

# GUIDE PROPOSAL FOR URBAN PLANNING FOR FOSTERING WILDFIRE RESILIENT TIMBER CONSTRUCTION IN THE URBAN-RURAL INTERFACE

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**ABSTRACT:** In wildfire-prone urban-rural interface areas, policies for fostering wildfire resilient timber construction need to consider the risks associated with the interaction between wildfires and buildings, implementing wildfire risk reduction strategies. By comprehensively integrating wildfire risk reduction considerations, urban planning can contribute to implementing policies for fostering wildfire resilient approaches to timber construction. However urban planning systems often fail to do so, addressing wildfires partially and inconsistently. Thus, there is a need to set out comprehensive approaches to urban planning for wildfire risk reduction. To address this gap, this paper aims to propose a guide for urban planning integrating wildfire risk reduction considerations that can contribute to foster wildfire resilient timber construction in wildfire-prone areas. The study was approached as inductive qualitative research of two case studies: the urban planning systems of Chile and Victoria (Australia). Based on the analysis, the research presents a normative guide for urban planning integrating wildfire risk reduction considerations based on three broad categories: legislation; spatial plans; and implementation processes. The framework presented serves as a guide to fostering resilient timber construction in wildfire-prone areas by comprehensively integrating wildfire risk reduction considerations into urban planning systems.

**KEYWORDS:** Timber construction, Policy, Urban-rural interface, Urban planning, Wildfires, Disaster risk reduction

## 1 INTRODUCTION

Wildfires are a natural hazard that refers to an out of control wildland fire burning over a large area [1]. Diverse natural and human processes are bound together Wildfire frequency and intensity are increasingly associated with worsening weather conditions that support extreme fires [2, 3].

In terms of wildfire interactions with timber structures, a small fire has three mechanisms of spread, growth and damage structures and settlements: embers and burning debris, heat radiation, and direct flame contact [4].

Embers and burning debris refer to small burning particles carried by the wind, often preceding the fire by a considerable distance. Embers can find their way around, under, or inside a building. They can enter structures through very small openings, such as windows or roof cavities; building form elements that tend to trap embers, such as complicated roof forms, are often a key weak point for structures [5]. Accordingly, embers are the most common mechanism for a structure's ignition during a wildfire [6].

Heat radiation is the energy that the fire gives out in all directions, drying and heating surrounding fuels. Radiation can greatly influence the other two mechanisms of ignition. Many materials are susceptible to ignition when exposed to considerable heat [4] and many wood products can ignite and burn.

Direct flames can ignite surrounding materials, including buildings if close to fuel sources. Flames increase their scope when their range is extended by the wind [4]. If a building is within proximity to vegetation or other fuel sources, direct flame contact significantly increases the chances of ignition and propagation of fire to structures, and it is very difficult and expensive to design and built structures that can withstand intense direct flame contact [6].

Additionally, fire-driven wind can be included as a fourth mechanism of fire attack [4, 6]. Fires are usually more intense and dangerous in windy conditions. Wind can damage structures, electricity lines and connections, or cause trees or other flying objects to fall. This facilitates embers to enter and ignite structures, and impedes firefighting efforts [4, 6].

Wildfires can pose significant risks at urban-rural interfaces and peri-urban areas where timber structures are in proximity to vegetated areas and humans' lives and material goods are more exposed to fire [7]. Moreover, settlement patterns in these areas – such as growing low-density urban sprawl and rural-residential developments that encroach upon fire-prone areas –also affect the frequency and severity of wildfires [8-11].

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Increasing wildfire risk does not necessarily imply that timber structures cannot be constructed in urban-rural interface areas prone to wildfires. Instead, resilient timber constructions emplaced in wildfire-prone areas need to need to acknowledge the risks associated with the interaction between wildfire hazards and buildings and consider disaster risk reduction (DRR) and mitigation strategies.

