrenos en zona de incendio Valparaíso, Construcción Obras de Mitigación muros de terceros, 3 roles, Cerro La Cruz y Las Cañas, comuna de Valparaíso–Resolución Exenta N°155 2567.	2017
16	Official document	SERVIU region Valparaíso	LP 75/2017. Programa “Conservación conectividad de los cerros afectados por el incendio 2014, conservación pasaje Bombero Manfatti, Cerro La Cruz, comuna de Valparaíso–Resolución Exenta N°155 3585. 2017, Resolución Exenta N°155 3585.	2017
17	Official document	SERVIU region Valparaíso	TD 64/2016. Programa de conservación muros para estabilizar terrenos en zona incendio de Valparaíso, Construcción obras de mitigación entre privados, ROLES N°5154-002, N°5154-005, N°5160-296 Y N°5160-379 Cerro Las Cañas, comuna Valparaíso–Resolución Exenta N°155 2641.	2016

18	Official document	SERVIU region Valparaíso	LP 08/2017. Programa vialidad urbana, proyecto mejoramiento Avenida Alemania, Etapa 1 comunidad de Valparaíso–Resolución Exenta N°155 0041.	2017
19	Official document	SERVIU region Valparaíso	LP 132/2016. Programa recuperación de barrios, proyectos zona seguras y señaléticas, Plaza El Recuerdo y Estatua La Virgen, Cerro Merced, comuna Valparaíso–Resolución Exenta N°155 2624	2017
20	Official document	SERVIU region Valparaíso	LP 133/2016. Programa recuperación de barrios, red de puntos seguros, subcomisaria Las Cañas, comuna de Valparaíso, red de puntos seguros, sede junta de vecinos Santa Rosa del Pajonal, Cerro Las Cañas, comuna Valparaíso–Resolución Exenta N°155 3009.	2017
21	Official document	SERVIU region Valparaíso	LP 135/2017. Programa recuperación de barrios, proyecto mejoramiento integral espacio deportivo y de habilitación infantiles, consolidación circuito Plazas calle Trípoli; consolidación mirador Trípoli con Cariolán, Cerro El Litre, comuna de Valparaíso–Resolución Exenta N°155 6231	2017
22	Official document	SERVIU region Valparaíso	LP 16/2017 Programa vialidad urbana, proyecto mejoramiento calle El Vergel, comuna de Valparaíso–Resolución Exenta N°155 7095.	2017
23	Official document	SERVIU region Valparaíso	LP 163/2017. Programa conservación de muros para estabilizar terrenos en zona incendio Valparaíso, mitigación muros de terceros, varios roles, calle Los Canelos y otros, varios cerros, comuna de Valparaíso–Resolución Exenta N°155 5591.	2017
24	Official document	SERVIU region Valparaíso	LP 175/2017. Programa conservación calle La Fontaine etapa I, entre Santa Teresa y Lambecho, Cerro El Litre, comuna de Valparaíso–Resolución Exenta N°155 7059	2017
25	Official document	SERVIU region Valparaíso	LP 193/2017. Programa conservación de muros para estabilizar terrenos en zona incendio, construcción obras de mitigación varios roles calle Azorín y otros, carro La Cruz, Las Cañas y Merced, comuna de Valparaíso–Resolución Exenta N°155 7064.	2017
26	Official document	SERVIU region Valparaíso	LP 194/2017. Conservación de muros para estabilizar terrenos, zona incendio Valparaíso, construcción de obras de mitigación entre privados, 9 roles, cerros Las Cañas, Merced y La Cruz, comuna de Valparaíso–Resolución exenta N°155 5753.	2017
27	Official document	SERVIU region Valparaíso	LP 199/2017. Programa conservación de muros para estabilizar terrenos en zona incendio, proyecto de muro contención en pasaje Rembrandt, Cerro El Litre, comuna de Valparaíso–Resolución Exenta N°5751.	2017

