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Challenges in Developing Wildfire Understanding from Wildfire Information through Spatial Planning Processes

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Abstract: This paper aims to explore the elements that condition and limit spatial planning processes for developing wildfire understanding from wildfire information. The central argument of this paper is that spatial planning's ability to develop wildfire understanding from new evidence and experience is critical for improving spatial planning systems to better integrate wildfire considerations to promote settlements' resilience to wildfires. The research involved using an inductive qualitative research approach for two case studies: Victoria (Australia) and Chile's spatial planning processes for developing wildfire understanding from wildfire information. Based on the analysis of the case studies and cross-case synthesis, key elements that challenge planning processes were identified, and herein, they are discussed in terms of four general categories of the process of knowledge development: (a) identification; (b) 'co-generation'; (c) reframing; and (d) implementation. The study identifies that the Victorian and Chilean spatial planning systems often fail to give spatial planning meaning to new and dynamic wildfire information due to key elements that constrain the processes of knowledge development. This implies that new wildfire information often does not translate into improvements in the planning system, which in turn entails missing the opportunity to promote settlements' resilience to wildfires.

Keywords: spatial planning; wildfire; resilience; disaster risk management

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1. Introduction

Disaster risk management and the development of resilience is directly related to promoting the sustainable development of cities and territories. Goal 11 of the Sustainable Development Goals [1], "Make cities and human settlements inclusive, safe, resilient and sustainable", identifies this link, highlighting the alignment of the Sustainable Development Goals with the Sendai Framework for Disaster Risk Reduction [2] through holistic disaster risk management. It also emphasizes the need to reduce the impact of disasters, mitigate and adapt to climate change, and develop resilience to disasters. Accordingly, dealing with climate-related hazards such as wildfires is critical for promoting sustainable development.

Wildfires imply a greater disaster risk at the wildland–urban interface (WUI) and peri-urban areas because, in these areas, humans' lives and material goods are more exposed to fire [3]. There is long-term evidence that fire behavior has changed [4,5]. Internationally, wildfire frequency and intensity are currently increasingly associated with worsening weather conditions that support extreme fires [4,5]. 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 [6]. This implies that wildfires need to be considered in the sustainable development and management of settlements.

Addressing wildfires for the sustainable development and management of settlements requires considering the physical aspects of wildfire disaster risk management (DRM),

complementing them with non-physical measures such as promoting community awareness and behavioral change [7,8]. There is increasing evidence that physical actions can contribute to reducing and managing wildfire risk by limiting the exposure of the vulnerable population, reducing the chances of structures catching fire, and facilitating active responses in case of an emergency (see [9–12]). Common physical actions that can contribute to wildfire DRM include considerations about settlements' location, the urban form, the management of natural elements, and the characteristics of buildings [13–16].The implementation of these physical measures involves aligning building design, urban design, spatial planning, and forest regulations and management [7,8].

To implement physical measures for wildfire DRM, it is increasingly common in wildfire-prone areas that spatial planning is expected to integrate wildfire considerations. Spatial planning can be defined as a process of dealing with the impacts of spatial problems and with the spatial coordination of policies to purposively achieve improved settlements [17], bridging the gap between spatial and a-spatial policies [18]. The 'spatial' concept is thus used in its wider sense [17], extending to notions such as economy or psychology rather than just being limited to three-dimensional geometrical spaces. Accordingly, spatial planning is widely acknowledged as a way to deal with disaster risk (see [1,2]) and wildfires (see [19–21]). Spatial planning is particularly suited to avoiding, reducing, and remediating risks via spatial and morphological regulation and design, functioning as the coordinating platform of the different disciplines of wildfire DRM [13].

In order to implement wildfire DRM measures though planning systems, spatial planning-related understandings about wildfires are critical. This is reflected in the first priority for action of the Sendai Framework, "understanding disaster risk", which emphasizes that DRM "should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment" [2]. Furthermore, studies in the literature emphasize that the development of disaster resilience requires learning from experiences related to previous disasters and applying DRM information [22,23]. This implies that spatial planning can promote the development of wildfire resilience by supporting continuous learning and acting upon changing conditions and new wildfire information [19]. To some extent, all spatial planning processes involve creating new information by gathering, analyzing, applying, monitoring, and updating evidence. In fact, evidence-based spatial planning and DRM processes—such as ISO 31000 [24]—have procedural similarities that can allow them to work together [25]. By mainstreaming wildfire DRM information into the planning processes, spatial planning systems could be adapted and refined over time, contributing to settlements' evolution into more desirable, better prepared states.

In this study, spatial planning processes for developing wildfire DRM understanding are conceptualized as non-linear ongoing processes of the (a) identification, (b) 'co-generation', (c) reframing, and (d) implementation of wildfire understandings, adapted from [26,27]. First, the identification of new challenges, considerations, and shifts about wildfire DRM evidence that could be addressed by spatial planning is important because it relates to spatial planning's aspiration to plan for DRM proactively. Second, spatial planning understandings about wildfires must be co-generated, recognizing the range of perspectives and actors involved in its construction [26]. Spatial planning is expected to manage conflicting interests to protect the collective good [28], ensuring a democratic approach that ensures that different voices are heard and that experts' insights are reconciled while mobilizing policy attention to values that might be compromised by the neglect of attention to certain important—but 'unpopular'—issues [29]. Acknowledging that, in risk reduction contexts, "scientific rationality without social rationality remains empty, but social rationality without scientific rationality remains blind" [30]. Third, developing spatial planning understandings about wildfires implies reframing wildfire information, giving it new context-specific spatial planning meaning [27]. Rather than just accumulating information, the process of reframing leads to new ideas about settlements as a result of the debate, encountering, and challenging of diverse and conflicting perspectives. Fourth,

acting refers to the ways spatial planning understandings about wildfires influence the implementation of wildfire measures [26]. This relates to the elements that allow for contextualizing wildfire DRM information to each specific case as well as to the ways the spatial planning systems update and change their instruments to evolving circumstances and new evidence.

Even though settlements' resilience to wildfires can be purposively facilitated by the continuous development and application of wildfire DRM information, some publications in the literature have identified that wildfire and DRM evidence has not been conducive to the development of institutional mechanisms to update and change the planning systems to put this information into action. There has been a large increase in the availability of wildfire and DRM information, yet its translation into meaningful decisions and actions has been limited, especially when integrating it at different spatial and governance levels [22,31–33]. Accordingly, spatial planning's full potential for dealing with wildfires has not been fully acted on [34,35]. This ultimately implies that development continues to occur in areas of high fire risk across the world [36].

The barriers associated with the development of wildfire DRM understandings that have been identified in the literature include cultural values, communication, mistrust [33], difficulties reframing traditional understandings of what constitutes disaster risk, and a lack of systemic data collection and monitoring [37]. Furthermore, a lack of collaborative approaches and the involvement of different actors in the co-creation of DRM understandings have also been identified as barriers to acting based on new DRM data [33,37,38]. In this context, compartmentalized world perceptions, scientific traditions, and reductionist education and training can impair the development of the understandings needed for the development of resilience [39]. Even more so, the spatial configurations that result from the actions of one actor that result in the wildfire exposure of another actor—what the authors of [40] conceptualize as "risk interdependence archetypes"—can impact the development of wildfire understandings. These interdependencies suggest conflicts associated with perceived distributive justice [41,42]—the real or perceived fairness of the outcomes and the distribution of their costs and benefits—resulting from the implementation of wildfire controls and regulations. Thus, these can influence and complicate the development of spatial planning understandings about wildfire DRM.

The characterization of the barriers to the development of DRM understandings presented contributes, to some extent, to explaining why the translation of new wildfire DRM information into spatial planning change has been limited. Nevertheless, it also suggests that there is a lack of nuanced and practical research about the limitations of the spatial planning processes of developing and using information about wildfire DRM. Accordingly, the objective of this study was to explore the elements that condition and limit spatial planning processes for developing wildfire understanding from wildfire information to guide systemic changes.

The next section of this paper describes the materials and methods used to conduct the research for this inductive qualitative study. Briefly, research was conducted using data from spatial planning documents, archival records, and semi-structured interviews, and these data were analyzed using qualitative content analysis techniques and several stages of coding and re-coding, all within the context of two case studies: Victoria (Australia) and Chile's spatial planning processes for developing wildfire understandings. Next, based on the case studies analysis and cross-case synthesis, the elements that condition and limit spatial planning processes for creating wildfire understandings from wildfire information are proposed and discussed in Section 3. These are organized into four general categories that correspond with the stages of the spatial planning processes: the (a) identification; (b) 'co-generation'; (c) reframing; and (d) implementation of wildfire understandings (adapted from [26,27]). It is argued that spatial planning's ability to create wildfire understandings from wildfire information is critical for changing the spatial planning system. However, it is identified that static spatial planning systems are often constrained to give spatial planning meaning to new and dynamic wildfire information. This implies that new wildfire

information does not translate into improvements in the planning system, which in turn implies the spurning of opportunities to promote settlements and make them more resilient to wildfires. Lastly, the conclusions of the study are provided in Section 4.

2. Materials and Methods

This paper was approached as an inductive qualitative study of two case studies [43]: Victoria (Australia) and Chile's spatial planning processes of the (a) identification; (b) 'co-generation'; (c) reframing; and (d) implementation of wildfire understandings adapted from [26,27]).

Victoria, Australia (see Figure 1), is characterized by very low-frequency fire regimes with very high-intensity fires. Fires are part of Victoria's landscape, yet climate change is increasing the frequency of extreme fire weather. Spatial planning in Victoria functions within a state legislative framework that deals with planning across urban and rural areas through a discretionary system separated from building regulations. Nevertheless, in wildfire matters, the planning and building systems overlap and function with some integration due to the Victoria Planning Provisions' integration of the Australian Standard AS3959 [44].

