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Long-established rules and emergent challenges: spatial planning and wildfires in Chile

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ABSTRACT

It is generally expected that spatial planning integrates wildfire risk reduction considerations in areas affected by this hazard. However, many spatial planning systems are challenged to adequately deal with this risk. There is a need for applied understandings of planning systems characteristics that facilitate or impede wildfire risk reduction. Accordingly, this research explores spatial planning limitations to the integration of wildfire risk reduction measures by comparing spatial planning and wildfire risk reduction measures based on five key dimensions: structure, realm, spatial scale, territorial boundaries, and time scale. The research used a qualitative case study strategy of the Chilean spatial planning system, employing qualitative content analysis of key documents. The results show that the long-established characteristics of Chile's spatial planning limit its ability to accommodate wildfire risk reduction measures in the five dimensions analyzed. The research contributes to understanding some of spatial planning's constraints to manage wider complex challenges.

KEYWORDS

spatial planning; wildfires; disaster risk reduction

1. Introduction

There is a general expectation that spatial planning can manage diverse challenges that extend to such diverse aspects as the environment, economy, psychology, social benefits, and risk reduction. However, in seeking to achieve these goals, planning commonly faces a fundamental dilemma between a reliance on strong but often rigid approaches within which planning has historically operated; and the need for flexibility to achieve goals in diverse, complex, dynamic, and sometimes conflicting systems. Recognizing this tension and understanding how it might influence spatial planning's capacity to address emergent challenges is critical to its success, especially in cases when planning appears to be failing.

It is increasingly common in wildfire-prone areas that spatial planning is expected to integrate wildfire risk reduction considerations (Moritz et al. 2014; UNDRR 2020). Spatial planning is particularly suited to achieving the many benefits of avoiding, reducing, and remediating risks via spatial and morphological regulation and design (Gonzalez-Mathiesen and March 2018; Moritz and Butsic 2020). Notwithstanding, wildfires are a complex challenge for urban-rural interfaces and peri-urban areas exposed to wildfire hazard. Addressing the physical aspects of wildfire risk reduction requires joining building, urban design, planning, and forest regulations and

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management. However, spatial planning systems are often less effective than desired in integrating wildfire risk reduction measures. These difficulties serve as a practical illustration of the fundamental dilemma between the rigidity of many pre-existing planning systems and their need to address dynamic, new, and spatially wider challenges.

Using the example of Chile's spatial planning system, this research highlights the limitations of a long-established, predetermined, and rigid spatial planning system in integrating wildfire risk reduction measures and actions. It compares key dimensions of wildfire risk reduction and spatial planning. The analysis reveals the discrepancies and tensions between the Chilean spatial planning system and the key elements of wildfire risk reduction.

We argue that a fundamental contrast exists between the formalities of Chilean planning and wildfires' characteristics as a physical phenomenon. The Chilean spatial planning system functions within a hierarchical and disciplinary framework of stable medium-term planning that establishes predetermined physical directions defined by national standards focused upon urban contexts. Conversely, wildfire risk reduction measures ideally consider wildfires' non-hierarchical nexus with diverse and dynamic systems, acknowledging that wildfire risk is associated with uncertainty and chance and that its risk reduction measures require consideration of the hazard's context-specific characteristics, especially in the areas where the distinction between urban and rural becomes blurred.

The analysis contributes to understanding some of the limitations of the Chilean spatial planning system in terms of integrating wildfire risk reduction measures. We argue that these limitations result from the Chilean spatial planning system's rigid characteristics that contrast with the measures needed to achieve wildfire risk reduction. Furthermore, it contributes to the exploration of spatial planning's ability to address emergent and wider challenges. It provides an applied illustration of the implications of the differences between the narrow approaches within which spatial planning has traditionally operated and the need to deal with wider challenges for planning practice, highlighting the need for complex and novel responses to emergent challenges.

This paper begins by surveying the spatial planning literature arguing that there is a fundamental dilemma between long-established rigid aspects of spatial planning, and the need to deal with emergent challenges, such as wildfire risk reduction. Next, the methods of data collection and analysis employed are described. The following section contrasts the characteristics of the Chilean spatial planning system with practical measures needed to implement wildfire risk reduction measures via spatial planning based on five key dimensions: (1) structure, (2) realm, (3) spatial scale, (4) territorial boundaries, and (5) time scale (adapted from Healey 2007; Hillier 2007, 2008). It is argued that the discrepancies between practiced spatial planning and wildfire risk reduction limit the ability to integrate wildfire risk reduction measures into the planning system.

2. Spatial planning and the emergent challenge of wildfire risk reduction

This section presents the theoretical background of this paper. First, it reviews spatial planning literature, arguing that pre-existing planning systems can face difficulties addressing emergent challenges. Second, it introduces wildfire risk reduction as one example of a wider and complex challenge many spatial planning systems are currently expected to address, arguing that there is a need for applied understandings of the spatial planning characteristics that facilitate or impede the implementation of wildfire risk reduction measures.

2.1. Pre-existing planning systems and the need to address new emergent challenges

Spatial planning can be defined as a process of dealing with the impacts of spatial problems and with the spatial coordination of policies to consciously achieve better settlements (Hall and Tewdwr-Jones 2010). Traditionally, and until the late 1960s and 1970s, the planning discipline was mainly concerned with the spatial arrangement of activities, and with the three-dimensional physical

characteristic of spaces such as structures' heights and separations, streets' width, and greenery (Hall and Tewdwr-Jones 2010; Healey 2007). However, understandings of the role of planning have changed. It is now expected that spatial planning manages both the physical and the dynamic aspects of co-existing in shared spaces (Healey 2007), bridging the gap between spatial and a-spatial policies (Bracken 2014). Thus, the concept *spatial* is used in a wider sense (Hall and Tewdwr-Jones 2010) that extends to ideas such as psychology, economy, risk reduction, and climate change.