28	Official document	SERVIU region Valparaíso	LP 211/2017. Programa conservación de muros para estabilizar terrenos en zona incendio Valparaíso, construcción obras de mitigación entre privados ROL N°5160-078, calle Los Alerces, cerro Las Cañas, comuna de Valparaíso–Resolución Exenta N°155 5764.	2017
29	Official document	SERVIU region Valparaíso	LP 214/2016. Programa conservación de pavimentos, muros y otros en zona incendio, proyecto complementario obras de contención y pavimentos, pasaje vecinal Los Cipreses, etapa II, cerro El Litre, comuna Valparaíso–Resolución Exenta N°155 1392.	2017
30	Official document	SERVIU region Valparaíso	LP 214/2017. Programa conservación pavimentos y escaleras ejes transversales Avenida Argentina, conservación escalera Simpson, entre Ruperto Chapiy David Porter, Valparaíso–Resolución Exento N°155 5761.	2017
31	Official document	SERVIU region Valparaíso	LP 216/2016. Programa Conservación de muros para estabilizar terrenos en zona incendio, construcción obras de mitigación entre privados 5 roles, calle Azorín y otros, Cerro La Cruz, Las Cañas, comuna de Valparaíso–Resolución Exenta N°155 1784.	2017
32	Official document	SERVIU region Valparaíso	LP 220/2016. Programa Conservación de muros para estabilizar terreno en zona incendio, Construcción obras de mitigación entre privados, 3 roles, Quebrada Kayser Cerro Merced, comuna de Valparaíso–Resolución Exenta N°155 2356.	2017
33	Official document	SERVIU region Valparaíso	LP 230/2017. Programa conservación conectividad de los barrios afectados por incendio 2014, conservación pasaje Tiziano, Tres Puentes y Lavados, cerro Merced, comuna Valparaíso–Resolución Exenta N°155 6019.	2017
34	Official document	SERVIU region Valparaíso	LP 53/2017. Programa recuperación de barrios, Quiero mi Barrio, ejecución de obras de circuito de Plazas Calle Trípoli, Plaza Acceso, Plaza de los Sueños y Mirador Trípoli con Cariolan, comuna de Valparaíso–Resolución Exenta N°155 2646.	2017
35	Official document	SERVIU region Valparaíso	LP210/2016. Programa de Conservación de conectividad de los barrios afectados por incendio abril 2014, Conservación escalera Los Obreros y Pasajes Los Canelos, Cerro Las Cañas, comuna de Valparaíso–Resolución Exenta N°155 2751.	2017
36	Official document	SERVIU region Valparaíso	TD 226/2016. Programa conservación de pavimentos, muros y otros en zona incendio, proyecto conservación pasaje Los Alerces, comuna de Valparaíso–Resolución Exenta N°155 3710.	2017

37	Official document	SERVIU region Valparaiso	TD 238/2016. Programa de conectividad de los barrios afectados por incendio abril 2014, ejecución obras Plaza Deportiva El Vergel alto y Zona Segura, Barrio Cerro La Cruz, comuna de Valparaiso–Resolución Exenta N°155 3235.	2017
38	Official document	SERVIU region Valparaiso	TD 245/2016. Programa conservación de muros para estabilizar terrenos en zona incendio Valparaiso, construcción colectivo obras de contención, calle Tiro al Blanco etapa II, Cerro La Cruz, comuna de Valparaiso–Resolución Exenta N°155 3703.	2017
39	Official document	SERVIU region Valparaiso	TD 25/2017. Programa Conservación muros para estabilizar terrenos en zona incendio construcción obras de mitigación ROL 5160-331, Av. Alemania, comuna Valparaiso–Resolución Exenta N°155 2641.	2017
40	Official document	SERVIU region Valparaiso	TD 266/2016. Programa conservación de muros para estabilizar terrenos en zona incendio, mitigación muros de terceros, 8 ROLES, Cerros La Cruz, Las Cañas y El Litre, comuna de Valparaiso -Resolución Exenta N°155 2723.	2017
41	Official document	SERVIU region Valparaiso	TD 268/ /2016. Conservación conectividad de los barrios afectados por el incendio, conservación escalera Los Canelos–Resolución Exenta N°155 2644.	2017
42	Official document	SERVIU region Valparaiso	LP 103/2017. Programa conservación de conectividad de los barrios afectados por incendio abril 2014; conservación calle Francisco Noguett, Cerro Merced, comuna de Valparaiso–Resolución Exenta N°155 1125.	2018
43	Official document	SERVIU region Valparaiso	LP 198/2017. Programa conservación de muros para estabilizar terrenos en zona incendio y conservación de pavimentos, muros y otros en zona incendio, para mitigación derrumbe de talud Camino Uno, Cerro La Cruz, Valparaiso–Resolución Exenta N°155 1189.	2018
44	Official document	SERVIU region Valparaiso	LP 238/2017. Programa conservación pavimentos, muros y otros en zona incendio; conservación parque El Litre, comuna de Valparaiso–Resolución Exenta N°155 1010.	2018
45	Official document	SERVIU region Valparaiso	LP 31/2018. Conservación calle La Fontaine, Cerro El Litre, Valparaiso. conservación y ensanche calle La Fontaine entre Lambecho y Pictón, Cerro El Litre, comuna Valparaiso–ORD. N° 155 02586.	2018
46	Official document	SERVIU region Valparaiso	LP 50/2018. Programa conservación conectividad de los barrios afectados por el incendio 2014, conservación pasaje El Álamo, saneamiento y modificación de cauce natural, comuna de Valparaiso–Resolución Exenta N°155 2283.	2018