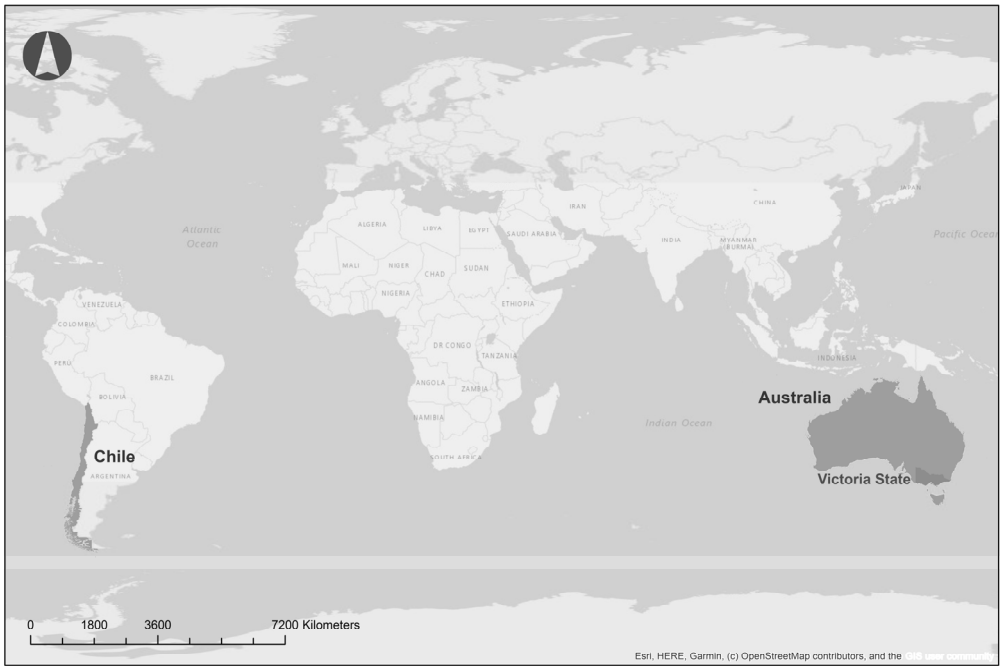

Figure 1. The locations of Chile and Victoria (Australia).

Chile's fire regime is dominated by frequent low-intensity fires with exceptionally intense events concentrated in the southern–central territory, the most populated areas of the country. Spatial planning and building in Chile functions within a national legislative framework that approaches spatial planning, urbanization, and construction in an integrated manner through a prescriptive system that focuses on the physical aspects of planning. The national framing instruments are hierarchically nested, and they set the overall framework for lower tiers of planning which can only act within it.

The case studies were selected based on their commitment to risk reduction, their settlements' high risk of exposure to wildfires, and preliminary evidence of having spatial planning systems' that include wildfire considerations and attempt to improve their wildfire DRM. Lassa, Surjan, Caballero-Anthony, and Fisher [45] believe that Chile and Australia's commitment to risk reduction is similar. In both cases, there are settlements at high risk of exposure to wildfires. Victoria's rural–urban fringe areas are among the most vulnerable to wildfires worldwide [46], and recent wildfires have increased the awareness of the fact

that most populated areas of southern–central Chile are exposed to wildfire risks [47,48]. Furthermore, there is preliminary evidence of general awareness about the need to address wildfires via spatial planning and of the initiatives to change the spatial system to better integrate wildfire considerations [49,50].

Data were collected from spatial planning documents and archival records (Victoria: 148 documents; Chile: 135 documents), as well as from semi-structured interviews (Victoria: 24 interviews; Chile: 18 interviews). Evidence from documents and archival records provided broad coverage of the current and previous spatial planning processes and instruments and emergency management instruments, documents, and records. Appendices A.1 and A.2 list the documents considered. These were complemented with interviews with key spatial planning, emergency management professionals and experts in the field, as well as community representatives who provided insightful and targeted information about the spatial planning system, its current ways, previous changes, and procedural opportunities. The interviews were conducted following a protocol to minimize biases, and participants were anonymized (a code was assigned to them as detailed in Appendices A.3 and A.4). Furthermore, the number of interviews was deemed appropriate, as a saturation point was reached in terms of the data obtained from them [51].

Per case, the data were analyzed using qualitative content analysis techniques that then were cross-case synthesized to generalize the elements that condition and limit spatial planning processes of wildfire knowledge development (see Figure 2). First, qualitative content analysis allowed for the undertaking of a thematic analysis of text based on implicit coding about different concepts of potential interest. The coding process was inductively approached by assigning a set of general codes to the data [43] in terms of the stages of the change processes (identification, 'co-generation', reframing, and implementation). For each of these categories, the data were further coded into several sub-categories that emerged from the data, coding each case independently. The researcher undertook the coding process by categorizing relevant fragments of text using the software 'NVivo12'. Second, cross-case synthesis techniques that compared cross-case patterns were used to produce theoretical generalizations [43,52] of the Chilean and Victorian spatial planning wildfire understandings. The synthesis was approached by comparing patterns previously found within each case study across the two cases. Based on this comparison, previously coded data were re-categorized using 'NVivo12' to reflect cross-case patterns and suggest generalizations. This study elaborates and expands on some of the results of my Ph.D. Thesis [53]. Furthermore, the individual case study results, such as the description of key events, actions or outcomes, are considered to be beyond the scope of this paper as they have already been published for Victoria [54,55] and partially for Chile [49].

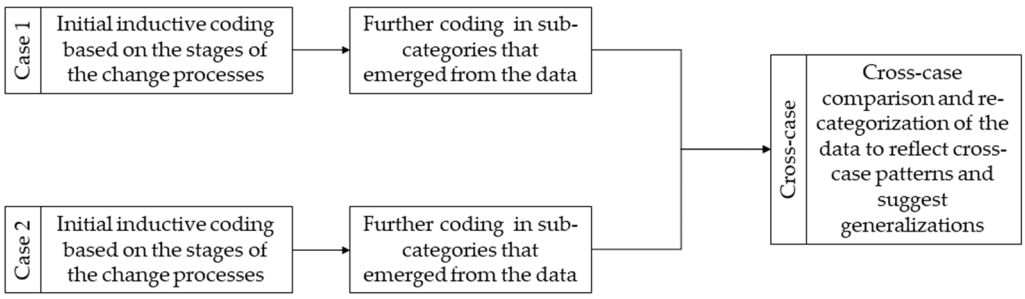

Figure 2. Flow chart of the research stages.

3. Results and Discussion

The elements that condition and limit spatial planning processes for creating wildfire understandings from wildfire information to guide systemic changes in Chile and Victoria were identified (see Table 1). Overall, it was identified that the Chilean and Victorian spatial planning systems are limited in their capacity to develop wildfire knowledge from new and dynamic wildfire information. Furthermore, it is argued that the lack of recognition of the

need to address wildfire DRM via spatial planning and about the ways of 'co-generating' wildfire understandings results in the failure to give spatial planning meaning to wildfire information. The results provide a practical example of key elements that condition and limit spatial planning's ability to integrate wildfire DRM. The results are organized into four sub-sections that correspond with the stages of the process of developing wildfire understandings: identification, 'co-generation', reframing, and implementation.

Table 1. Key findings per case according to each stage of the process.

	Chilean Spatial Planning System	Victorian Spatial Planning System
Identification	Increasing the awareness of wildfire risks and of spatial planning's role, coupled with the limited mainstream knowledge about it. Emerging knowledge about the need to deal with wildfires via spatial planning from CONAF (National Forest Corporation, Chile).	The long history of catastrophic wildfires impacting settlements created awareness about settlement's wildfire exposure and triggered periodic review and change. Gradual knowledge development about the need to deal with wildfires via spatial planning from the Country Fire Authority. Wildfire disasters have been followed by in-depth inquiries that provide recommendations that inform spatial planning change. General structural changes to the spatial planning system have formalized the integration of wildfire into planning.
Co-generation	Independent origins of wildfire and planning systems with limited integration through time which complicate the integration of the views and work practices of both systems. Reluctance to constrain forestry due to its importance to the economy of southern–central Chile. Decision making becomes politicized, detracting from the technical aspects that justify projects.	Independent origins of wildfire and planning systems and difficulty integrating the views and work practices of both systems. Public and political pressures against the wildfire provisions influence planning change based on economics or politics to the detriment of the best wildfire knowledge.
Reframing	Each regulatory plan may identify risk areas and determine conditions for use and development based on criteria of their convenience, generating a fragmented approach to risk assessment. Fairness perceptions of wildfire measures create tensions between small landowners and residents of interface areas, forestry companies, and informal settlements.	Sets risk-based planning as a policy objective, but it lacks a definition of the system's level of risk tolerance, and it also fails to guide human life prioritization. Predisposition to approve dwellings despite having reasons to refuse them on wildfire grounds. Tensions arise with the introduction of wildfire requirements for new development when neighboring properties (previously developed) do not comply with them.
Implementation	Tension between the 'one size fits all' central government approach and the need for context-specific solutions according to each territory. Disconnection in the planning and management of urban and rural areas. Lack of guidance or coordination implementation within a rigid system based exclusively on codified laws and regulations. Overly complicated and rigid process of spatial of risk identification.	Prioritization of human life (policy objective) above all other policy considerations restricts development due to wildfire risk, yet its lack of detail implies its ambiguous implementation. The bushfire mapping process is undertaken to identify hazards using static and non-contemporary techniques, and its revision process (an unsystematic revision process) is based on local requests.