The conceptual shift to a wider understanding of spatial planning highlights the fundamental relationship of the discipline with the ongoing need to adapt to emergent challenges and change. This requires novel ways of approaching governance interventions' design and operationalization (Healey 2007), often refuting current ways of doing things (Albrechts, Barbanente, and Monno 2020). However, spatial planning systems operate within a set of inherited historical contexts including laws, rules, agencies, funding bodies, political and technical processes, solutions, and markets that frame systems' scope and capacities to act and change (March 2012), framing what can and what cannot be planned (Friedmann 2019). Some practices that may go back several centuries condition the effectiveness of contemporary institutions and limit the possibilities for modern democratic change (Flyvbjerg 1998). Thus, when trying to meet new challenges that do not comply with planning's predetermined mechanisms, planners often struggle to embrace change and get caught in the rigidity of pre-existing planning systems that impede them from adapting and changing, knowing what they want to accomplish but not knowing how to achieve it (Hillier 2005). From this perspective, in this research, rigidity is associated with the difficulty to adapt and change to evolving contexts, and rigid planning systems refer to those that experience those difficulties.

Contrasting the pre-existing systems that frame the spatial planning's scope and capacities to act versus the characteristics of the emergent challenges contributes to understanding discrepancies between them. This can point to limitations of spatial planning systems in integrating the emergent wider challenges planning is expected to address. Adapted from literature that addresses this dilemma (Healey 2007; Hillier 2007, 2008), a framework that synthesizes key dimensions that can be associated with misalignments between planning systems and emergent challenges is proposed:

1. **Structure.** Spatial planning usually operates through centralized structures with hierarchical communication modes and pre-established paths – what Hillier (2007, 2008) calls arborescent hierarchies and structures – . Conversely, the wider challenges planning is now expected to address – physical and dynamic (Healey 2007) –, such as access to affordable housing or equitable services, can have multiple, non-hierarchical links with other systems that involve a range of parties, disciplines, government levels and sectors seeking to connect, different areas of knowledge and practice around a place (Healey 2007)
2. **Realm.** Spatial planning systems' traditional realm corresponds to tangible things, physical structures, and absolute ideas. Instead, intangible realms, such as communities' health, perceptions, and values, are involved in the continuous processes for adapting to emergent complex challenges. This relates to what Hillier (2008) distinguishes as planning realms of the actual and the virtual.
3. **Spatial scale.** Spatial planning usually operates at specific scales; often framing instruments are centrally defined at the national/state scale and implemented at the local scale. Instead, the complex challenges planning is currently expected to address, such as climate change adaptation, are defined at multiple interconnected scales, from global to local which implies that wider global forces that appear to be very distant can be closely connected and shape local contexts, and vice-versa.
4. **Territorial boundaries.** Spatial planning systems have often been defined by boundaries that set what is inside or outside the urban area or administrative unit, 'the inevitability of drawing boundaries' (Hillier 2008, 27). Simultaneously, planning should also accommodate for wider

spatial planning challenges that might need more fluid and porous treatments (Hillier 2008) that integrate rural areas and acknowledge settlements' networks.

5. **Time scale.** Conventionally, spatial planning understands time linearly, according to stable disciplinary processes. In contrast, wider spatial planning challenges, such as Disaster Risk Reduction (DRR), can be associated with dynamic and relational temporal scales including daily, weekly, yearly, and generational. Furthermore, the planning processes of change usually occur in uneven ways, rather than in a linear sequence (Healey 2007).

Recognizing these five dimensions of potential discrepancy between a given spatial planning system and a new, wider challenge this system is expected to address is critical. This can contribute to understanding some of the spatial planning characteristics that might condition the systems' capacity to address emergent issues, especially in cases when planning seems to be failing to address a particular problem.

2.2. The emergent challenge of wildfire risk reduction

Wildfires represent an emergent and complex challenge for urban-rural interfaces and peri-urban areas. Wildfires refer to grass, scrub, or forests burning uncontrolled over a large area (Ramsay and Rudolph 2003). Wildfire risk can be understood as the function of the characteristics of the hazard, exposure, and vulnerability (March et al. 2020). Accordingly, wildfire-prone urban-rural interfaces and peri-urban areas are where lives, properties, and assets are more exposed to wildfires (Gill and Stephens 2009). Even more so, settlement patterns in these areas can affect the frequency and severity of wildfires (Butt et al. 2009). Coupled with an increased occurrence of extreme fire weather due to climate change (Jones et al. 2020; Urrutia-Jalabert et al. 2018), this implies that wildfire events that impact urban contexts are becoming increasingly frequent.

Spatial planning is now commonly expected to integrate wildfire risk reduction considerations. Spatial planning is widely acknowledged as a way to deal with the risks of disasters (UNDP 2015; UNDRR 2020) and wildfires (Gonzalez-Mathiesen and March 2018; Moritz et al. 2020). There is increasing evidence that physical actions implemented via spatial planning can contribute to reducing wildfire risk by limiting the exposure of vulnerable populations, reducing the chances of structures catching fire, and facilitating active response in case of an emergency (Leonard et al. 2016; Syphard, Brennan, and Keeley 2014, 2017; Syphard et al. 2012). The management of wildfire risk focuses on urban-rural interface and peri-urban areas and requires the consideration of different social, economic, and environmental systems. This implies that addressing the physical aspects of wildfire risk reduction requires integrating building, urban design, planning, and forest regulations and management, complementing them with non-physical measures, such as behavioural change and community awareness. Thus, spatial planning can be expected to function as a coordinating platform for the implementation of the physical aspects of wildfire risk reduction (Gonzalez-Mathiesen and March 2018). Accordingly, wildfires serve as an example of a new challenge that pre-existing planning systems are expected to address.