47	Official document	SERVIU region Valparaíso	LP 72/2018. Programa de construcción de muros y estabilización terreno zona incendio, construcción obras de mitigación entre privados, 4 ROLES, pasaje Los Castaños y otros, cerro Las Cañas, comuna Valparaíso–Resolución N°155 2784.	2018
48	Transparency	MINVU	Informe de gestión CIERRE PERIODO 2021 RECONSTRUCCIÓN INCENDIO 2014	2025
49	Transparency	SERVIU region Valparaíso	Informe de gestión cierre periodo 2021 reconstrucción incendio 2014	2023
50	Media	Publimetro	Minvu anunció Plan de Reconstrucción de Valparaíso	2014

Appendix A.2. Santa Olga 2017

	Origin	Entity	Document Name	Date
1	Official document	MINVU	Reporte Plan Reconstrucción, Incendio Forestal Maule 2017	2019
2	Official document	MINVU	Reporte Plan Reconstrucción, Incendio Forestal Maule 2017	jun-19
3	Official document	MINVU	Reporte Plan Reconstrucción, Incendio Forestal Maule 2017	2021
4	Official document	MINVU	Reporte Plan Reconstrucción, Incendio Forestal Maule 2017	2022
5	Official document	MINVU	Reporte Plan Reconstrucción, Incendio Forestal Maule 2017	2023
6	Official website	Bomberos Constitución	Se inaugura nuevo cuartel 5ta Compañía de Constitución en Santa Olga	2020
7	Official website	CORMA	Inauguran moderno parque urbano en Santa Olga	2020
8	Official website	Desafío Levantemos Chile	Proyecto de reconstrucción incendio área centro-sur-enero/febrero 2017.	2018
9	Official website	Desafío Levantemos Chile	Construye un complejo educacional para mil alumnos en Santa Olga y entrega 240 casas a la fecha.	2018
10	Official website	Gobierno Regional del Maule	Anteproyecto Regional de Inversiones ARI 2021	2021
11	Official website	Ministerio de Obras Públicas. MOP	Subsecretario Sergio Galilea destacó avance en proceso de reconstrucción de la Nueva Santa Olga	2017
12	Official website	Ministerio del Medio Ambiente	Finaliza proyecto enfocado a la reforestación nativa y el desarrollo forestal sustentable en Santa Olga	2019
13	Academic Paper	Article	Learned from Chile, Evaluating Strategic Reconstruction Master Plans in Post-Disaster Scenarios	2018
14	Media	VNL Radio	Santa Olga contará con terminal de buses rural.	2017

15	Media	CSN	Inaugurada cancha de fútbol Santa Olga	2020
16	Media	Diario Sustentable	Ministerio de Vivienda y CMPC firman convenio para reconstrucción de Santa Olga	2017
17	Media	Diario Sustentable	Colaboración público-privada genera importantes logros en reconstrucción de Santa Olga tras los incendios	2018