3.1. Identification—Technical Information That Recognizes the Importance of Addressing Wildfire DRM via Spatial Planning Precedes the Desire to Improve the Planning System

This sub-section discusses the importance of developing understandings that recognize the need to address wildfire DRM via spatial planning to initiate systemic change. The case

study findings show that it is not disasters but an increased understanding of the need to address wildfires via spatial planning that triggers the process of spatial planning change. Generalizing from these findings, this sub-section argues that wildfire disasters per se do not translate into imagining improved spatial planning systems. Instead, it postulates that *a growing body of technical information that recognizes the importance of addressing wildfire DRM via spatial planning is a prerequisite for the desire to change the spatial planning systems to arise*.

Spatial planning change is envisioned based on what is previously known, and in that sense, change is always preceded by wildfire experience. Both case studies show that wildfire events that affected settlements were critical in increasing awareness about the need to address wildfires via spatial planning. Even more so, the results suggest that these events triggered wildfire DRM research that eventually informed spatial planning change. For instance, in Victoria, processes of inquiry after wildfire events to understand the causes of major wildfire events and to identify the changes needed for wildfire prevention and protection (for instance, [56–61] have been relevant in triggering change. Most noticeably, the recommendations of Victorian Royal Commission [59] following the 2009 fires have led to significant changes in the Victorian spatial planning system and its ways to deal with wildfires. As one interviewee stated, "we've got a substantially better system following the [Victorian Royal Commission] recommendations" (CFAREP2). Yet, the case studies' findings also suggest that wildfire disasters alone do not translate into imagining improved spatial planning systems. For example, the results show that, historically, in Chile, there has been an emphasis on post-disaster reconstruction and aid campaigns with a strong focus on housing provision, with attempts to improve the spatial planning system to integrate wildfire considerations only taking place recently. This aligns with studies in the literature that support the notion that wildfire events do not necessarily trigger systemic improvements for long-term risk reduction and mitigation [62,63].

The desire to change the spatial planning system *depends on technical information that emphasizes spatial planning's potential role in wildfire DRM.* The case study results envisioning spatial planning improvements were preceded by a growing body of knowledge that addressed wildfire DRM concerning the design and construction of structures and cities. These results are aligned and provide an applied example for studies in the literature on resilience (e.g., [39,64,65]), which support the notion that systems' accumulated experiences increase their innovation potential and can modify their interaction strategies to adapt to changing conditions. These findings support these theories and provide new applied insights for spatial planning systems dealing with wildfires, highlighting that spatial planning change depends on pre-existing technical knowledge about the need to deal with wildfires through the design and regulation of buildings and settlements. As stated by one planner interviewed, the Victorian Bushfire Royal Commission [59] recommendations and changes to the planning system were "nothing new [. . .] a statement of the obvious" (DELWPREP1).

Explicit wildfire information that inspires spatial planning change associated with wildfires *is generally held and constructed outside the spatial planning system*. The research findings demonstrate that in both case studies, the body of knowledge that addressed wildfire DRM associated with spatial planning that preceded the desire to change the spatial planning system was developed by wildfire agencies. For instance, in Victoria, one of the first guidelines for wildfire DRM in a spatial planning context was developed for the Loddon Campaspe region of Victoria [66], which was then updated for the State of Victoria [67]. Similarly, in Chile, the first technical documents that addressed these issues were developed by the National Forestry Corporation (CONAF). These referred to the interactions of forests and settlements [68] vegetation management around buildings and structure retrofitting [69], minimum separation between structures and the forest, and critical construction characteristics [70]—concepts that were then included in many land use plans for the Biobío region developed and amended between 2003 and 2009.

3.2. 'Co-Generation'—Spatial Planning Systems Have Difficulties Considering Diverse Stakeholders' Inputs to 'Co-Generate' Wildfire Understandings

This sub-section discusses spatial planning processes for creating wildfire understandings from wildfire information, focusing on the sources of information and stakeholders involved in the process. The case studies evidence that the spatial planning processes for creating wildfire understandings do not create arenas to engage, test, and recognize the different wildfire claims. Social understandings and technical information are interwoven and interdependent in the process, yet opportunities for community engagement are very limited, and decisions usually depend on the judgments of politicians. Generalizing from the case studies' findings, this sub-section suggests that *spatial planning systems often fail to reconcile the views of experts, politicians, and communities, which constrains their ability to 'co-generate' wildfire understandings.*

The 'co-generation' of wildfire spatial planning understandings implies *reconciling the experts' inputs with the insights and perceptions of politicians and communities*. Beck [30] emphasizes the need and complementarity of scientific rationality and social rationality to develop risk knowledge. However, the case studies show that spatial planning systems have difficulties reconciling diverse wildfire perspectives and that sectoral approaches and divergent understandings remain. For instance, some comments from Chilean wildfire agents suggest a misunderstanding and naivety on their part towards spatial planning's capacity to restrict development. This is aligned with Gallopín's [39] argument that supports that compartmentalized reality perceptions and reductionist scientific traditions impair the development of socio-ecological resilience. Ultimately, these sectoral approaches imply that the work between agencies is not only uncoordinated but misunderstood.

In general terms, *technical and social understandings are interwoven and interdependent in the process of developing spatial planning understandings about wildfires*. The spatial planning processes for developing wildfire understandings need to balance technical information with political sensitivities and the perceptions of communities to avoid compromising the quality of the outputs or including provisions that will be too hotly contested. However, it stands out from the case studies that spatial planning systems are often constrained to do so. The spatial planning processes are limited in their capacity to handle multiple pieces of wildfire information. Evidence from this study shows that these processes do not create arenas to engage, test, and recognize different knowledge claims. Communities' voices are not systematically included in the processes, leading to the establishment of contested wildfire provisions. Furthermore, valid wildfire information can be dismissed through political decisions, which can result in sub-optimal wildfire provisions.

The co-generation of wildfire understandings requires spatial planning systems to *collaborate with wildfire professionals and often outsource wildfire data*. In some instances, spatial planning systems might generate their data, but commonly, the information used in the planning process is developed by other organizations. The case studies show that technical wildfire data that inform the process are often developed by or in collaboration with other agencies. However, the case studies also show that the 'best' alternatives to treat wildfire risk from a technical point of view can be politically sensitive or perceived as unacceptable by the community.

The case study results indicate that *overarching wildfire definitions often respond to political views instead of to their technical appropriateness*. A Victorian fire scientist stated, "policy-makers make all the key decisions about stringency levels and what factors you do and don't include [. . . and] we generate the maps under their policy decisions". For example, in Victoria, the 2014 changes to the BMO introduced by the Liberal party—simplifying and relaxing the requirements, especially for individual dwellings—were aligned with their more pro-development approach. Conversely, the 2017 changes emphasizing the prioritization of human life above any other considerations introduced to the BMO by the Labour Party correspond with a more collective and government-interventionist approach. As one interviewee stated, "do governments need to protect us from ourselves? [. . .] that's a political question, not a technical question" (CONSULTANT1). This implies that politics

and ideological viewpoints have a significant impact on the outputs of the process. This is consistent with Flyvbjerg's argument that power defines reality by establishing what counts as knowledge [71]. Furthermore, this contradicts Rydin's argument that the relevance of a knowledge claim depends on its ability to be validated or refuted when tested [29].

Communities can inform the process almost exclusively through their representatives. It stands out from the case study findings that there is a lack of community consultation and engagement in the spatial planning processes associated with mapping wildfire areas and establishing wildfire controls. Indirectly, their views might be represented by politicians in office concerned with voters' perceptions. However, the elected majority might not represent minority groups, and often powerful stakeholders are in a privileged position to influence politicians.

3.3. Reframing—Wildfire Information Must Be Reframed to Make Situated Sense in Terms of Risk Tolerance and Perceived Fairness to Give It Spatial Planning Meaning

This sub-section discusses the process of reframing new information about wildfire DRM to give them spatial planning meaning. The case study findings show what it entails to reframe wildfire information to give it spatial planning meaning in Chile and Victoria. Generalizing from the case study findings, this sub-section suggests that *wildfire information must be reframed to make situated sense in terms of risk tolerance and perceived fairness to give it spatial planning meaning*. It argues that this implies making a value judgment about a level of 'desired robustness' within the spectrum of risk aversion and risk taking, as well as balancing individual property rights versus the common good.

The process of giving spatial planning meaning to wildfire information implies *accessing, interpreting, and re-assembling the information according to the system's levels of risk tolerance*. Improved spatial planning mechanisms can avoid or reduce settlements' wildfire risk; however, wildfire risks cannot be completely removed or anticipated. Therefore, this paper argues that developing an understanding of the level of risk tolerance is essential for giving planning meaning to wildfire data. Based on this level of risk tolerance, spatial planning systems reframe the wildfire risk information and treatment options when defining the appropriate planning mechanisms for the context and expectations.

Developing spatial planning understandings about the level of risk tolerance implies *making a value judgment about a level of 'desired robustness' within the spectrum of risk-averse and risk-taking*. Establishing a 'desired robustness' within the risk-tolerance spectrum requires considering that systems inclined to take risks can become fragile and that the risk-averse ones can become rigid. The case study results show the challenges of finding the appropriate balance within the risk tolerance spectrum. For example, in Victoria, the 2011 reform to the wildfire planning controls established a system that was more risk-averse than its predecessors were. Some stakeholders perceived that these changes complicated development, increasing the system's rigidity. After the BMO's public and political backlash, the government adjusted the BMO controls [72] to facilitate the development of single dwellings, establishing a system that allows for more risk taking, increasing the potential fragility of new development.