Despite wider agreement on the need to include wildfire risk reduction considerations into spatial planning, in practice, spatial planning systems can often struggle to integrate and act on wildfire risk reduction comprehensively (Leone and Tedim 2020). The literature suggests these challenges planning systems in diverse contexts, including California (Moritz et al. 2020), Australia, (Groenhart, March, and Holland 2012) Europe (Galiana-Martín 2017) and Chile (Castillo, Julio-Alvear, and Garfias 2014). This implies that the translation of wildfire risk reduction considerations into meaningful spatial planning decisions and actions has been limited. Ultimately, the lack of adequate integration of wildfire risk reduction measures into spatial planning implies that development continues to occur in areas of high fire risk across the world (Norman 2018). This highlights the need for applied understandings of the characteristics of spatial planning mechanisms and

processes that facilitate or difficult the implementation of wildfire risk reduction measures and practices. Thus, this research aims to explore the spatial planning limitations to integrate wildfire risk reduction considerations by comparing key dimensions of spatial planning and wildfire risk reduction measures.

3. Materials and methods

The study used a qualitative research approach in the form of a case study (Yin 2018). Chile's spatial planning system was selected. The criteria for selecting this case study include:

- wildfires represent an emergent challenge for this spatial planning system;
- there have been several unsuccessful attempts to integrate wildfire considerations into this spatial planning system;
- the system is still (at the time of writing) struggling to integrate wildfire risk reduction measures and actions;
- the analysis can contribute to exploring why this spatial planning system is struggling to integrate wildfire considerations;
- the case offers opportunities for learning valuable lessons for Chile and internationally.

3.1. The Chilean wildfire context

Chile's wildfire regime is characterized by frequent low-intensity fires with exceptionally intense fires, and fire occurrence has a high seasonality, closely associated with precipitation and temperature variations (CONAF 2018a; González et al. 2011). Chile's south-central areas are the most impacted by wildfires (Castillo, Julio-Alvear, and Garfias 2014), which also corresponds with the most populated areas of the country. Most fire ignitions are associated with human activities, both accidental (56,3%) or intentional (32%) (CONAF 2018b). Furthermore, wildfire events that impact settlements are becoming increasingly common. For example, the 'Great Valparaiso fire' (2014) resulted in more than 2900 houses being destroyed, 926 hectares burned, 15 fatalities, and over 12,500 displaced (Reszka and Fuentes 2015). Moreover, in 2017, 'Tormenta de Fuego'¹ (2017), the worst recorded wildfire event in Chile's history, burned 546,677 hectares, caused 11 fatalities, and destroyed 2831 buildings, displacing over 8129 people.

3.2. The Chilean spatial planning context

In general terms, the Chilean spatial planning system's framing instruments are centrally defined at the national scale, and spatial plans are mostly designed and implemented at the local scale (with supervision from ministerial regional offices).

Chilean spatial planning agencies comprise three administrative levels: national, regional, and local. At the national level, the Ministerio de Vivienda y Urbanismo² (MINVU) is the agency responsible for preparing, evaluating, and amending the national legislative framework. At the regional level, the Secretaría Regional Ministerial³ (SEREMI) MINVU is responsible for overseeing the application of the national policies at the regional level and supporting local planning agencies. At the local level, Municipalities are responsible for the implementation of the National Law, Ordinance, and Technical Standards. They oversee the design of new blueprints or amendments of land-use plans and other spatial plans, for approval by the SEREMI MINVU. Usually, Municipalities are also responsible for the implementation of spatial planning instruments through the building and planning permit processes and other enforcement processes. Despite general compliance with planning laws and development controls, 81,643 families are living in 969 informal settlements along the

country that do not comply with them challenging the planning and development of cities (Centro de Estudios Socio-territoriales 2021).

The Chilean spatial planning instruments also operate at three spatial scales: national, regional, and local. At the national level, a national legislative framework of hierarchically nested instruments set the overall framework for lower tiers of planning which can only act within it, based on three levels of action: Law – *Ley General de Urbanismo y Construcciones*⁴ (LGUC) (1976 as amended) –, Ordinance – *Ordenanza General de Urbanismo y Construcciones*⁵ (OGUC) (1992 as amended) –, and Technical Standards. These are complemented by planning policies that provide general guidance. At the regional level, mostly indicative instruments and policies guide the development of the territory. At the local level, regulatory instruments – such as land-use plans called *Plan Regulador Comunal*⁶ (PRC) – spatialize policies and legislations by applying them to the land. These spatial plans are binding regulations, mandatory for everyone that intends to build, develop or use land within the area regulated that are implemented through the process of obtaining a building and planning permit.

In general terms, the origins of the Chilean spatial planning system are closely related to DRR, particularly associated with earthquakes. Since its origins – between the nineteenth Century and the 1950s –, spatial planning integrated DRR considerations, which have been reinforced by several legislative changes following disasters. This implies that there is an overall awareness of the relationship between DRR and spatial planning.

Currently, the Chilean spatial planning system allows for wildfire DRR, but it is insufficiently addressing them. The national legislative framework of the Chilean spatial planning system enables DRR at the local levels in a generic manner (articles 105 and 116 of the LGUC and articles 2.1.7, 2.1.10, and 2.1.17 of the OGUC). Furthermore, some municipalities exposed to the hazard include wildfire considerations in their local plans, mostly associated with vegetation management and generating a distance between the hazard and the settlement.

Given Chile's wildfire-prone characteristics, over time the Chilean government has developed recovery processes and strategies. These usually focus on post-disaster reconstruction and aid campaigns with a strong emphasis on housing provision.