Addressing the physical aspects of wildfire DRR for timber constructions requires joining building, urban design, urban planning, and forest regulations. Urban planning has the ability to operate as the coordinating platform for the implementation of these measures [12, 13]. Urban planning is a potentially powerful approach to reducing wildfire risks to structures and settlements. Thus, it can contribute to foster resilient approaches to timber construction. In fact, urban planning is widely acknowledged as a way to deal with wildfire risk [for instance 14, 15-20]. However urban planning systems for dealing with wildfires are often incomplete or inadequately used, and there is limited guidance as to what integrating wildfire DRR considerations into urban planning entails in practice [12, 21]. Thus, there is a need to set out integrated approaches to urban planning for wildfire DRR.

To address this knowledge gap, this paper aims to propose a guide for urban planning integrating wildfire DRR considerations that can contribute to foster wildfire resilient timber construction in wildfire-prone areas based on three broad categories: legislation; spatial plans; and implementation processes.

## 2 METHOD

The study was approached as inductive qualitative research of two case studies: the urban planning systems of Chile and Victoria (Australia), which were analysed from the perspective of their integration of wildfire considerations. The multiple case study strategy allows the development of analytic generalisations about concepts associated with the integration of wildfire DRR considerations that can contribute to foster wildfire resilient timber construction in wildfire-prone areas that arise from the research [22].

Data was collected from documentation representing three levels of urban planning instruments: legislation; spatial plans; and implementation processes. Documents are selected as a source of data because they provide broad coverage of current urban planning instruments. Data was also collected from semi-structured interviews with key urban planning, emergency management professionals and experts in the field, and community representatives living in wildfire-prone areas with some involvement in urban planning processes for building timber structures. Interviews provide insightful and targeted complementary information about the urban planning system's current ways and opportunities.

For the case study of Chile, the instruments considered per level selected are listed in table 1; additionally, 18 interviews were undertaken. For Victoria, the

instruments considered per level are listed in table 2; furthermore, 24 interviews were undertaken.

**Table 1:** Documentation considered per level of urban planning decisions for Chile's case study.

Level	Instruments
Legislation	<ul style="list-style-type: none"> <li>• Ley General de Urbanismo y Construcciones<sup>4</sup> (LGUC) [23]</li> <li>• Ordenanza General de Urbanismo y Construcciones<sup>5</sup> (OGUC) [24]</li> </ul>
Spatial plans	<ul style="list-style-type: none"> <li>• Límite Urbano<sup>6</sup></li> <li>• Plan Regulador Comunal<sup>7</sup> (PRC)</li> <li>• Plan Regulador Intercomunal<sup>8</sup> (PRI) or Plan Regulador Metropolitano<sup>9</sup> (PRM)</li> <li>• Plan Seccional<sup>10</sup></li> <li>• Política Nacional de Desarrollo Urbano<sup>11</sup> (PNDU)</li> <li>• Estrategia Regional de Desarrollo<sup>12</sup></li> <li>• Plan Regional de Ordenamiento Territorial<sup>13</sup> (PROT)</li> </ul>
Implementation processes	<ul style="list-style-type: none"> <li>• Building and planning permit as regulated by the LGUC and the OGUC</li> </ul>

**Table 22:** Documentation considered per level of urban planning decisions for Victoria's case study.

Level	Instruments
Legislation	<ul style="list-style-type: none"> <li>• Planning and Environment Act [25]</li> <li>• Victoria Planning Provisions (VPP)</li> <li>• AS3959 – Construction of Buildings in Bush Fire Prone Areas [26]</li> </ul>
Spatial plans	<ul style="list-style-type: none"> <li>• Planning Scheme</li> <li>• BMO Mapping</li> <li>• Schedules</li> <li>• Urban Growth Boundary</li> </ul>

<sup>4</sup> General Law of Urban Planning and Constructions

<sup>5</sup> General Ordinance of Urban Planning and Constructions

<sup>6</sup> Urban Boundary

<sup>7</sup> Communal Regulatory Plan

<sup>8</sup> Intercommunal Regulatory Plan

<sup>9</sup> Metropolitan Regulatory Plan

<sup>10</sup> Sectional Plan

<sup>11</sup> National Plan for Urban Development

<sup>12</sup> Regional Development Strategy

<sup>13</sup> Regional Territorial Plan

	<ul style="list-style-type: none"> <li>• Regional Growth Plan</li> <li>• Metropolitan Planning Strategy</li> <li>• Growth Corridor Plan</li> <li>• Framework Plan</li> <li>• Precinct Structure Plan.</li> </ul>
Implementation processes	<ul style="list-style-type: none"> <li>• Planning permit process according to the Planning and Environment Act, the BMO and the AS3959</li> </ul>