During the process of defining the level of risk tolerance, *spatial planning systems can be tempted to establish risk-averse regulations that are unenforceable*. Beck [30] argues that, in some countries, strict safety regulations are established knowing they will be unenforceable to shift responsibility to the people's cultural blindness to hazards. Evidence from the case studies shows that spatial planning regulations for dealing with wildfires are no exception to this. For example, the Chilean legislative framework requires a permit application to be accompanied by a 'well-founded study' approved by the 'competent agency', establishing—in paper—the pathway to developing areas exposed to hazards and decision-making integration with other relevant agencies. However, the lack of definitions about the content of the study or which agency is the competent one depending on the case implies that these regulations are unenforceable.

The process of developing wildfire understandings also implies *giving spatial planning meaning to wildfire information in terms of 'fairness'*. Procedural and distributive justice considerations are fundamental for DRM via spatial planning [41,42]. In alignment with the literature, this paper argues that spatial planning systems make sense of wildfire information according to wider perceptions of procedural and distributive fairness. Based on understandings about what would be 'fair', especially in distributive terms, spatial planning systems reframe wildfire information and treatment options when defining the spatial planning mechanisms that are appropriate for the context and expectations.

Developing spatial planning understandings about what would be 'fair' implies *balancing individual property rights versus the common good*. The common good can be related to the end-point of resilience [73], DRM [2], and spatial planning [74]. Spatial planning systems embody fundamental assumptions and reassertions of individual rights and trade-offs against the common good [75]. Thus, establishing limits to private property rights when the common good is at stake is inherent to spatial planning. However, as the two case studies show, limiting land development potential due to wildfires can be difficult and contested. For instance, in Victoria, Melbourne's significant population growth and urban development pressure is associated with a push for maintaining the model of disperse growth, which often leads to newcomers to areas exposed to wildfires that are not fully aware of their exposure or well prepared for an emergency (COMMUREP2, COMMUREP3, EMVREP, and YARRAREP). In Chile, a suburbanization phenomenon, often in affluent condominiums, is increasingly prevalent as rural land can be sub-divided in lots of a minimum of 5000 m^2, allowing for low-density development in peri-urban contexts. Additionally, the development of social housing in rural areas is permitted by the Chilean law, using public funding through subsidies' schemes to allow low-income families to settle in areas that are likely to be exposed to wildfires. This is consistent with the work of the authors of [41,76], who argue that, in wildfire contexts, the spatial planning emphases on individual property rights often erode the common good. This highlights that reframing wildfire information is inherently associated with finding a balance between the state's population protection versus individual freedoms and rights.

'Fairness' tensions are exacerbated in wildfire contexts because the way a site is used and developed impacts the wildfire risk profile of their neighbors, and vice versa. Hamilton et al. [40] conceptualize 'risk interdependence archetypes' as the spatial configurations by which one actor is exposed to wildfire risk via the actions of another actor. The interdependences of wildfire risk have implications for the perceived fairness of spatial planning controls. In general, the establishment of risks to the community resulting from individuals' actions should be taken into consideration and avoided. Further complexities and tensions can arise with the introduction of wildfire requirements for new developments when neighboring properties (previously developed ones) do not comply with them. As one community representative stated, "no point stopping me from building a house that's built to [the highest] standard when all around us are timber shacks". Even more so, tensions can also arise when spatial planning attempts to limit individual property rights due to wildfire risks resulting from neighboring activities. For instance, in Chile, small landowners and residents of WUI areas are often exposed to fires associated with forestry plantations. As one interviewee alluded to, how do you tell people they must provide considerable defendable space because a forestry plantation was established next to them? It could also be assumed that, in these cases, the 'forest' should provide an adequate distance to settlements, but what if the workers settled—informally—next to the forestry plantations where they work? There are no simple or universal answers to these questions, yet they underlie the process of reframing wildfire information to give it spatial planning meaning.

3.4. Implementation—Static Spatial Planning Operationalization Limits the Consideration of the Dynamic Temporal and Spatial Dimensions of Wildfire DRM

This sub-section discusses the processes of the ongoing development of understandings associated with the implementation of wildfire spatial planning instruments. The

case study findings show that the implementation of new wildfire instruments is usually based on static understandings, which limits the consideration of the dynamic temporal and spatial dimensions of wildfires. Generalizing from the case study findings, this sub-section postulates that *static approaches to spatial planning implementation limit the consideration of new dynamic temporal and spatial understandings of wildfire DRM during the ongoing implementation stages*.

Static approaches to wildfire mapping limit spatial planning's ability to develop ongoing understandings of the dynamic characteristics of the hazard and risk. Landscape coverage, fuel availability, and weather conditions that vary through time influence fire behavior. Furthermore, new fire-prone structures themselves can increase fuel availability and promote house-to-house fire spreading [77,78]. Ideally, wildfire mapping should consider the changes in these elements. However, the results show that the Chilean and Victorian spatial planning systems tend to be static and prone to prioritize pragmatic approaches to wildfire mapping above more complex mapping techniques. In Chile, risk maps are incorporated into land use plans through the regular processes for elaborating or modifying these plans. The law indicates that land use plans should be updated at least every ten years [79]. However, interviewees emphasize that, in practice, just the process of modifying a plan takes between two to ten years, which implies that the ongoing re-assessment of wildfire risk areas is impossible, meaning that risk maps become extremely static. Likewise, in Victoria, the BMO mapping process identifies wildfire hazard using static and old techniques without appropriately considering the landscape context and fire's interaction with urban areas (CFAREP2, CSIROREP1, and DELWPREP6, as well as "1990s type technology" (DEWLPRREP6)). It does not consider the spatial and temporal dynamics of fire, such as vegetation changes or climate change, and how these might impact on risk. Even more so, the BMO mapping process could lead to "perverse planning outcomes" (DELWPREP6) because it assumes the fire hazard in urban areas is low (DELWPREP2 and DELWPREP4), which "can lead to quite substantial underestimation of the hazard risk in urban areas" (DELWPREP6). A more contemporary approach would entail spatializing the risk rather than the hazard. Following a risk-based approach using contemporary modeling techniques that model fire behavior—especially in interface areas—would be more appropriate (CFAREP2, CSIROREP1, and DELWPREP6). This would require considering the dynamic aspects of fire, such as the landscape context and its impact on risk (CFAREP2 and DELWPREP6), and fire behavior when interacting with urbanized areas (DELWPREP6).

Some *centralized spatial planning systems have difficulties dealing with the context-specific characteristics of wildfire risk*. Wildfire risk depends on the hazard's dynamic characteristics particular to each site, its immediate surroundings, and the wider landscape. Standardized approaches can provide consistency and reliability to wildfire DRM, but these should be balanced with context particularities. The case studies suggest that some centralized systems have more difficulties dealing with context-specific characteristics of wildfires than others. In Chile, spatial planning is defined by predetermined standards framed at the national level and operationalized in a decentralized way, with limited room for context-specific innovation or discretion. Following the civil law system, spatial planning in Chile is based on codified laws and regulations, and only those are binding. This implies that land use plans can only specify elements identified by the national frameworks, and the decision to grant a permit depends only on the application's compliance with the laws and regulations. Conversely, the Victorian spatial planning system does allow for context-specific considerations. Permit applications in areas identified as highly exposed to wildfires are required to provide a hazard site assessment, a landscape assessment, and a wildfire management statement developed for that site. Following the common law system, the permit application process in Victoria is characterized by its rule-making discretion, encouraging decision making based on context-specific appropriateness regarding wildfires. Overall, the differences between the cases highlight that some standardized approaches for dealing with wildfires can consider context-specific issues better than others.

Spatial planning implementation processes are constrained to develop an ongoing understanding of the dynamic wildfire landscape. Wildfires occur across landscapes, and fire behavior is affected by the topography (static) and coverage (dynamic) of a certain territory. It is precisely by considering the landscape scale that spatial planning instruments can make an important contribution to risk reduction. They can contribute to directing development to areas where risks are considered acceptable and to restricting development in areas where risks are considered beyond acceptable. However, the case study findings suggest that spatial planning systems are limited in their capacity to develop ongoing understandings of dynamic wider landscape considerations. For example, in Chile, there are regulatory asymmetries between urban and rural areas that fundamentally challenge spatial planning's capacity to plan and manage fringe areas. In Victoria, adjustments to the planning system's strategic level were introduced in 2017 to improve the consideration of the landscape scale, strengthen the system's capacity to direct new developments to low-risk areas, and reinforce the legal grounds to refuse a planning permit when the wildfire landscape context is considered too risky. Nevertheless, the consideration of wildfire landscapes in Victoria is in its nascent stage, and the integration of the different spatial scales of wildfires and their management is still limited.

4. Conclusions

In summary, the findings of this study highlight that developing spatial planning understandings based on wildfire information is critical for changing and improving spatial planning systems so that they can contribute to wildfire DRM. However, this study identified that the Chilean and Victorian spatial planning systems are constrained during processes for creating wildfire understandings derived from new and dynamic wildfire information. Ultimately, this implies that new wildfire evidence and experience often do not translate into improvements to the planning system, which in turn indicates that the opportunity to promote more resilient settlements is missed.

This paper explored spatial planning processes for engendering wildfire understanding from wildfire information, suggesting generalizations about key elements that condition and limit spatial planning in Chile and Victoria. It identified that the understandings within the system and in the wider context determine the spatial planning processes of systemic change, distinguishing that these determinants vary depending on the stage of the process.

It was observed that, initially, (1) *the desire to change the spatial planning system is always preceded by a growing body of technical information that recognizes the importance of integrating wildfire DRM into spatial planning*. As shown by the case study findings, an increased understanding of the need to address wildfires via spatial planning is an essential precursor of the process of spatial planning change.