Appendix A.3. Castro 2021

	Origin	Entity	Document Name	Date
1	Official document	Ministerio del Interior y Seguridad	Decreto 305. Declara zona afectada por catástrofe a los sectores de la comuna de Castro que señala y dispone medidas que indica.	2021
2	Official document	MINVU	Informe que define áreas de riesgo transitorias, denominadas zonas críticas para la comuna de Castro	2022
3	Official document	Municipalidad de Castro	Plan de Desarrollo comunal de Castro (2023–2026)	2022
4	Official document	Municipalidad de Castro	Cierra el ciclo de reconstrucción: Entregan últimas casas de Población Camilo Henríquez	2022
5	Official document	SECPLAN.	Decreto Exento N° 085. Construcción: Obras de confianza PQMB Tejiendo Sueños	2024
6	Official document	SERNAGEOMIN	Evaluación de susceptibilidad de remociones en masa de las laderas de las poblaciones Yungai y Camilo Henríquez posterior al incendio de diciembre de 2021	2022
7	Transparency	MINVU	Diagnóstico Compartido, “Barrio Tejiendo Sueños”, comuna de Castro	2024
8	Transparency	MINVU	INFORME 3: Diagnóstico compartido Consultoría de estudio diagnóstico y elaboración plan maestro, Programa Quiero mi Barrio “Barrio Tejiendo Sueños	2024
9	Transparency	Municipalidad de Castro	Cierra el ciclo de reconstrucción: Entregan últimas casas de Población Camilo Henríquez	2022
10	Official website	CONAF	Plan de protección contra incendios forestales. Comuna de Castro	2022
11	Official website	Consejo del Salmón Chile	Reconstrucción de Castro	2022
12	Official website	Desafío Levantemos Chile	Tras incendio en diciembre de 2021: Finalizan obras en la población Camilo Henríquez con la entrega de 49 viviendas de alto estándar	2021
13	Official website	Movidos	Informe de Emergencia Incendio Castro; Santiago, 2021	2021

Appendix A.4. Punta Lavapie 2023

	Origin	Entity	Document Name	Date
1	Official document	Ministerio de Hacienda	Decreto 213 Exento Identifica listado de obras específicas a que se refiere el Artículo 8° de la Ley N°20.444, que se crea el Fondo Nacional de la Reconstrucción y establece mecanismos de incentivo tributario a las donaciones efectuadas en caso de catástrofe.	2023
2	Official document	MINVU	Resolución 597 Exenta. Llama a proceso de selección en condiciones especiales para el otorgamiento de subsidios habitacionales del fondo solidario de elección de vivienda [...]	2023
3	Official document	Programa para Pequeñas Localidades	Informe Diagnóstico, Programa para Pequeñas Localidades. Sistema de localidades de Llico, Rumena y Punta Lavapie	2023
4	Transparency	MINVU	ORD. N°4503. Entrega información sobre reconstrucción postincendio 2023 en Punta Lavapie.	2025
5	Official website	Delegación Presidencial Provincial de Arauco	Delegación Presidencial Provincial de Arauco. Inician construcción de alcantarillado particular de Villa Las Estrellas en Punta Lavapie.	2024
6	Official website	Fondo Nacional de la Reconstrucción	Donación 15 viviendas emergencia Punta Lavapie.	2023
7	Official website	Fondo Nacional de la Reconstrucción	Rehabilitación del sistema de APR Punta Lavapie	
8	Media	Diario Concepción	Punta Lavapie: inversión busca mejorar infraestructura portuaria y evacuación antes catástrofes	2023
9	Media	Diario Concepción	Recuperación en Punta Lavapie	2024
10	Media	Diario Concepción	Gobierno compra a 4 proveedores viviendas de emergencia para Biobío	2023