The data were analysed using qualitative content analysis, and cross-case synthesis techniques. Qualitative content analysis was undertaken by thematic analysis of text-based on implicit coding [22, 27] based on the three levels of urban planning instruments: legislation; spatial plans; and implementation processes. For each of these three general categories, the data were further coded in several sub-categories that corresponded with the characteristics, strengths, and challenges of each level of urban planning (within each case, independently). The coding process was undertaken by the researcher by reading the text, identifying, and categorising relevant fragments of it, using the ‘NVivo12’ software to organise the data coded. A cross-case synthesis was conducted to compare the characteristics of the Chilean and Victorian urban planning instruments that facilitate or difficult dealing with wildfires. The synthesis considered patterns associated with the three levels of urban planning decisions (legislation; spatial plans; and implementation processes). The cross-case generalisation was undertaken by synthesising: the critical instruments for wildfire DRR per level; the current limitations of these instruments, and the instrument’s potential role in wildfire DRR.

### 3 RESULTS AND DISCUSSION

This section presents the characteristics of the Chilean and Victorian urban planning instruments that facilitate or impede dealing with wildfires. Based on a cross-case synthesis informed by the strengths and deficiencies identified in both case studies, theoretical generalizations in the form of a normative guide for urban planning integrating wildfire DRR considerations are presented based on three broad categories: legislation; spatial plans; and implementation processes. The legislative level is identified as fundamental to enable, guide and coordinate wildfire DRR measure for wildfire resilient timber construction. The importance of considering wildfire DRR when establishing directions for development and construction via spatial plans is also recognized. Lastly, the relevance of facilitating site-specific decision-making in the implementation and enforcement processes of wildfire DRR land use

policies, regulations and development controls to a site is identified.

This guide serves as a direction for planners and government officials intending to integrate wildfire DRR considerations into urban planning, as well as a benchmark for appraisal of existing urban planning systems. Ultimately, the implementation of this guide can contribute to developing comprehensive policies and regulations for fostering wildfire resilient timber construction in wildfire-prone areas.

#### 3.1 LEGISLATIVE FRAMEWORK

The legislation typically provides a suite of framing instruments for urban planning that establish responsibilities and powers. These are mainly oriented to the production and implementation of policy and plans. They set the legal basis for urban planning capacities and limits.

The case studies show that the Chilean and Victorian legislative frameworks are only partially and inconsistently setting the overarching urban planning mechanism and processes for wildfire DRR, and that they are failing to adequately frame the underlying DRR values of the system. This lack of overarching direction constrains the implementation of wildfire measures at lower tiers of planning. Furthermore, the case studies also provide evidence that the Chilean and Victorian frameworks are not adequately coordinating inter-disciplinary collaborations and that urban planning decision-making regarding wildfire DRR remains mostly sectoral. Thus, urban planning decision-making about wildfire DRR remains mostly sectoral, which challenges addressing wildfire connections with diverse complementary or sometimes conflicting social, economic, and environmental systems.

Informed by the case study findings, we argue that the legislative framework is essential for fostering wildfire resilient timber construction in the urban-rural interface areas by enabling, guiding, and coordinating wildfire DRR actions that are then applied at lower governance tiers of planning. This includes framing risk assessment processes for planning decisions, articulation of the levels of risk that are considered acceptable and framing of timber construction requirements.

Generalizing from the case studies, we suggest that key instruments at the legislative framework’s level of urban planning, and their roles in wildfire DRR, include:

##### *Legislation.*

- Enable and contextualise urban planning for wildfire DRR.
- Require de inclusion of wildfire considerations in the planning decision at the relevant levels.
- Require a wildfire risk assessment considering existing and future risks.
- Specifying the type of information needed for decision-making.
- Establish links to advise from relevant agencies.