Within wildfire recovery contexts and increased awareness during the past decades there have been several attempts to integrate wildfire considerations into Chilean spatial planning, yet these attempts have been largely unsuccessful. For example, between 2003 and 2009, 20 valid local land-use plans (PRC) in the Biobío region included wildfire mitigation measures. However, establishing wildfire-related requirements were subsequently ruled as outside the scope of planning instruments by the *Contraloría General de la República*.⁷ Later, the 2014 fires triggered the issue of 'Circular 350' – DDU 269 to establish the definition of wildfire risk areas in planning instruments. This statement was again legally contested, and the regulatory changes intended did not materialize. Furthermore, as a response to the 2017 fires, there is an ongoing bill to create the *Servicio Nacional Forestal*⁸ (SERNAFOR) and modify the National Planning Law (LGUC), to better address disaster risks and to include wildfire hazard. However, at the time of submitting this article, almost five years have passed since the SERNAFOR bill was initiated in Congress and no concrete progress has been made so far. Overall, these change attempts suggest that there is increased awareness about what the Chilean spatial planning needs to accomplish for managing wildfire risk. Yet, the description of these failures also shows that real changes to the spatial planning system for integrating wildfire risk considerations have not materialized and wildfires remain an emergent and complex challenge for the Chilean spatial planning system.

3.3. Data collection and analysis

The research first compared key dimensions of the Chilean spatial planning and wildfire risk reduction measures. Second, it explored the spatial planning limitations to integrate wildfire risk reduction measures and actions due to the differences that this comparison raised. The analysis

was undertaken using qualitative content analysis techniques of implicit coding for thematic analysis by coding the underlying meaning of the text (Sproule 2010). The coding categories corresponded with the five key dimensions of planning systems and the emergent challenges the discipline is expected to address: (1) structure, (2) realm, (3) spatial scale, (4) territorial boundaries, and (5) time scale (adapted from Healey 2007; Hillier 2007, 2008). NVivo12 software was used to organize the data coded by the researchers.

Data was collected from documentation representing three levels of spatial planning instruments: legislation; spatial plans; and implementation processes (see Table 1). Documentation was selected as a source of data because it provides broad coverage of current planning instruments. Furthermore, national and international academic and disciplinary literature was used to characterize wildfire risk reduction measures. This source of data was selected because it provides broad coverage of wildfire risk reduction ideals. Complementarily, data was also collected from 18 semi-structured interviews with key spatial planning, emergency management professionals and experts in the field, and community representatives living in wildfire-prone areas with some involvement in planning processes in wildfire contexts. Interviews provide insightful information about the planning system's characteristics and challenges when dealing with wildfires.

4. Results and discussion – Chile's spatial planning rigid characteristics impeding its ability to accommodate wildfire risk reduction measures

The comparison of the key dimensions of the Chilean spatial planning system and wildfire risk reduction measures shows that they differ in the five dimensions of potential misalignments (adapted from Healey 2007; Hillier 2007, 2008) (see Table 2). In summary, the research found that the Chilean spatial planning system functions within a disciplinary framework, hierarchically structured, of stable medium-term planning. It provides rigid physical directions defined at the national level, mainly for urban contexts with very limited capacity to act on rural contexts (outside the urban boundary of settlements). Conversely, wildfire risk reduction measures have non-hierarchical links with diverse social, economic, and environmental systems, and are influenced by dynamic factors across the spectrum of the temporal scale, from very long-term to very short-term. Wildfire risk is associated with uncertainty and chance and its reduction requires it being dealt with at different spatial scales, from global to local, with a context-specific implementation, especially in the areas where the distinction between urban and rural becomes blurred. The limitations of this analysis are acknowledged, including that the generalizations derived from Chile's case study are restricted to conceptual generalizations that should not be taken as rules as they

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

| Level | Instruments |
|--------------------------|---|
| Legislation | <i>Ley General de Urbanismo y Construcciones^a (LGUC) (1976 as amended) Ordenanza General de Urbanismo y Construcciones^b (OGUC) (1992 as amended)</i> |
| Spatial plans | <i>Límite Urbano^c Plan Regulador Comunal^d (PRC) Plan Regulador Intercomunal^e (PRI) or Plan Regulador Metropolitano^f (PRM) Plan Seccional^g Política Nacional de Desarrollo Urbano^h (PNDU) Estrategia Regional de Desarrolloⁱ Plan Regional de Ordenamiento Territorial^j (PROT)</i> |
| Implementation processes | <i>Building and planning permit as regulated by the LGUC and the OGUC</i> |

^aGeneral Law of Urban Planning and Constructions.

^bGeneral Ordinance of Urban Planning and Constructions.

^cUrban Boundary.

^dCommunal Regulatory Plan.

^eIntercommunal Regulatory Plan.

^fMetropolitan Regulatory Plan.

^gSectional Plan.

^hNational Plan for Urban Development.

ⁱRegional Development Strategy.

^jRegional Territorial Plan.

Table 2. Summary of the differences between Chile's spatial planning system and wildfire risk reduction measures.

| | <i>Spatial planning system</i> | <i>Wildfire risk reduction measures</i> |
|------------------------|--|--|
| Structure | <i>Hierarchical legislative and institutional framework with a strong sectoral focus</i> | <i>Multiple non-hierarchical nexus with different social, and economic, environmental systems</i> |
| Realm | <i>Tangible three-dimensional geometrical spaces mainly of individual places and structures guided through prescriptive regulations giving definite and precise directions</i> | <i>Intangible estimation of risk based on the likelihood of a natural hazard taking place, and the consequences on vulnerable people</i> |
| Spatial scale | <i>One-size-fits-all predetermined national framework that does not provide the appropriate guidance for risk identification or treatment</i> | <i>Requires to be dealt at different scales, from global to local, with a context-specific implementation.</i> |
| Territorial boundaries | <i>Urban contexts, with very limited capacity to address issues outside the urban boundary</i> | <i>Across the landscape, risks are usually greater in the areas where the distinction between urban and rural is unclear</i> |
| Time scale | <i>Stable, as it focuses on medium-term goals (difficult to change) slowly operationalized via the planning permit process, which are very difficult to reverse once development is in place</i> | <i>Dynamic, impacted by changing weather conditions and available fuels, which are influenced by factors across the spectrum of the temporal scale, from very long-term to very short term</i> |

reflect specific contextual conditions (Yin 2018). Nevertheless, this study provides a practical illustration of the fundamental dilemma between the rigid approaches within which spatial planning has traditionally operated and the complex challenges spatial planning is now expected to address. This contributes to understanding some of the limitations spatial planning systems might have when trying to integrate wildfire risk reduction considerations. Furthermore, understanding this duality provides a starting point for suggesting directions for improving spatial planning's ability to better address wildfires.