References

- Gill, M.; Stephens, S. Scientific and social challenges for the management of fire-prone wildland–urban interfaces. *Environ. Res. Lett.* **2009**, *4*, 034014. [[CrossRef](#)]
- March, A.; Riddell, G.; Nogueira de Moraes, L.; Stanley, J.; van Delden, H.; Beilin, R.; Dovers, S.R.; Maier, H. Urban planning capabilities for bushfire: Treatment categories and scenario testing. *Aust. J. Emerg. Manag.* **2020**, *35*, 32–40.
- Libonati, R. Megafires are here to stay—And blaming only climate change won't help. *Nature* **2024**, *627*, 10. [[CrossRef](#)]
- Miritis, V.; Dickman, C.R.; Nimmo, D.G.; Doherty, T.S. After the 'Black Summer' fires: Faunal responses to megafire depend on fire severity, proportional area burnt and vegetation type. *J. Appl. Ecol.* **2024**, *61*, 63–75. [[CrossRef](#)]
- Carrillo-García, C.; Girola-Iglesias, L.; Guijarro, M.; Hernando, C.; Madrigal, J.; Mateo, R.G. Ecological niche models applied to post-megafire vegetation restoration in the context of climate change. *Sci. Total Environ.* **2023**, *855*, 158858. [[CrossRef](#)] [[PubMed](#)]
- Le Breton, T.; Schweickle, L.; Dunne, C.; Lyons, M.; Ooi, M. Fire frequency and severity mediate recruitment response of a threatened shrub following severe megafire. *Fire Ecol.* **2023**, *19*, 67. [[CrossRef](#)]
- Butt, A.; Buxton, M.; Haynes, R.; Lechner, A. Peri-urban growth, planning and bushfire in the Melbourne city-region. In Proceedings of the State of Australian Cities (SOAC 2009), Canning Bridge, WA, Australia, 24–27 November 2009; pp. 1–14.