### ***Policy.***

- Ensure the alignment with the direction of other overarching national policies or international agreements.
- Articulate how wildfire information is considered to guide decision-making processes and the selection of future growth patterns.
- Articulate acceptable risk tolerance guiding decision-making.

### ***Regulation.***

- Link decisions to advice of wildfire emergency managers.
- Require consideration of wildfire risks in all relevant planning decisions.
- Guide the level of risk tolerance framing the system and informing decision-making.

### ***Standards and codes.***

- Restrict growth or certain uses in areas where risk is considered unacceptable.
- In areas where development is considered acceptable, ensure appropriate building standards that specify DRR treatment mechanisms and mitigation strategies according to the system's level of risk tolerance.

## **3.2 SPATIAL PLANS**

Spatial plans set broad directions for development, spatially influencing the location and characteristics of new development. These instruments are geographically specific; they translate and apply to land in local contexts the overarching intentions of the legislative framework. Accordingly, they play an important role in balancing wildfire DRR with other development requirements and priorities.

The case study findings show that, in practice, the Chilean and Victorian spatial plan's ability to direct the gradual change of settlements' physical characteristics applying development and building controls that increase settlements' resistance to wildfires is limited. This implies that wildfire assessments and mapping often inform spatial decisions partially and inconsistently; strategic plans are not fully able to direct new development and growth to wildfire-suitable locations; and land use plans are limited in their ability to direct and control the use and development of land in ways that prevent or reduce wildfire risks.

Informed by the case study results, we argue that, for fostering wildfire resilient timber construction, spatial plans – and in particular strategic growth plans – are essential to balance wildfire DRR with other development requirements and direct new development to suitable locations, avoiding or reducing locational risk factors or impacts, recognising that some land may be unsuitable for certain development or activities. To do so, spatial plans must be based on the assessment of existing and future risks, identifying wildfire exposure and risk, usually via mapping.

Generalising from the case studies, we suggest that key spatial plans, and their roles in wildfire DRR, include:

### ***Regional plans.***

- Understand wildfire risk at a landscape scale, considering rural-urban relationships and impacts.
- Coordinate infrastructure networks and priorities.
- Identify and protect areas of special importance.

### ***Strategic growth or expansion areas.***

- Provide adequate space for growth in areas suitable for development.
- Support outcomes that manage risk to development in areas identified as suitable expansion areas.

### ***Local policies and strategies.***

- Ensure the alignment with the direction of overarching wildfire DRR policies.
- Articulate how wildfire risk is integrated with decision-making.

### ***Structure plans.***

- Identify sector-specific actions to reduce wildfire risk and facilitate adaptation to wildfires.
- Incrementally drive wildfire resilient urban forms.
- Contribute to managing areas with greater wildfire hazard exposure.

### ***Zones, overlays, and controls.***

- Implement wildfire DRR provisions for wildfire-prone areas.
- Articulate acceptable wildfire risk tolerance parameters.
- Implement wildfire resilience provisions through appropriate built form.
- Limit development or certain activities in areas where risks are considered too serious.
- Avoid reconstruction in wildfire-prone areas after a fire.

### ***Wildfire mapping.***

- Map hazard and risk articulating risk levels to inform new development decisions.
- Declare the underlying assumptions and criteria of assessment.

## **3.3 IMPLEMENTATION PROCESSES**

Urban planning is typically implemented on a site-by-site basis by granting planning and development permit approvals, so it is important that these achieve overarching standards set at higher tiers. Other implementation instruments include urban development and infrastructure projects and land reclamation and buyback schemes. Urban planning's implementation via individual projects implies that change is gradual, continuous, and dependant on other stakeholders' needs and motivations to use and develop land.

The case study findings evidence that the permit process in Chile and Victoria can only deliver discrete change that incrementally might result in settlements' increased wildfire DRR. Thus, it is inherently limited in its capacity to promote more dramatic types of settlement

change that contributes to resilient timber construction in wildfire-prone areas. Furthermore, other implementation instruments – including urban development and infrastructure projects, land reclamation, buy-back schemes, and retrofitting strategies – offer alternatives to the permit-by-permit approach. Their use can contribute to developing more sophisticated approaches to urban planning operationalisation of DRR, countering the limitations of the planning permit process. However, the case study findings also show that these alternatives are rarely used.