4.1. Structure – hierarchical spatial planning disciplinary framework versus wildfires' multiple non-hierarchical nexus between diverse systems

The Chilean spatial planning system functions within a hierarchical legislative and institutional framework with a strong sectoral focus. The national legislative framework (LGUC and OGUC) enables DRR at the local level in a generic manner, with no specific reference to wildfires. Furthermore, spatial planning agencies in Chile are also hierarchically organized and can only act based on pre-established requirements and processes. Locally, Municipal planning agencies are responsible for the application of national regulations and have very limited opportunities for context-specific innovation. Moreover, opportunities for integration with other agencies are very limited and there is no formal integration with the *Corporación Nacional Forestal*⁹ (CONAF), Chile's primary forest and wildfire management agency, or any other fire or emergency management agency at any institutional level.

In contrast to the Chilean spatial planning system, which functions within a hierarchical framework with a disciplinary focus, the implementation of wildfires risk reduction measures requires the consideration of wildfires' non-hierarchical nexus with diverse systems. Wildfire behaviour is influenced by topography, weather conditions, and vegetation or other available fuels (Sullivan et al. 2012); which in their turn have multiple non-hierarchical nexus with different social, economic, and environmental systems that can take place at different scales of time and space, such as climate change or agricultural business and practices (Jones et al. 2020; Urrutia-Jalabert et al. 2018). As previously mentioned, Chile's south-central areas are the most impacted by wildfires, which corresponds with the most populated areas of the country. This also corresponds with the area where forestry plantations are developed, mostly through corporate land-holdings, that have become an important part of the economy of south-central Chile (Instituto Forestal 2018). Even more so, climate change is increasing the occurrence of fire weather (Urrutia-Jalabert et al. 2018). Thus, wildfire hazard, communities, forest plantations, economic

revenues, and global environmental trends, to name a few, are bound together in Chile's wildfires. Ideally, wildfire risk reduction should be integrally addressed by spatial planning, using comprehensive solutions that consider the multiple aspects of the problem through coordinated actions across diverse sectors (Gonzalez-Mathiesen and March 2018; Syphard, Brennan, and Keeley 2017). This implies that spatial planning measures for wildfire risk reduction must consider wildfires' nexus with different complementary or sometimes conflicting systems, and establish institutional arrangements that allow for interdisciplinary approaches and flexibility for local implementation.

These results show the first difference between the Chilean spatial planning system and wildfire risk reduction measures and actions, which corresponds with the first dimension of potential misalignments (structure) (adapted from Healey 2007; Hillier 2007, 2008). The results suggest that the Chilean planning system fails to address wildfires' non-hierarchical nexus with diverse systems, partially, because the planning system functions within a rigid, hierarchical, and sectoral structure. Chile's rigid hierarchical planning system with a narrow disciplinary emphasis and the lack of institutional arrangements that align the agencies' work implies wildfire risk reduction is approached from a sectoral perspective, and the work between agencies and planning levels is uncoordinated and often misunderstood.

4.2. Realm – prescriptive spatial planning of tangible physical directions versus intangible wildfire risk uncertainty

The Chilean system approaches spatial planning through prescriptive regulations concerned with tangible three-dimensional aspects of individual places and structures. The country follows a Civil law system – a system of codified laws with origins in Roman law – which means that only legislative enactments are binding and that judicial decisions do not constitute a binding precedent. This also means that spatial planning and its regulations are approached in the same prescriptive manner. Furthermore, the system addresses urban planning, urbanization, and construction in an integrated manner, focusing on the physical aspects of spatial planning. Thus, regulatory instruments provide prescriptive norms – mainly through land-use plans – that give definite and precise directions with an emphasis on concrete physical aspects that must be met by new development.

In contrast to the Chilean spatial planning system's focus on establishing rigid physical directions for development, wildfire risk reduction measures are determined by attempts to modify risk, which is intangible and associated with potentiality, uncertainty, and chance. Wildfire risk reduction measures are defined based on an evidence-based process of systematic risk assessment and treatment (Ansell and Wharton 1992; ISO 31000, 2018). An essential part of the process is estimating the wildfire risk, considering the likelihood of a natural hazard taking place, and the probable consequences on vulnerable people and properties. Ideally, planning systems attempting to reduce wildfire risk need to accommodate for risk's uncertainty, balancing risk-taking and risk-averse approaches. Establishing a risk-based approach to spatial planning – ideally coordinated and guided at the central level – could contribute to the systematization of the decision-making processes facing wildfire uncertainty so that spatial planning practices can work with potential risks and adapt to the unexpected, balancing other development with wildfire risk reduction considerations (Gonzalez-Mathiesen and March 2021).

Spatial planning's tangible realm versus wildfire risk reduction intangible realm corresponds with the second potential misalignment that constrains the Chilean spatial planning's attempts to address complex challenges (adapted from Healey 2007; Hillier 2007, 2008). These results suggest that the prescriptive rigidity and physical orientation of the Chilean spatial planning system are inherently challenged by problems that do not comply with the system's predetermined categories such as wildfire risk reduction measures. The Chilean spatial planning prescriptive system does not allow for discretionary decisions, causing the system to be very limited in its

ability to establish a risk-based approach that allows balancing risk-taking and risk-averse approaches.