8. Moskwa, E.; Bardsley, D.K.; Weber, D.; Robinson, G.M. Living with bushfire: Recognising ecological sophistication to manage risk while retaining biodiversity values. *Int. J. Disaster Risk Reduct.* **2018**, *27*, 459–469. [CrossRef]
9. Tedim, F.; Xanthopoulos, G.; Leone, V. Forest Fires in Europe: Facts and Challenges. In *Wildfire Hazards Risks, and Disasters*; Elsevier: Amsterdam, The Netherlands, 2014; pp. 77–99. [CrossRef]
10. Castillo, M.; Julio-Alvear, G.; Garfias, R. Current Wildfire Risk Status and Forecast in Chile: Progress and Future Challenges. In *Wildfire Hazards Risks Disasters*; Elsevier: Amsterdam, The Netherlands, 2015; pp. 59–75.
11. González, M.E.; Lara, A.; Urrutia, R.; Bosnich, J. Cambio climático y su impacto potencial en la ocurrencia de incendios forestales en la zona centro-sur de Chile (33–42 °S) [Climate change and its potential impact on forest fire occurrence in south-central Chile (33–42 °C)]. *Bosque* **2011**, *32*, 215–219. [CrossRef]
12. Urrutia-Jalabert, R.; González, M.E.; González-Reyes, Á.; Lara, A.; Garreaud, R. Climate variability and forest fires in central and south-central Chile. *Ecosphere* **2018**, *9*, e02171. [CrossRef]
13. Williams, C.J. Climate Change in Chile: An Analysis of State-of-the-Art Observations, Satellite-Derived Estimates and Climate Model Simulations. *J. Earth Sci. Clim. Change* **2017**, *8*, 400. [CrossRef]
14. Arana, M.T.; Casagrande, A.; Cavieres, A.; Espejo, S.; Gilabert, H.; Leon, J.; Robert, A. Prevención de Incendios Forestales: Propuestas para una Mirada más Efectiva e Integral [Forest Fire Prevention: Proposals for a More Effective and Comprehensive Approach]. 2018. Available online: <https://politicaspUBLICAS.uc.cl/publicacion/prevencion-de-incendios-forestales-propuestas-para-una-mirada-mas-efectiva-e-integral/> (accessed on 26 August 2025).
15. Reszka, P.; Fuentes, A. The Great Valparaíso Fire and Fire Safety Management in Chile. *Fire Technol.* **2015**, *51*, 753–758. [CrossRef]
16. CONAF. ¿Cómo Preparo mi Casa y Entorno Frente a los Incendios Forestales? *Manual de Prevención de Incendios Forestales [How do I Prepare my House and Surroundings for Forest Fires? Wildfire Prevention Manual]*; Documento de Trabajo N°601; Corporación Nacional Forestal: Santiago, Chile, 2015.
17. Garay Moena, R.M.; Castillo Soto, M.; Tapia Zarricueta, R. Viviendas ubicadas en áreas de riesgo de incendios forestales de interfaz. Un análisis territorial y normativo desde Chile [Dwellings located in wildland-urban interface risk areas. A territorial and regulatory analysis from Chile]. *Univ. Politècnica De Catalunya* **2021**, *46*, 9523. [CrossRef]
18. UNDRR. Terminology. Available online: <https://www.unisdr.org/we/inform/terminology> (accessed on 25 August 2025).
19. United Nations International Strategy for Disaster Reduction. *Sendai Framework for Disaster Risk Reduction*; United Nations International Strategy for Disaster Reduction: Geneva, Switzerland, 2015.
20. Global Facility for Disaster Reduction and Recovery. *Investing in Urban Resilience, Protecting and Promoting Development in a Changing World*; Global Facility for Disaster Reduction and Recovery: Washington, DC, USA, 2016.
21. United Nations. *Transforming our World: The 2030 Agenda for Sustainable Development*; United Nations Development Programme: New York, NY, USA, 2015.
22. Gonzalez-Mathiesen, C.; March, A. Establishing Design Principles for Wildfire Resilient Urban Planning. *Plan. Pract. Res.* **2018**, *33*, 97–119. [CrossRef]
23. Stangel, P. Prospects of Urban Morphology in Resilience Assessment. In *Resilience-Oriented Urban Planning: Theoretical and Empirical Insights*; Yamagata, Y., Sharifi, A., Eds.; Springer: Cham, Switzerland, 2018; pp. 181–194.
24. Moritz, M.A.; Butsic, V. *Building to Coexist with Fire: Community Risk Reduction Measures for New Development in California*; University of California, Agriculture and Natural Resources: Berkeley, CA, USA, 2020.
25. Syphard, A.D.; Brennan, T.J.; Keeley, J.E. The importance of building construction materials relative to other factors affecting structure survival during wildfire. *Int. J. Disaster Risk Reduct.* **2017**, *21*, 140–147. [CrossRef]
26. Leonard, J.; Opie, K.; Bianchi, R.; Newnham, G.; Holland, M. *Wye River/Separation Creek Post-Bushfire Building Survey Findings*; CSIRO: Clayton, VIC, Australia, 2016.
27. Syphard, A.D.; Keeley, J.E.; Massada, A.B.; Brennan, T.J.; Radeloff, V.C. Housing arrangement and location determine the likelihood of housing loss due to wildfire. *PLoS ONE* **2012**, *7*, e33954. [CrossRef] [PubMed]
28. Syphard, A.D.; Brennan, T.J.; Keeley, J.E. The role of defensible space for residential structure protection during wildfires. *Int. J. Wildland Fire* **2014**, *23*, 1165–1175. [CrossRef]
29. McEntire, D.A. Triggering agents, vulnerabilities and disaster reduction: Towards a holistic paradigm. *Disaster Prev. Manag. Int. J.* **2001**, *10*, 189–196. [CrossRef]
30. Paton, D.; Tedim, F. Enhancing forest fires preparedness in Portugal: The relevance of integrating risk communication with community engagement and development. In *Proceedings of the GRF Davos, Planet@Risk, Davos, Switzerland, 1 October 2013*.
31. Kingdon, J.W. *Agendas, Alternatives, and Public Policies*; Little, Brown: New York, NY, USA, 1984.
32. Birkmann, J.; Buckle, P.; Jaeger, J.; Pelling, M.; Setiadi, N.; Garschagen, M.; Fernando, N.; Kropp, J. Extreme events and disasters: A window of opportunity for change? Analysis of organizational, institutional and political changes, formal and informal responses after mega-disasters. *Nat. Hazards* **2010**, *55*, 637–655. [CrossRef]
33. Manyena, S.B. Disaster event: Window of opportunity to implement global disaster policies? *Jambá J. Disaster Risk Stud.* **2013**, *5*, a99. [CrossRef]