Informed by the case study finding, we argue that implementation processes can play an important role in guiding where and how new timber construction development occurs so that wildfire risks are not increased even though they do not exert absolute control over the actual ways other stakeholders use and development land. Considering that development is largely driven by projects, mainstreaming wildfire DRR considerations into planning permits and development approvals is critical. The sum of small individual project decisions has profound long-term impacts that can contribute to foster the construction of wildfire resilient timber structures in wildfire-prone areas.

Generalising from the case studies, we suggest that key implementation processes, and their roles in wildfire DRR, include:

#### ***Planning permit.***

- Ensure compliance with overarching instruments.
- Undertake context-specific risk assessment at the appropriate scales.
- Ensure that projects are designed to withstand wildfires, implementing mitigation strategies.
- Ensure that projects consider backup measures (such as civilians' evacuation alternatives or sheltering options).
- Integrate relevant government agencies in the decision-making processes.

#### ***Urban development and infrastructure project.***

- Undertake previously established tests to avoid wildfires' impact on infrastructure.
- Comply with the overarching instruments.
- Consider redundancy and backup measures.
- Integrate relevant government agencies in the decision-making process.

#### ***Land reclamation.***

- Improve settlement patterns and built form to treat existing or future wildfire risks.
- Expand resettlement options for displaced people.

## **4 CONCLUSION**

Given the risks associated with development in urban-rural interface areas exposed to wildfires, this paper argues that an integrated and comprehensive policy framework is essential to appropriately reduce and mitigate risks to fostering wildfire resilient timber construction. The normative guide provided above is

based upon three main levels of urban planning: legislative framework; spatial plans; and implementation processes. This framework can be used to better integrate wildfire DRR considerations into urban planning to fostering resilient timber construction in wildfire-prone areas.

The case study findings show that there are certain characteristics of planning instruments that facilitate dealing with wildfires via urban planning. Nevertheless, they also demonstrate that vague and incomplete instruments limit urban planning's ability to promote wildfire resilient timber construction. This suggests that more integrated approaches to urban planning instruments that comprehensively address wildfires are necessary.

Accordingly, this paper contributes to addressing the need to set out integrated approaches to urban planning for wildfire DRR by providing new applied understandings about the role and factors that improve urban planning instruments' ability to promote wildfire resilient timber construction. The factors suggested can contribute to improving urban planning's ability to increase settlements' physical resistance to the effects of wildfire hazard when using or developing land. Furthermore, they enhance urban planning's ability to control the discrete and incremental adaptation and change of settlements' physical characteristics in wildfire-prone contexts. By doing so, we argue that systematic approaches to urban planning for wildfire DRR provide important long-term benefits that foster wildfire resilient timber construction.

It must be acknowledged that this guide will need to be adapted as appropriate to specific circumstances and contexts. It is also appropriate to acknowledge the limitations and of many planning systems themselves and that a range of capability, capacity, financial and time-bound issues can preclude from undertaking wildfire DRR actions. Furthermore, other development goals alongside competing demands tend to be privileged above wildfire DRR. Moreover, it must be highlighted that functioning and sophisticated urban planning instruments can only deliver building stock upgrade through discrete and incremental change. In addition, urban planning instruments are not the sole determinants of land development. Urban planning operates within a wider context that influences its capabilities and limitations. Many other instruments and agencies influence wildfire DRR as part of broader considerations. Also, over time, many other actors, and drivers of change influence planning systems as well as the development of wildfire-prone urban-rural interface areas, such as population growth, economic forces, politics and social expectations, to name a few.

## **ACKNOWLEDGEMENTS**

We would like to acknowledge that this paper is partially informed by the Land Use Planning for Disaster Resilient Communities [21] handbook that Professor Alan March and Constanza Gonzalez-Mathiesen authored for the Australian Institute of Disaster Resilience.

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