During the process of developing systemic changes to better integrate wildfire information, it was generalized from the results that (2) *spatial planning systems are constrained to 'co-generate' wildfire understandings, as they often fail to reconcile the information developed by wildfire experts with the perspectives and perceptions of politicians and communities.* The case studies evidence that spatial planning processes for developing wildfire understandings do not create opportunities to engage, test, and recognize different wildfire claims. Social understandings and technical information are interwoven and interdependent in the process, yet opportunities for community engagement are very limited, and decisions usually depend on the judgments of politicians.

Furthermore, (3) developing spatial planning meaning based on new wildfire information requires reframing it to make situated sense in terms of risk tolerance and perceived fairness. The case studies evidence that this implies making a value judgment about the level of 'desired robustness' within the spectrum of risk aversion and risk taking and balancing individual property rights versus the common good.

Lastly, it was observed that (4) *static approaches to spatial planning implementation limit the consideration of new dynamic temporal and spatial understanding of wildfire DRM*. The case study findings show that considering the temporal and spatial dynamics of wildfires, such

as vegetation changes or climate change, can present considerable challenges for spatial planning systems because the implementation of new wildfire instruments and practices is usually based on static understandings and plans. This is particularly evident in the way wildfire mapping is included in spatial planning. Ultimately, these static approaches to planning can imply a substantial underestimation of the hazard risk, especially in WUI areas.

The theoretical generalizations suggested provide a practical example of some of the elements that condition and limit spatial planning's ability to integrate wildfire DRM. These generalizations contribute to the awareness of spatial planning processes of identifying, 'co-generating', reframing, and implementing new wildfire information. Furthermore, distinguishing these elements emphasizes that not only is the development of information required to deal with wildfires but also the overcoming of barriers to putting information into action by applying it in effective and contextualized ways. These propositions contribute to spatial planning, DRM, and resilience theories by providing more complete and nuanced insights about the barriers and facilitators for changing spatial planning systems to promote the resilience of settlements, which ultimately contributes to the sustainable development of settlements. Furthermore, by acknowledging and using this logic, planners can be more effective in promoting systemic change. Even more so, this research highlights the importance of increasing the awareness about the need to integrate wildfire considerations into the spatial planning system, both from the technical perspective to trigger spatial planning change and from the perspective of wider information campaigns (both international and local) to promote the acceptance and maintenance of these measures over time in communities exposed to wildfires.

It is acknowledged that this work has several limitations. The research focus was limited to spatial planning instruments and processes for dealing with the physical aspects of wildfire DRM, yet many other issues beyond the scope of this study can influence settlements' resilience to wildfires. The research generalizations derived from the case studies are limited to conceptual generalizations, and they do not necessarily represent all the spatial planning systems seeking to promote settlements' resilience to wildfires internationally (nor across Australia). The data used also have limitations. Some documents might have been unintentionally missed, the documents themselves could have author bias, and the data from the interviews are limited to the interviewees' perspectives and could have been biased by the institutional roles played by the interview subjects [51] as well as by possible involuntary biases due to the construction of questions [43].

Future studies could examine the theoretical generalizations suggested in this paper in other international contexts, or expand them to spatial planning systems seeking to promote resilience to other specific or multiple hazards. Furthermore, other means of technical analysis could be used to explore the challenges in integrating wildfire information to the spatial planning processes from different perspectives. Even more so, specific issues identified in this study, such as the challenges of addressing dynamic issues by traditionally static spatial planning systems, could be expanded on and further developed.

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Institutional Review Board Statement: The interviews were approached following a protocol approved by the Human Research Ethics Committee of the University of Melbourne (Ethics ID number: 1748705.1).

Informed Consent Statement: Informed consent was obtained from all interviewees involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The author declares no conflicts of interest.

Appendix A

Appendix A.1. List of Documents and Archival Records Considered for the Chilean Case Study

Category	Year	Document
Bushfire—Report	1838	Sobre las Causas de la Disminución de los Montes de la Provincia de Coquimbo (Gay, 1838)
Bushfire—Law	1873	Decree (n/no.)—Reglamento General sobre la Corta de Bosques (1873)
Bushfire—Law	1874	Codigo Penal (1874 as amended)
Local planning	1874	Law (n/no.)—Apertura i prolongacion de calles i paseos públicos en la ciudad de Santiago (1874)
Local planning	1876	Law (n/no.)—Transformacion de la ciudad de Valparaíso (1876)
Reconstruction—Law	1906	Law 1887—Que dicta medidas para reparar los daños causados a la ciudad de Valparaiso por el terremoto de agosto de 1906 (1906)
Bushfire—Law	1907	Creation of the Reserva Forestal de Malleco
Local planning	1909	Law 2203—Que fija las disposiciones a que debera sujetarse la construccion de edificios, apertura, ensanche, union, prolongacion o rectificacion de calles de la ciudad de Santiago (1909)
Local planning	1912	Law 2658—Law for the transformation of the city of Concepcion (1912)
Planning—Law	1929	Law 4563 (1929)
Bushfire—Law	1931	Decree 4363-Aprueba texto definitivo de la ley de bosques (1931)
Planning—Law	1931	Decree with Law force 345—Ley y Ordenanza General sobre Construcciones y Urbanización (1931).
Planning—Law	1936	Decree 4882—Ley y Ordenanza General sobre Construcciones y Urbanización (1936)
Planning—Law	1936	Law 5950—Crea La Caja De La Habitacion Popular (1936)
Reconstruction—Law	1939	Law 6334—Crea las corporaciones de reconstruccion y auxilio y de fomento a la produccion (1939)
Planning—Law	1943	Law 7600—Substituye el texto de la Ley n° 5,950, que creo la Caja De La Habitacion Popular por el que se indica (1941).
Planning—Law	1949	Decree 884—Reemplaza Ordenanza General De Construcciones (1949)
Planning—Law	1953	Decree with Law force 285—Sobre organizacion y atribuciones de la Corporacion de la Vivienda (1953)
Planning—Law	1953	Decreto con Fuerza de Ley 224—Fija el texto de la Ley General De Construcciones y Urbanizacion (1953)
Reconstruction—Law	1960	Decree 874—Fija Las Atribuciones Del Ministerio De Economia, Fomento Y Reconstruccion (1960)
Reconstruction—Law	1960	Law 14171—Cambia nombre al Ministerio de Economia, modifica la leyes que indica, establece y aumenta los impuestos que señala, concede al Presidente de la Republica las facultades que menciona y dispone coordinar la inversion de los recursos fiscales como tambien los recursos de las instituciones semifiscales de administracion autonoma y empresas del Estado orientandolos hacia los fines de reconstruccion y fomento de la produccion (1960)
Planning—Law	1963	Decree 880—Fija el texto definitivo del Decreto con Fuerza de Ley n° 224, de 1953, Ley General de Construcciones y Urbanizacion y de la Ley 6.071 (1963)
Reconstruction—Law	1965	Law 16282—Fija disposiciones para casos de sismos o catastrofes, establece normas para la reconstruccion de la zona afectada por el sismo de 28 de marzo de 1965 y modifica la ley n° 16.250 (1965)
Bushfire—Policy	1966	Plan de Reforestacion Nacional (1966)
Bushfire—Policy	1967	Plan Nacional de proteccion contra incendios forestales (1967)

Category	Year	Document
Bushfire—Law	1970	Decree 728—Concede personalidad juridica y aprueba los estatutos a la corporacion denominada Corporacion de Reforestacion, con domicilio en Santiago (1970)
Bushfire—Report	1970	Publication of the second edition of the book La sobrevivencia de Chile: la conservación de sus recursos naturales renovables (Elizalde, 1970)
Planning—Policy	1971	Politica Habitacional (1971)
Bushfire—Law	1972	Decree 5—Aprueba reglamento para la explotacion de pino insigne en la Provincia de Maule (1972).
Bushfire—Law	1973	Decree 455—Aprueba las reformas que ha acordado introducir en sus estatutos la Corporacion de Reforestacion (1973)
Local planning	1973	Plan Regulador Comunal de Rancagua (1973)
Bushfire—Law	1974	Decree Law 701—Fija regimen legal de los terrenos forestales o preferentemente aptos para la forestacion, y establece normas de fomento sobre la materia (1974)
Local planning	1974	Plan Regulador Comunal de Calbuco (1974)
Bushfire—Law	1976	Decree 1027—Reglamenta ejercicio de funciones sobre prevencion y combate de incendios forestales (1976)
Planning—Law	1976	Decree with Law force 458—Ley General de Urbanismo y Construcciones (1976 as amended)
Reconstruction—Law	1977	Decree 104—Fija el texto refundido, coordinado y sistematizado del titulo i de la ley 16.282 (1977)
Planning—Commission	1977	Decree 718—Crea Comision Mixta De Agricultura Y Urbanismo (1977)
Planning—Law	1977	Ordenanza general de construcciones y urbanización actualizada y concordada (1977)
Local planning	1979	Decree 420—Modifica Plan Intercomunal de Santiago y su Ordenanza (1979).
Bushfire—Law	1979	Decree Law 2565—Sustituye decreto ley 701, de 1974, que somete los terrenos forestales a las disposiciones que señala (1979)
Planning—Policy	1979	Politica Nacional de Desarrollo Urbano (1979)
Bushfire—Law	1980	Decree 259—Reglamento del Decreto Ley n° 701, de 1974, sobre fomento forestal (1980).
Bushfire—Law	1980	Decree 276—Reglamento sobre roce a fuego (1980)
Bushfire—Law	1982	Decree 733—Ministerio del Interior; Subsecretaria del Interior: Deroga Decretos Supremos N°S. 1.027, de 1976, y 1.040, de 1979, y aprueba normas que indica (1982)
Bushfire—Law	1984	Law 18348—Crea la Corporación Nacional Forestal y de Protección de Recursos Naturales Renovables (1984)
Bushfire—Law	1984	Law 18362—Crea un Sistema Nacional de Areas Silvestres Protegidas del Estado (1984)
Planning—Policy	1985	Decree 31—Politica Nacional de Desarrollo Urbano (1985)
Planning—Policy	1987	Decree 158—Precisiones a algunos aspectos contenidos en la Política Nacional de Desarrollo Urbano (1987).
Bushfire—Report	1990	Sistemas de prevención incendios forestales (Haltenhoff, 1990)
Planning—Law	1992	Decree 47—Fija Nuevo Texto De La Ordenanza General De La Ley General De Urbanismo Y Construcciones (1992)
Planning—Law	1996	DDU 9—Plan Regional de Desarrollo Urbano (1996)
Bushfire—Law	1998	Decre 192—Aprueba reglamento para el pago de las bonificaciones forestales (1998).
Bushfire—Law	1998	Decre 193—Aprueba Reglamento General del Decreto Ley nº 701, de 1974, sobre fomento forestal (1998). It indicated that areas with risk of landslide should be considered as areas fitted for forestry.
Bushfire—Law	1998	Decree with Force of Law 850—Fija el texto refundido, coordinado y sistematizado de la Ley nº 15.840, de 1964 y del DFL. Nº 206, de 1960 (1998)