4.3. Spatial scale – one-size fits all spatial planning versus context-specific wildfire risk reduction

Spatial planning in Chile is defined by predetermined standards framed at the national level and operationalized by decentralized allocations of responsibilities, with limited room for context-specific innovation. The planning system is based on codified laws and regulations, and only those are binding. This implies that regulatory plans can only specify elements that are legally grounded in the national legislative and regulatory frameworks. Similarly, the decision to grant a permit is made based only on the application's compliance with the laws and regulations, with no discretion in the decision. Furthermore, the national legislative framework enables DRR at the local levels, but it does not provide any practical guidance or coordination about what constitutes a risk zone, how to designate it, or how to determine minimum planning or building standards. This lack of central guidance is especially problematic within a planning system based on a rigid framework that does not allow for innovative responses at the local level.

Contrasting with Chilean spatial planning's one-size-fits-all national framing, the design and implementation of wildfire risk reduction measures require considering different governance and spatial scales, including the context-specific characteristics of the hazard and exposure. As previously problematized, wildfires have links with diverse systems at different spatial scales, from global to local, that intersect and impact in a unique geographically and temporally situated manner. Any specific wildfire risk depends on the hazard and exposure characteristics particular to each site, its immediate surroundings, and the wider landscape (Gonzalez-Mathiesen and March 2021). This implies that wildfire risk reduction requires to be dealt with at different scales, from global to local, with a context-specific implementation (Moritz et al. 2020). Ideally, systems attempting to implement wildfire risk reduction measures should comprehensively consider them across the different governance and spatial scales the systems operate. For example, this could be approached by centrally establishing measures to coordinate the criteria used to determine wildfire risk and the mechanisms to reduce and mitigate it at the local level through approaches that facilitate considering context-specific characteristics, for instance by requiring site-specific risk assessment in the planning permit process.

The case study findings associated with the spatial scales the Chilean spatial planning system operates versus the fact that wildfire risk reduction must be dealt at different scales, from global to local, with a context-specific implementation, also correspond with the third potential misalignment between planning systems and its complex emergent challenges. Functioning within a centrally defined system can be an advantage for guiding DRR consistently across the territory if diverse scales are considered and flexible arrangements for local implementation are in place. Yet, the results suggest that the centralized one-size-fits-all approach of the Chilean spatial planning system has difficulty dealing with the context-specific characteristics and implementation of wildfire risk reduction measures. This difficulty is exacerbated by the lack of guidance for local implementation of risk assessment and risk reduction measures.

4.4. Territorial boundaries – urban spatial planning system versus wildfires across the landscape with greater risk at the urban-rural interface

The Chilean spatial planning system focuses on urban areas and has almost no capacity to act on rural territories. This is historically rooted in the introduction of the urban boundary in 1891, which created a major regulatory distinction between urban areas and the rest of the territory. Current land-use planning instruments (PRC) focus on urban contexts, and they cannot address issues outside the urban boundary; indicative territorial instruments are nonbinding and have no concrete

integration into the existing regulatory framework. Thus, there is a disconnection between the land-use regulations that focus on urban contexts and the indicative instruments with a territorial focus. Furthermore, the legal urban boundary may not correspond with the actual edges of settlements. Often, the urban boundary is larger than the settlement's footprint, leading to PRC regulating urban areas that are effectively rural without the legal authority to impede forestry plantation. [Figures 1](#) and [2](#) illustrate how ambiguous the distinction between urban and rural can become. In Portezuelo, the urban footprint does not correspond with the urban boundary and the buffer zone established along this boundary. Thus, there is undeveloped 'urban' land used for agricultural purposes which implies that the separation between vegetation and development (and consequent reduction of the exposure to the hazard) is not being achieved by the buffer zone. In Mañihuales, a forest was planted inside the settlement, which creates a source of fuel that increases the fire exposure of the settlement. Even more so, development outside the urban boundary is regulated by general agricultural regulations and landowners have considerable freedom to use their land. Rural land can be subdivided into lots of 5000 m² minimum, allowing for low-density development in peri-urban contexts, and the development of social or affordable housing is also permitted. [Figure 3](#) illustrates a typical development of 5000 m² lots in rural land. This type of development can increase the available fuels, the exposure of people (often not fully aware of their fire exposure or well prepared to respond to an emergency), and the probability of ignition.

In contrast to Chilean spatial planning's artificial distinction between urban and rural areas, wildfire risk reduction requires special consideration of areas where the distinction between urban and rural becomes blurred. In particular, the urban-rural interface areas and peri-urban areas are where lives, properties, and assets are more exposed to wildfires. Furthermore, in wildfire contexts, fire-prone structures themselves can become a hazard, increasing the available fuel and promoting house-to-house fire spread (Cohen and Stratton 2008; Price and Bradstock 2013). Thus, the distinction between urban planning and territorial planning is irrelevant and even detrimental if it is associated with regulatory discrepancies, because spatial planning aiming to manage wildfire risk focuses precisely on the fringe areas where the distinction between urban and rural becomes blurred.