34. Davis, I.; Alexander, D.E. *Recovery from Disaster*; Routledge, Taylor & Francis Group: Abingdon, UK; New York, NY, USA, 2016.
35. UNISDR. *Build Back Better in Recovery, Rehabilitation and Reconstruction*; United Nations Office for Disaster Risk Reduction: Geneva, Switzerland, 2017.
36. Schumann, R.L.; Mockrin, M.; Syphard, A.D.; Whittaker, J.; Price, O.; Gaither, C.J.; Emrich, C.T.; Butsic, V. Wildfire recovery as a “hot moment” for creating fire-adapted communities. *Int. J. Disaster Risk Reduct.* **2020**, *42*, 101354. [CrossRef]
37. Marten Caceres, R.; Boano, C.; Abrassart, T. Urban Planning and Natural Hazard Governance. In *Oxford Research Encyclopedia of Natural Hazard Science*; Oxford University Press: Oxford, UK, 2019.
38. Sapountzaki, K.; Wanczura, S.; Casertano, G.; Greiving, S.; Xanthopoulos, G.; Ferrara, F. Disconnected policies and actors and the missing role of spatial planning throughout the risk management cycle. *Nat. Hazards* **2011**, *59*, 1445–1474. [CrossRef]
39. King, D.; Gurtner, Y.; Firdaus, A.; Harwood, S.; Cottrell, A. Land use planning for disaster risk reduction and climate change adaptation: Operationalizing policy and legislation at local levels. *Int. J. Disaster Resil. Built Environ.* **2016**, *7*, 158–172. [CrossRef]
40. Groenhart, L.; March, A.; Holland, M. Shifting Victoria’s emphasis in land-use planning for bushfire: Towards a place-based approach. *Aust. J. Emerg. Manag.* **2012**, *27*, 33.
41. Gonzalez-Mathiesen, C.; March, A. Long-established rules and emergent challenges: Spatial planning and wildfires in Chile. *Int. Plan. Stud.* **2023**, *28*, 37–53. [CrossRef]
42. Gonzalez-Mathiesen, C.; March, A.; Yunis-Richter, F. Integrando la gestión del riesgo de los incendios forestales y la planificación territorial: Una Reseña del contexto histórico de Chile [Integrating wildfire risk management and territorial planning: A review of the historical context of Chile]. *REDER* **2024**, *8*, 68–82. [CrossRef]
43. SENAPRED. Incendios Forestales [Wildfires]. Available online: <https://senapred.cl/informate/evento/resumen-nacional-de-incendios-forestales-2> (accessed on 6 February 2024).
44. Ministerio del Interior y Seguridad Pública. *Valparaíso ¡Se Levanta! La Reconstrucción en Cifras a 6 Meses del Incendio* [Valparaíso Rises! Reconstruction, 6 Months After the Fire]; Ministerio del Interior y Seguridad Pública: Santiago, Chile, 2014; Volume 8.
45. Fritis Estay, A.; Diaz Valdivieso, G.; Salaz Lizana, I.; Salinas Constanso, K. Intervención de barrio para la transformación: Aplicación al Programa Quiero mi Barrio, Chile [Neighborhood intervention for transformation: Application to the Quiero mi Barrio Program, Chile]. *REDER* **2019**, *3*, 84–96. [CrossRef]
46. Gobierno de Chile. *Medidas Para Enfrentar Emergencia y Reconstrucción Incendios Regiones Centro/Sur* [Measures to face Emergency and Reconstruction Fires Central/South Regions]; Gobierno de Chile: Santiago, Chile, 2017.
47. Galilea, S. *La Tormenta de Fuego y la Nueva Santa Olga*, 1st ed.; Universidad de Chile: Santiago, Chile, 2019.
48. Micheletti, S.; Pancani, D.; Pisani, E. Análisis comparativo de la lógica técnico-política de reconstrucción: Terremoto e incendios forestales en el Maule, Chile [Comparative analysis of the technical-political logic of reconstruction: Earthquake and forest fires in Maule, Chile]. *Rev. INVI* **2019**, *35*, 155–183. [CrossRef]
49. Ministerio del Interior y Seguridad Pública. *Decreto 305. Declara como zona afectada por catástrofe a los sectores de la comuna de Castro que señala y dispone medidas que indica* [Declares the specified sectors of the commune of Castro as an affected zone and establishes the indicated measures]; Biblioteca del Congreso Nacional; Ministerio del Interior y Seguridad Pública: Santiago, Chile, 2021.
50. MINVU. *Informe que Define Áreas de Riesgo Transitorias, Denominadas Zonas Críticas Para la Comuna de Castro, Provincia de Chiloé, Región de Los Lagos* [Report Defining Transitory Risk Areas, Designated as Critical Zones for the Municipality of Castro, Chiloé Province, Los Lagos Region]; Resolución Exenta N° 06; Ministerio de Vivienda y Urbanismo: Santiago, Chile, 2022.
51. Programa para Pequeñas Localidades. *Informe Diagnóstico, Programa Para Pequeñas Localidades. Sistema de Localidades de Llico, Rumena y Punta Lavapié* [Diagnostic Report, Program for Small Localities. Locality System of Llico, Rumena and Punta Lavapié]; Programa para Pequeñas Localidades: Santiago, Chile, 2023; 74p.
52. Yin, R.K. *Case Study Research and Applications: Design and Methods*; Sage: Thousand Oaks, CA, USA, 2018.
53. Ministerio del Interior. Servicio Nacional de Prevención y Respuesta ante Desastres, SENAPRED [National Service for Disaster Prevention and Response, SENAPRED]. Available online: <https://web.senapred.cl/nosotros/> (accessed on 28 July 2025).
54. Ministerio Secretaría General de la Presidencia. *Ley 20285 Sobre Acceso a la Información Pública* [Law 20285 On Access to Public Information]; Ministerio Secretaría General de la Presidencia: Santiago, Chile, 2025.
55. Kuffer, M.; Pfeffer, K.; Sliuzas, R. Slums from space—15 years of slum mapping using remote sensing. *Remote Sens.* **2016**, *8*, 455. [CrossRef]
56. Li, Z.; Xin, Q.; Sun, Y.; Cao, M. A deep learning-based framework for automated extraction of building footprint polygons from very high-resolution aerial imagery. *Remote Sens.* **2021**, *13*, 3630. [CrossRef]
57. Ministerio de Vivienda y Urbanismo. *Reporte Plan de Reconstrucción: Incendio Valparaíso* [Reconstruction Plan Report: Valparaíso Fire]; Ministerio de Vivienda y Urbanismo: Santiago, Chile, 2018; Volume 4.
58. Ministerio de Vivienda y Urbanismo. *Reporte Plan de Reconstrucción: Incendio Valparaíso* [Reconstruction Plan Report: Valparaíso Fire]; Ministerio de Vivienda y Urbanismo: Santiago, Chile, 2023; Volume 4.