Category	Year	Document
Guidelines	1998	Publication of the technical guidelines 'Silvicultura Preventiva' (Haltenhoff, 1998)
Bushfire—Law	1998	Law 19561—Modifica el Decreto Ley nº701, de 1974, sobre fomento forestal (1998)
Bushfire—Law	1998	Decree 1341—Aprueba reglamento que establece normas contables aplicables a los contribuyentes que realizan actividades forestales de conformidad al decreto ley nº701, de 1974, sobre fomento forestal (1998).
Planning—Decree	2000	Decree 259 (2000)
Planning—Commission	2001	Decree 187—Crea Consejo Nacional Para La Reforma Urbana (2001).
Planning—Law	2001	Decree 75—Modifica decreto nº 47, de 1992, Ordenanza General de Urbanismo y Construcciones (2001)
Planning—Commission	2001	Collaboration between MINVU Biobio and CONAF Biobio (2001–2006)
Planning—Report	2001	Report from the Grupo de Trabajo para la Reforma Urbana 'Plan de reforma urbana' (2001).
Bushfire—Law	2002	Decree 156—Aprueba Plan Nacional de Proteccion Civil, y deroga Decreto nº 155, de 1977, que aprobo el Plan Nacional de Emergencia (2002)
Local planning	2003	Planning instruments including regulations for bushfire risk in the Biobio Region (2003–2008)
Local planning	2003	Concepcion Metropolitano PRM (2003)
Local planning	2003	Chiguayante PRC (2003)
Guidelines	2006	Manual con Medidas para la Prevención de Incendios Forestales, IX Región (CONAF, 2006)
Guidelines	2006	Manual con Medidas para la Prevención de Incendios Forestales, VII Región (CONAF, 2006)
Guidelines	2006	Manual con Medidas para la Prevención de Incendios Forestales, VIII Región (CONAF, 2006)
Guidelines	2006	Manual Medidas Prediales de Protección de Incendios Forestales (CONAF, 2006)
Guidelines	2006	Silvicultura Preventiva. Silvicultura para la prevención de incendios forestales en plantaciones forestales (CONAF 2006)
Local planning	2006	Ranquil PRC (2006)
Bushfire—Law	2007	Deree with Force of Law 4—Fija texto refundido, coordinado y sistematizado del Decreto con Fuerza de Ley nº 1, de mineria, de 1982, Ley General de Servicios Electricos, en materia de energia electrica (2007)
Planning—Report	2007	Información para la gestión de riesgo de desastres estudio de caso de cinco países: Chile (CEPAL, 2007)
Local planning	2007	Chillan-Chillan Viejo PRI (2007)
Local planning	2007	Florida PRC (2007)
Local planning	2007	Los Angeles PRC (2007)
Local planning	2007	Portezuelo PRC (2007)
Local planning	2007	Quillon PRC (2007)
Local planning	2007	Quirihue PRC (2007)
Planning—Law	2008	Contraloría's Judgement about Temuco-Labranza's PRC-IX Region (2008)
Bushfire—Law	2008	Law 20283-Ley sobre recuperación del bosque nativo y fomento forestal (2008)
Local planning	2008	Laja PRC (2008)
Local planning	2008	Los Alamos PRC (2008)
Local planning	2008	Nacimiento PRC (2008)
Local planning	2008	Ninhue PRC (2008)

Category	Year	Document
Local planning	2008	Santa Barbara PRC (2008)
Planning—Law	2009	Contraloría's Judgement about Loncoche's PRC-IX Region (2009)
Planning—Law	2009	DDU 227-Planificación urbana, formulación y contenidos Plan Regulador Comunal (2009)
Planning—Law	2009	Decree 10—Modifica Decreto nº 47, de 1992, Ordenanza General de Urbanismo y Construcciones en el sentido de adecuar diversas disposiciones sobre planificación y normas técnicas (2009)
Planning Commission	2009	Decree 195—Crea comisión asesora de estudios habitacionales y urbanos (2009).
Bushfire—Law	2009	Decree 93—Reglamento general de la ley sobre recuperacion del bosque nativo y fomento forestal (2009).
Bushfire—Law	2009	Decree 95—Reglamento del fondo de conservacion, recuperacion y manejo sustentable del bosque nativo (2009).
Local planning	2009	Cabrero PRC (2009)
Local planning	2009	Canete PRC (2009)
Local planning	2009	El Carmen PRC (2009)
Local planning	2009	Lebu PRC (2009)
Local planning	2009	Niquen PRC (2009)
Local planning	2009	Yumbel PRC (2009)
Planning—Law	2010	Contraloría's Judgement about Pemuco's PRC-VIII Region (2010)
Planning—Report	2010	Agreement between MINVU and Programa de las Naciones Unidas para el Desarrollo (PNDU) (2010)
Bushfire—Report	2010	Los Grandes Incendios Forestales en Chile 1985–2009 (Haltenhoff, 2010)
Planning—Report	2010	Plan de Reconstrucción MINVU Chile Unido Reconstruye Mejor (2010)
Mapping	2010	29 communes identified as critical in terms of the occurrence of bushfires (2010)
Local planning	2010	Coelemu PRC (2010)
Local planning	2010	San Carlos PRC (2010)
Planning—Law	2011	Decree 9—Modifica Decreto nº 47, de 1992, Ordenanza General de Urbanismo y Construcciones en materia de densidades y riesgo (2011)
Guidelines	2011	Prevention guidelines developped by CONAF for Coquimbo, Valparaiso and Metropolitan regions (2011), and O'Higgins and Los Lagos (2012)
Planning—Law	2012	Law 20582—Modifica Normas Legales De Urbanismo Y Construcciones Para Favorecer La Reconstrucción (2012)
Bushfire—Report	2013	Guia para trabajar con habitantes de areas rurales y de la interfase forestal/urbana (Haltenhoff, 2013)
Planning—Report	2013	Urban Policy Reviews, CHILE (OECD, 2013)
Planning-Disaster Risk	2014	DDU 269-Definicion de areas de riesgo por amenazade incendio en los Instrumentos de Planificacion Territorial (2014)
Planning—Policy	2014	Política Nacional De Desarrollo Urbano (2014)
Planning—Commission	2014	Decree 78—Crea Consejo Nacional De Desarrollo Urbano (2014).
Bushfire Reconstruction—Law	2014	Decree 947—Señala zona afectada por catástrofe derivada de incendio y dispone medidas que indica (2014)
Planning—Commission	2014	Manual práctico de jurisprudencia administrativa sobre Planes Reguladores Comunales, Intercomunales y Metropolitanos, y Regionales de Desarrollo Urbano (Contraloria, 2014)
Planning—Report	2014	Rural Policy Reviews: Chile (OECD, 2014)
Bushfire—Report	2014	Prevencion incendios forestales. Lineamientos y enfasis estrategicos 2014–2019 (Haltenhoff Duarte, 2014)

Category	Year	Document
Mapping	2014	42 communes identified with great bushfire occurrance, 28 of these identified as critical in terms of the occurrence of bushfires (2014)
Bushfire—Report	2015	¿Cómo preparo mi casa y entorno frente a los incendios forestales? Manual de prevención de incendios forestales (CONAF, 2015)
Planning—Commission	2015	Decree 34—Comisión Interministerial de Ciudad, Vivienda y Territorio (2015)
Planning—Report	2016	Chile, Informe Nacional Habitat III (Gobierno de Chile, 2016)
Local planning	2016	Plan de Desarrollo Comunal (PLADECO) of Hualqui (2016)
Bushfire—Policy	2016	Plans for protection against communal bushfires developed by CONAF (2016)
Bushfire—Law	2017	Chamber of Deputies approved the bill that creates the Servicio Nacional Forestal (SERNAFOR) and modifies the LGUC (2017)
Bushfire—Law	2017	Submission of the bill that creates the Servicio Nacional Forestal (SERNAFOR) and modifies the LGUC to the Chamber of Deputies (2017)
Bushfire—Commission	2017	Committee of experts meetings-Consejo de política forestal (2017)
Bushfire—Policy	2017	Estrategia para el fortalecimiento de la Gestión de incendios forestales (Gobierno de Chile, 2017)
Bushfire—Policy	2017	Política Forestal 2015-2035. Protocolo de plantaciones forestales (CONAF, 2017)
Planning—Report	2018	1. Sistema de Indicadores y Estándares de Calidad de Vida y Desarrollo Urbano (CNDU, 2018)
Planning—Report	2018	2. Propuestas para implementar un Sistema de Planificación Urbana Integrada (CNDU, 2018)
Planning—Report	2018	3. Propuestas para una nueva institucionalidad para la gobernanza urbana (CNDU, 2018).
Planning—Report	2018	4. Medidas para implementar una politica de suelo para la integracion social urbana (CNDU, 2018).
Planning—Report	2018	5. Propuestas para un modelo integral de conservación del patrimonio urbano (CNDU, 2018).
Planning—Report	2018	Informe Final 144-2018 Seremi Vivienda Y Urbanismo Sobre Auditoria Al Proceso De Otorgamiento De Permisos De Edificación Y Recepción De Inmuebles Emplazados En Zonas De Riesgo Identificadas En Los Ipt Junio-2018 (Contraloria General de la Republica, 2018)