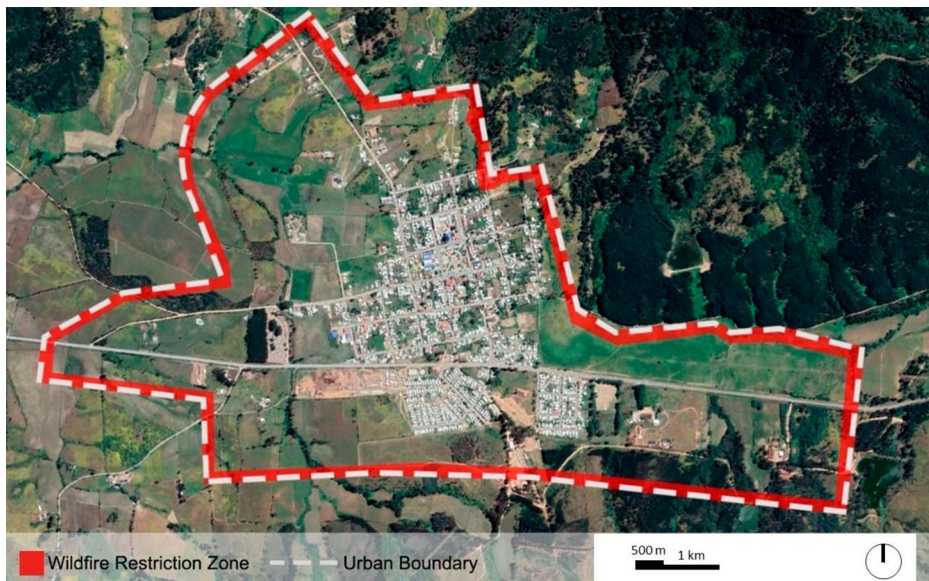


Figure 1. PRC of Portezuelo approved in 2007 and its zone of wildfire restriction surrounding the settlement versus the actual footprint of the settlement (Source: adapted from Google Earth, 2020a; Municipalidad de Portezuelo, 2007).



Figure 2. Villa Mañihuales and a forest plantation inside the settlement (Source: adapted from Google Earth, 2020b; MINVU, n.d.).

The Chilean spatial planning focus on urban contexts versus the need for reducing wildfire risk across the landscape corresponds with the fourth dimension (territorial boundaries) that erodes spatial planning's ability to integrate complex challenges. The results show that the Chilean spatial

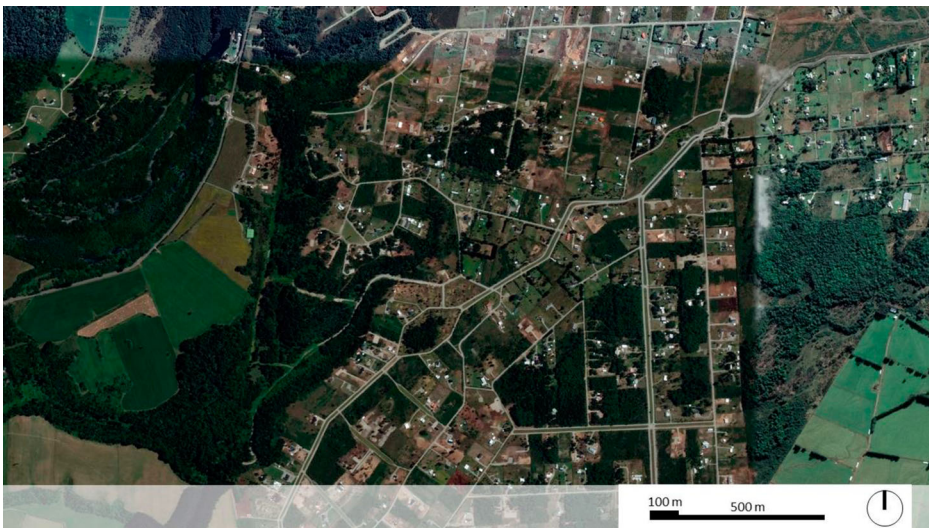


Figure 3. Image showing an example of a typical development of 5000 m² lots in rural land located in the route between Puerto Varas and Puerto Montt. (Source: adapted from Google Earth, 2022).

planning distinction between urban and rural territories for regulatory planning purposes fundamentally challenges the system's capacity to plan and manage fringe areas, where wildfire risks are greater. Furthermore, the fact that urban and rural areas are regulated in such a different manner, especially when the legal boundary and the actual settlement fringe do not correspond, restricts and creates ambiguities for the spatial planning system to promote wildfire risk reduction. The ongoing SERNAFOR law project that intends to introduce the concept of urban-forest interface to provide a legal framework for reconciling the work and approaches of spatial planning and wildfire management systems might contribute to managing fringe areas. Yet, a territorially integrated approach to spatial planning would be a more sophisticated way to increase the Chilean planning system's ability to facilitate wildfire risk reduction in interface areas.

4.5. Time scale – stable medium-term planning versus temporally dynamic wildfires

The Chilean spatial planning system guides settlement change based on three stable timescales, consistent over time: (a) medium-term goals operationalized via permit applications, (b) development characteristics difficult to reverse once constructed, and (c) slow and reactive processes to develop and update regulations and plans. The requirement to apply for a building and planning permit is the main implementation process of the spatial planning system, which results in site-by-site operationalization. Accordingly, the permit process seeks to slowly achieve the medium-term development goals of the spatial planning system. Once development is in place, it is extremely difficult to reverse, and therefore permit approvals have long-term impacts. Furthermore, the processes in place to develop and update regulations and plans are rigid, slow, overly complicated, and politicized. This impacts the content and timing of changes to the planning system and generates a predisposition to promote smaller and less contested adjustments above transformations.

In contrast to the stable processes of change of the Chilean spatial planning system, wildfire risk reduction needs to consider wildfire's dynamic factors across a time spectrum, from very long-term to very short-term. The behaviour of fire is influenced by the topography, weather conditions, and available fuels; these last two are very variable and dynamic through time. Weather conditions are affected by long-term trends, such as climate change; medium-term ones, such as a prolonged period of drought; and very short-term ones, like daily weather temperatures and even precise instances when the wind changes or it starts to rain. Furthermore, available fuels can also vary in the long and short term. Long-time scale influences can be associated with historical clearances to replace forests with prairies and agriculture (Elizalde 1970) or forestry development (Nahuelhual et al. 2012). Also, medium-term changes, for instance, associated with the life cycle of a forest plantation impact the fire behaviour on a context-specific basis. Even more so, the fuel's moisture content is affected by short-term weather cycles. Ideally, a planning system that periodically re-assesses wildfire risk, considering longer-term projections such as climate change trends, for instance, for a 100-year horizon, and medium to short-term scenarios, such as forest plantation life cycles, could contribute to considering the range of temporal scales relevant for wildfire risk reduction.