59. Corporación Nacional Forestal. *Descripción y Efectos “Tormenta de Fuego” 18 de Enero al 5 de Febrero de 2017. Regiones de O’Higgins, Maule y Biobío* [Description and Effects of the “Firestorm” January 18 to February 5, 2017. O’Higgins, Maule and Biobío Regions]; CONAF: Santiago, Chile, 2017.
60. Ministerio de Vivienda y Urbanismo. *Reporte Plan de Reconstrucción, Incendio Forestal Maule 2017* [Reconstruction Plan Report, Maule Wildfire 2017]; Ministerio de Vivienda y Urbanismo: Santiago, Chile, 2021.
61. Ministerio de Vivienda y Urbanismo. *Reporte Plan de Reconstrucción, Incendio Forestal Maule 2017* [Reconstruction Plan Report, Maule Wildfire 2017]; Ministerio de Vivienda y Urbanismo: Santiago, Chile, 2023.
62. Corporación Nacional Forestal. *Plan de Protección Contra Incendios Forestales. Comuna de Castro* [Wildfire Protection Plan. Municipality of Castro]; CONAF: Santiago, Chile, 2022.
63. Fondo Nacional de la Reconstrucción. Donación 15 Viviendas Emergencia Punta Lavapié [Donation of 15 Emergency Housing in Punta Lavapié]. Available online: <https://donaciones.hacienda.gob.cl/proyecto/461> (accessed on 9 September 2024).
64. Harvey, H.; Dunifon, R.; Pilkauskas, N. Under Whose Roof? Understanding the Living Arrangements of Children in Doubled-Up Households. *Demography* **2021**, *58*, 821–846. [CrossRef]

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