Appendix A.2. List of Documents and Archival Records Considered for the Victorian Case Study

Category	Year	Description for Thesis
Bushfire—Report	1885	Final Report of the Select Committee upon the fire brigade system (1885).
Fire—Act	1890	Fire Brigades Act (1890).
Royal Commission	1900	Eleventh progress report of the Royal Commission on State Forests and Timber Reserves (1900).
Bushfire—Report	1907	Bush Fires Committee Minutes of Evidence (1907).
Planning—Act	1921	Local Government Act (Amendment 1921).
Planning—Act	1938	Slum Reclamation and Housing Act (1938).
Royal Commission	1939	Victoria Royal Commission-The Stretton Report (1939).
Fire—Act	1944	Country Fire Authority Act (1944).
Planning—Act	1944	Town and Country Planning Act (1944).
Royal Commission	1944	Victoria Royal Commission On Yallourn Bushfires (1944).
Local planning	1954	Melbourne Metropolitan Planning Scheme (MMPS) (1954).

Category	Year	Description for Thesis
Fire—Act	1958	Country Fire Authority Act (1958).
Fire—Act	1958	Forest Act (1958).
Fire—Act	1958	Metropolitan Fire Brigades Act (1958).
Planning—Act	1958	Town and Country Planning Act (1958).
Planning—Act	1961	Town and Country Planning Act (1961).
Local planning	1966	Shire of Upper Yarra Planning Scheme (1966).
Planning—Act	1968	Town and Country Planning (Amendment) Act 1968.
Bushfire—Report	1977	Report of the Board of Inquiry into the Occurrence of Bush and Grass Fires in Victoria (1977). It reported on the causes and origins of major bushfires, as well as the adequacy and effectiveness of measures at the time, and explored whether different or additional practices were needed.
Bushfire—Report	1978	Design and Siting Guidelines: Rural Subdivision Principles (Government Printer 1978).
Local planning	1982	Upper Yarra Valley and Dandenong Ranges Regional Strategy Plan (1982).
Local planning	1983	Shire of Upper Yarra Interim Development Order (Part of Shire) (1983).
Local planning	1983	Shire of Upper Yarra Interim Development Order Amendment no. 76 (12 July 1983).
Bushfire—Report	1983	Design and Siting Guidelines: Rural Subdivision Principles (Morris and Barber, 1983).
Bushfire—Report	1984	Bushfires and the Australian Environment (1984).
Bushfire—Report	1984	Report of the Bushfire Review Committee on bushfire disaster preparedness and response in Victoria, Australia, following the Ash Wednesday fires (1984).
Planning—Act	1985	Town and Country (Transfer of Functions) Act (1985).
Local planning	1985	Shire of Upper Yarra Planning Scheme (1985).
Planning—Act	1987	Planning and Environment Act (1987).
Local planning	1988	Upper Yarra Planning Scheme (1988).
Mapping	1988	Priority Burning Zones (1988–1989).
Bushfire—Report	1991	Planning Conditions and Guidelines for Subdivisions (Country Fire Authority 1991).
Mapping	1991	Fire Hazard Mapping (CFA, 1991).
Standard	1991	AS3959 (1991) Construction of buildings in bushfire-prone areas.
Bushfire—Report	1992	Report of the Victorian Auditor-General on Fire Protection (1992).
Local planning	1992	Upper Yarra Valley and Dandenong Ranges Regional Strategy plan (Amendment no. 29; 1992).
Planning—Report	1993	Minister for Planning's Projects Steering Committee: Committee Recommendations and Project Team Report (Perrott Committee Report) (1993).
Local planning	1993	Upper Yarra Valley and Dandenong Ranges Regional Strategy plan (Amendment no. 51; 1993).
Standard	1993	Building and Bushfire-Prone Areas-CSIRO & Standards Australia (SAA HB36-1993) [80].
Local planning	1994	Victorian Local Government Amalgamations (1994–95).
Local planning	1994	Planning Authorities Repeal Act 1994.
Local planning	1995	Upper Yarra Valley and Dandenong Ranges Regional Strategy plan (Amendment no. 75; 1995).
Planning—Act	1996	Planning and Environment (Planning Schemes) Act (1996).
Local planning	1996	Upper Yarra Valley and Dandenong Ranges Regional Strategy plan (Amendment no. 90; 1996).
Fire—Act	1997	Country Fire Authority (Amendment) Act (1997).

Category	Year	Description for Thesis
Local planning	1997	Yarra Ranges Planning Scheme Notice of Preparation (11 September 1997).
Victoria planning provisions	1997	Victoria Planning Provisions (1997).
Victoria planning provisions	1997	Victoria Planning Provisions Amendment V3 (13 October 1997).
Victoria planning provisions	1998	Victoria Planning Provisions Amendment VC5 (25 March 1999).
Planning—Report	1998	Formation of the Development Assessment Forum (DAF).
Standard	1999	AS3959 (1999) Construction of buildings in bushfire-prone areas.
Bushfire—Report	2002	Natural Disasters in Australia: reforming mitigation, relief and recovery arrangement (2002).
Mapping	2002	WMO mapping criteria changes (2002) .
Bushfire—Report	2003	A Nation Charred: Report on the inquiry into bushfires (2003).
Bushfire—Report	2003	Report of the Victorian Auditor-General on Fire prevention and preparedness (2003).
Bushfire—Report	2003	Report of the Inquiry into the 2002-2003 Victorian Bushfires (2003).
Response	2003	A Nation Charred: Report on the inquiry into bushfires, Australian Government Position (2003).
Bushfire—Report	2004	National Inquiry on Bushfire Mitigation and Management-COAG Report (Ellis, Kanowski, and Whelan, 2004).
Planning—Report	2005	Endorsement of the Leading Practice Model developed by the Development Assessment Forum (DAF) (2005).
Mapping	2005	WMO mapping criteria changes (2005).
Victoria planning provisions	2005	Victoria Planning Provisions Amendment VC34 (22 September 2005).
Planning—Report	2006	Cutting red tape in planning (2006).
Victoria planning provisions	2006	Victoria Planning Provisions Amendment VC42 (9 October 2006).
Victoria planning provisions	2006	Victoria Planning Provisions Amendment VC44 (14 November 2006).
Planning—Report	2008	Victoria's Planning Framework for Land Use and Development (2008).
Victoria planning provisions	2008	Victoria Planning Provision Amendment VC46 (4 February 2008).
Planning—Report	2009	Modernising Victoria's Planning Act (2009).
Response	2009	2009 Victorian Bushfires Royal Commission Interim Report, Victorian Government Response (2009) .
Royal Commission	2009	2009 Victorian Bushfires Royal Commission Interim Report (2009).
Royal Commission	2009	2009 Victorian Bushfires Royal Commission Interim Report 2 (2009).
Standard	2009	AS3959 (2009) Construction of buildings in bushfire-prone areas.
Victoria planning provisions	2009	Victoria Planning Provisions Amendment VC53 (23 February 2009).
Victoria planning provisions	2009	Victoria Planning Provisions Amendment VC54 (12 March 2009).
Victoria planning provisions	2009	Victoria Planning Provisions Amendment VC57 (11 May 2009).
Victoria planning provisions	2009	Victoria Planning Provisions Amendment VC61 (10 September 2009).