The different time scales of the Chilean spatial planning system versus wildfire risk reduction measures correspond with the fifth dimension of potential misalignment. The results suggest that the temporal stability of the Chilean spatial planning system is challenged to address wildfires' time scale spectrum in a timely appropriate manner. The Chilean spatial planning operationalization on a site-by-site basis promotes slow, gradual changes mainly through new settlements, which can prevent improving the risk profile of settlements. Including other operationalization strategies, such as the development of infrastructure projects that can play a role in mitigation, could improve the capacity of the spatial planning system to reduce wildfire risk, especially in existing settlements. Furthermore, Chilean spatial planning's processes to develop and update regulations and plans fail to integrate the dynamic temporal changes in weather conditions and available fuels.

5. Conclusions

This study explored the Chilean spatial planning system's limitations to integrate wildfire risk reduction considerations due to the discrepancies and tensions between the Chilean spatial planning's rigid pre-existing approaches and the need for complex responses to accommodate wildfire risk reduction measures. This exploration contributes to explaining why the Chilean spatial planning system, knowing what needs to be accomplished for managing wildfire risk, has been unable to adequately integrate wildfire risk reduction considerations, not knowing how to adapt the system to implement them.

The research shows that the Chilean spatial planning system is constrained in its ability to integrate wildfire risk reduction measures in the five dimensions analyzed: (1) structure; (2) realm; (3) spatial scale; (4) territorial boundaries; and (5) time scale. First, the Chilean spatial planning system functions within a hierarchical legislative and institutional structure with a strong sectoral focus. Conversely, wildfire risk reduction measures have a non-hierarchical nexus with diverse social, economic, and environmental systems. This suggests that the Chilean planning system fails to address wildfires' non-hierarchical nexus with diverse systems, partially, because the planning system functions within a hierarchical and sectoral structure. Second, the Chilean spatial planning is concerned with providing rigid and precise physical directions through prescriptive land-use planning regulations. On the contrary, wildfire risk reduction measures are determined by attempts to modify risk, which is intangible and associated with potentiality, uncertainty, and chance. This suggests that the prescriptive rigidity and physical orientation of the Chilean spatial planning system are limited in their ability to establish a risk-based approach to wildfire risk reduction. Third, the Chilean spatial planning system operates within a one-size-fits-all national framework. In contrast, wildfire risk reduction measures require considering different governance and spatial scales, including the context-specific characteristics of the hazard and exposure. This suggests that the Chilean spatial planning system fails to deal with the context-specific design and implementation of wildfire risk reduction measures, partially, due to its centralized one-size-fits-all approach. Fourth, the Chilean spatial planning system focuses on urban areas, and it has almost no capacity to act on rural ones. Conversely, wildfire risk reduction measures need to be implemented across the landscape, particularly in the urban-rural interface areas. This suggests that the Chilean spatial planning urban focus fundamentally challenges the system's capacity to promote wildfire risk reduction in interface areas. Fifth, the Chilean spatial planning system sets stable medium-term goals. In contrast, wildfire risk reduction needs to consider wildfire's dynamic factors across a time spectrum, from very long-term to very short-term. This suggests that the Chilean spatial planning system is challenged to address wildfires' time scale spectrum in a timely and appropriate manner, partially, due to its temporal stability.

The analysis of this case study contributes an applied illustration of a spatial planning system that in practice is inherently challenged by a problem that does not comply with its predetermined mechanisms. It provides an applied example of the key dimensions that suggest potential misalignments between long-established planning systems and emergent wider challenges (adapted from Healey 2007; Hillier 2007, 2008). The results provide a practical example of the extent that pre-existing approaches can condition and limit the possibilities for change as argued by Flyvbjerg (1998). This research suggests that major improvements to some long-established spatial planning systems are needed for solving the tensions between the rigidity of regulations within which they conventionally operated and the need to deal with diverse, and sometimes conflicting challenges, such as climate change or income disparities. Accordingly, the five dimensions analyzed can suggest a starting point for identifying and overcoming the barriers to action in cases when planning seems to be failing to address a particular problem.

This analysis also provides insights into the limitations spatial planning systems might have when trying to integrate with wildfire risk reduction, which contributes to explaining why spatial planning systems struggle to act on wildfire risk comprehensively (Groenhart, March, and Holland

2012; Leone and Tedim 2020). Rigid and sectoral spatial planning institutional and regulatory frameworks can be challenged in being able to address wildfire's multiple nexus points with social, economic, and environmental systems. Stable planning systems with medium-term goals can be constrained to adequately address wildfires' temporal scale spectrum. Overly focusing on prescriptive regulations with a physical orientation can difficult dealing with wildfire risks and their dynamic uncertainties. Centralized one-size-fits-all approaches might have difficulties dealing with the context-specific characteristics of wildfire risk. Artificial distinctions between urban and rural territories for regulatory planning purposes fundamentally difficult planning and managing fringe areas, where wildfire risks are greater. Overall, understanding these discrepancies and the practical limitations they imply suggests a starting point for the development and implementation of wildfire risk reduction measures and practices via spatial planning.

Notes

1. Fire storm
2. Ministry of Housing and Urbanism
3. Regional Ministerial Secretariat
4. General Law of Urbanism and Constructions
5. General Ordinance of Urban Planning and Constructions
6. Communal Regulatory Plan
7. Comptroller General of the Republic
8. National Forest Service
9. National Forestry Corporation

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