Category	Year	Description for Thesis
Local planning	2009	Greater Geelong Planning Scheme-Amendment C172 (9 July 2009).
Local planning	2009	Campaspe Planning Scheme—Amendment C021 (13 August 2009).
Local planning	2009	Mansfield Planning Scheme-Amendment C014 (24 September 2009).
Planning—Report	2010	Advisory Committee reports about Wildfire Management Overlay (2010).
Response	2010	Commonwealth Response to the Final Report of the 2009 Victorian Bushfires Royal Commission (2010).
Response	2010	Integrated planning and building framework for Bushfire in Victoria, A response to the 2009 Victorian Bushfires Royal Commission (2010).
Royal Commission	2010	2009 Victorian Bushfires Royal Commission Final Report (2010).
Victoria planning provisions	2010	Victoria Planning Provisions Amendment VC65 (22 January 2010).
Victoria planning provisions	2010	Victoria Planning Provisions Amendment VC66 (27 July 2010).
Victoria planning provisions	2010	Victoria Planning Provisions Amendment VC70 (14 May 2010).
Victoria planning provisions	2010	Victoria Planning Provisions Amendment VC71 (20 September 2010).
Victoria planning provisions	2010	Victoria Planning Provisions Amendment VC73 (31 August 2010).
Victoria planning provisions	2010	Victoria Planning Provisions Amendment VC76 (19 November 2010).
Local planning	2010	Southern Grampians Planning Scheme—Amendment C010 (21 January 2010).
Local planning	2010	Central Goldfields Planning Scheme—Amendment C021 (21 January 2010).
Local planning	2010	Queenscliffe Planning Scheme—Amendment C020 (21 January 2010).
Local planning	2010	Glenelg Planning Scheme—Amendment C016 (21 January 2010).
Local planning	2010	Yarra Ranges Planning Scheme—Amendment C093 (28 January 2010).
Local planning	2010	Casey Planning Scheme—Amendment C128 (28 January 2010).
Local planning	2010	Bass Coast Planning Scheme—Amendment C109 (4 February 2010).
Local planning	2010	Frankston Planning Scheme—Amendment C058 (4 February 2010).
Local planning	2010	East Gippsland Planning Scheme—Amendment C083 (11 February 2010).
Local planning	2010	Northern Grampians Planning Scheme—Amendment C011 (11 February 2010).
Local planning	2010	Greater Bendigo Planning Scheme—Amendment C138 (11 February 2010).
Local planning	2010	French Island and Sandstone Island Planning Scheme—Amendment C003 (11 February 2010).
Local planning	2010	Mount Alexander Planning Scheme—Amendment C034 (11 February 2010).
Local planning	2010	South Gippsland Planning Scheme—Amendment C026 (11 February 2010).
Local planning	2010	Alpine Resorts Planning Scheme—Amendment C020 (11 February 2010).
Local planning	2010	Mornington Peninsula Planning Scheme—Amendment C009 (11 February 2010).
Local planning	2010	Loddon Planning Scheme—Amendment C018 (11 February 2010).
Local planning	2010	Ararat Planning Scheme—Amendment C022 (11 February 2010).
Local planning	2010	Alpine Planning Scheme—Amendment C011 (11 February 2010).
Local planning	2010	Horsham Planning Scheme—Amendment C038 (18 February 2010).
Local planning	2010	Wellington Planning Scheme—Amendment C063 (18 February 2010).
Local planning	2010	Moorabool Planning Scheme—Amendment C018 (4 March 2010).

Category	Year	Description for Thesis
Local planning	2010	Knox Planning Scheme—Amendment C083 (27 May 2010).
Local planning	2010	West Wimmera Planning Scheme—Amendment C020 (27 May 2010).
Local planning	2010	Mornington Peninsula Planning Scheme—Amendment C159 (8 July 2010).
Local planning	2010	Hindmarsh Planning Scheme—Amendment C010 (8 July 2010).
Local planning	2010	Mornington Peninsula Planning Scheme-Amendment C146 (16 September 2010).
Planning—Report	2011	Victorian Planning System Ministerial Advisory Committee Initial Report (2011).
Mapping	2011	Bushfire Management Overlay (BMO) replaced the WMO (2011).
Progress report	2011	Bushfires royal commission implementation monitor, Progress Report (2011).
Response	2011	Implementing The Government's Response To The 2009 Victorian Bush Fires Royal Commission (May 2011).
Response	2011	Victorian Government Response to The Victorian Bushfires Royal Commission Recommendations 27 and 32 (2011).
Victoria planning provisions	2011	Victoria Planning Provisions Amendment VC83 (18 November 2011).
Victoria planning provisions	2011	Victoria Planning Provisions Amendment VC86 (18 November 2011).
Planning—Act	2012	Planning and Environment Amendment (VicSmart Planning Assessment) Act (2012).
Progress report	2012	Bushfires royal commission implementation monitor, Final Report (2012).
Planning—Report	2012	Planning and Environment amendment research brief (Parliament of Victoria).
Mapping	2013	BPA mapping updated (August 2013).
Progress report	2013	Bushfires royal commission implementation monitor, Annual Report (2013).
Victoria planning provisions	2013	Victoria Planning Provisions Amendment VC102 (28 October 2013).
Victoria planning provisions	2013	Victoria Planning Provisions Amendment VC81 (18 February 2013).
Victoria planning provisions	2013	Victoria Planning Provisions Amendment VC89 (05 March 2013).
Victoria planning provisions	2013	Victoria Planning Provisions Amendment VC97 (05 March 2013).
Progress report	2014	Bushfires royal commission implementation monitor, Annual Report (2014).
Victoria planning provisions	2014	Victoria Planning Provisions Amendment VC108 (16 April 2014).
Victoria planning provisions	2014	Victoria Planning Provisions Amendment VC109 (31 July 2014).
Fire—Policy	2015	Safer together (DELWP, 2015).
Progress report	2015	Progress Report Victorian Bushfires Royal Commission Implementation of recommendations and actions (2015).
Victoria planning provisions	2015	Victoria Planning Provisions Amendment VC101 (29 October 2015).
Victoria planning provisions	2015	Victoria Planning Provisions Amendment VC119 (30 April 2015).
Progress report	2016	Progress Report Victorian Bushfires Royal Commission Implementation of recommendations and actions (2015).
Planning—Act	2017	Victorian Planning Authority Act (2017).

Category	Year	Description for Thesis
Bushfire—Report	2017	Inquiry into fire season preparedness, Final report (2017).
Planning—Report	2017	Managing Victoria's Planning System for Land Use and Development (2017).
Mapping	2017	BMO mapping updated (3 October 2017).
Response	2017	Inquiry into fire season preparedness Government Response (2017).
Victoria planning provisions	2017	Victoria Planning Provisions Amendment VC140 (12 December 2017).
Mapping	2018	BPA mapping updated (May 2018).
Victoria planning provisions	2018	Victoria Planning Provisions Amendment VC148 (31 July 2018).
Standard	2018	AS3959 (2018) Construction of buildings in bushfire-prone areas.

Appendix A.3. List of Interviewees from the Chilean Case Study

Code	Institution	Level	Role
MINVUREP1	*Ministry of Housing and Urbanism* (MINVU)-	National	Head of the Urban Development Division
MINVUREP2	MINVU	National	Analyst (urban planning and norms)
MINVUREP3	MINVU	National	Former National Urban Reconstruction Coordinator after the 2010 earthquake and tsunami
MOPREP1	*Ministry of Public Works* (MOP)	National	National deputy director of architecture overseeing Santa Olga's reconstruction
CONAFREP	*National Forestry Corporation* (CONAF)	National	Executive Director
FORESTRYREP1	Arauco Forestry Company	National	Head of Forest Fire Protection
SEREMIREP1	*Regional Ministerial Secretariat* (SEREMI) MINVU	Regional—Biobio	Planning official
SEREMIREP2	SEREMI MINVU	Regional—Biobio	Planning official
SEREMIREP3	SEREMI MINVU	Regional—Biobio	Planning official
ONEMIREP	*National Emergency Office of the Ministry of the Interior* (ONEMI)	Regional—Biobio	Emergency management official
AGSUST	*Sustainability and Climate Change Agency*	Regional—Biobio	Secretary for the Regional Committee of Clean Production of the Agency for Sustainability and Climate Change
COELEMUREP	Coelemu Municipality	Local—Coelemu	Director of the Communal Planning Secretariat
COMREP1	Ranguelmo Fire Brigade and Fire-wise community	Local—Ranguelmo	Secretary fire brigade and fire-wise vice-president
COMREP2	Ranguelmo Fire Brigade	Local—Ranguelmo	Capitan fire brigade
ACA1	Universidad del Biobio	-	Academic Advisor 27F reconstruction and Post 2017 wildfire prevention project
ACA2	Universidad del Biobio	-	Academic/Consultant Advisor 27F reconstruction and Post 2017 wildfire prevention project
ACA3	Universidad del Biobio	-	Academic Post-2017 wildfire prevention project
ACA4	Universidad de Concepcion	-	Academic Researcher in risk assessment

Appendix A.4. List of Interviewees from the Victorian Case Study (Author's Development)

Code	Institution	Level	Role
FPAREP	Fire Protection Association Australia (FPAA)	Federal	Wildfire accreditation representative
CSIROREP1	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Federal	Wildfire researcher
CSIROREP2	CSIRO	Federal	Wildfire researcher
DELWPREP1	Department of Environment, Land, Water, and Planning (DELWP)-now consultant	State	BMO definition
DELWPREP2	DELWP	State	BMO mapping
DELWPREP3	DELWP	State	Hazard improvement project
DELWPREP4	DELWP	State	Hazard improvement project
DELWPREP5	DEWLP	State	Hazard improvement project
DELWPREP6	DELWP	State	Forest, Fire, and Regions group-Forestry and Phoenix modeling
CFAREP1	Country Fire Authority (CFA)	State	Manager of Natural Environment & Bushfire Safety Community Capability
CFAREP2	CFA	State	Service Delivery Team Leader
EMVREP	Emergency Management Victoria (EMV)	State	Research and Innovation
BENDIGOREP	Bendigo City Council	Local—Bendigo	Strategic planning officer
LATROBEREP1	LaTrobe City Council	Local—LaTrobe	Strategic planning officer
LATROBEREP2	LaTrobe City Council	Local—LaTrobe	Strategic planning officer
YARRAREP	Yarra Ranges City Council	Local—Yarra Ranges	Statutory planning officer
CASEYREP	Casey City Council	Local—Casey	Statutory planning officer
COMMUREP1	Community	Local—Emerald	BMO victims
COMMUREP2	Community	Local—Arthurs Creek	Affected by 2009 fires and CFA volunteer
COMMUREP3	Community	Local—Arthurs Creek	Affected by 2009 fires and CFA volunteer
CONSULTANT1	Consultant	-	Consultant
CONSULTANT2	Consultant	-	Consultant
CONSULTANT3	Consultant	-	Consultant
ACADREP1	Australian National University	-	Academic

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