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# From Disaster Risk Construction to Disaster Risk Reduction: Exploring the Agency of Urban Land-Use Planning in Chile

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## ABSTRACT

This paper explores how the existing urban land-use regulatory framework and its associated planning practices in Chile have contributed to disaster risk construction in urban areas. It uses Actor Network Theory as an analytical framework, and in-depth interviews and focus groups to analyse the existing urban land-use regulatory framework and its innovation process. Drawing on the knowledges and perception of practitioners, and the revision of a case study, the paper unpacks the agency of the existing urban land-use regulatory framework in enhancing disaster risk, and how its rigidity and the obstacles for its modification, prevents the advance towards disaster risk reduction.

## KEYWORDS

Urban land-use; regulatory framework; disaster risk reduction; Actor Network Theory

## Introduction

Urban Land-Use Planning has been considered as a relevant dimension for advancing towards Disaster Risk Reduction (DRR). Several studies addressing the intersection between disaster risk and urban development highlight that the lack of LUP contributes to the increased exposure and vulnerability of urban settlements (Castro *et al.*, 2015; Jaque *et al.*, 2017; Moris *et al.*, 2017). Moreover, the existing international framework for DRR, such as the Hyogo Framework 2005–2015, and more recently the Sendai Framework 2015–2030, have underlined the role of LUP practices, policies and management as a relevant dimension to be systematically incorporated at local and national levels in order to address the exposure and vulnerability of urban settlements (Yamin *et al.*, 2013; UNISDR, 2005; 2015).

However, the existence of urban LUP systems does not ensure the implementation of DRR practices. The extent to which urban LUP could be considered as an approach for DRR will largely depend on its regulatory framework as it sets the parameters to prevent urban construction in hazard-prone areas, establishes land-uses and urban development restrictions, and influences the planning practices and cultures embedded at national and local levels. Furthermore, the adaptation of the existing LUP systems towards DRR will largely depend on the extent to which disaster risk is incorporated into the regulatory framework that supports it, as it sets the normative parameters for defining disaster risk, the scope for addressing the existing vulnerabilities, the extent to which private property

could be limited in order to reduce exposure, as well as the scope for planning practice and innovation.

In fact, Chilean urban settlements are characterised by conditions of high vulnerability and exposure to natural hazards, despite the application of the existing urban land-use regulatory framework through land-use plans. Moreover, the 2010 earthquake and tsunami resulted in widespread questioning of the existing urban land-use regulatory framework and its contribution to DRR, particularly since planned urban settlements were highly impacted (Camus *et al.*, 2016; Lagos *et al.*, 2008; Moris *et al.*, 2017; OECD, 2013). However, since the 2010 earthquake and tsunami, a series of innovations have been proposed to the existing urban land-use regulatory framework in order to enhance the role of the urban LUP system towards DRR (MINVU, 2015).

Thus, our paper explores how the existing urban land-use regulatory framework in Chile has contributed to disaster risk construction in urban areas, as well as how the proposed innovations could enhance its role in DRR. The study reviews existing academic literature regarding the role of urban planning in the processes of disaster risk construction, as well as in-depths in the knowledges and perceptions of planning experts and practitioners regarding the role of the existing urban land-use regulatory framework in disaster risk construction. Second, the study revises the case of the urban settlement of Alerce in Southern Chile, which was planned as a satellite city to the city of Puerto Montt in order to provide an integral response to the local housing needs, that would be urbanised with dwellings, several services, public spaces and facilities, as well as an industrial site to provide economic development and employment opportunities for its inhabitants, but due to a series of planning and implementation gaps (Crisosto & Salinas, 2017; Surawski, 2006), its development resulted in urban segregation and in the increasing social and economic vulnerability of its inhabitants (Municipalidad de Puerto Montt, 2016; MINVU, 2011).

Finally, the research draws on Actor Network Theory as an analytical framework considering, on one hand, the principle of *generalised symmetry*, in order to explore the agency of the existing urban land-use regulatory framework as a *non-human* intermediary between urban development and natural hazards, and on the other hand, adopting the notion of *translation* in order to unpack the process of innovation of the existing urban land-use regulatory framework towards DRR and its limitations.

## Literature Review

### *Disaster Risk Construction and Urban Land-use Planning*

The idea that disasters are not only a consequence of natural hazards, but to a great extent, of social conditions and interventions on the environment, has enhanced the way in which disaster risk construction is understood and addressed (Adger, 2006; O'Brien *et al.*, 2007; Pelling, 2003). In urban contexts, disaster risk construction is conceived as a coevolutionary process between human and environmental realms. Pelling (2003) suggests that 'there is no simple one-way line of causality in the production of human or environmental conditions: "nature" does not cause "natural disasters"; rather risk in the city is an outcome of a myriad of feedback loops and thresholds and competing ideas, mechanisms and forms', and thus, there is a bidirectional relation between urbanisation and disaster risk (Norgaard, 1994; O'Brien *et al.*, 2007; Pelling, 2003, p. 7).

In fact, disaster risk in Chilean urban settlements is associated with the progression of vulnerability (Blaikie *et al.*, 1994; Wisner *et al.*, 2004), characterised by a series of root causes, dynamic pressures and unsafe conditions which are described by several authors, illustrating disasters as a result of uneven processes of development and coevolutionary processes between society and the environment (Figure 1) (Castro *et al.*, 2015; Sandoval & Sarmiento, 2018; Moris *et al.*, 2017).

Considering that urban LUP is regarded as a relevant factor of urban development, it is important to unpack its role within the processes of disaster risk construction in Chile. In fact, in Figure 1, it is possible to identify a variety of vulnerability factors that are directly or indirectly associated with the existing urban land-use regulatory framework and planning practices. These include *Root Causes* associated to neoliberal dynamics that impact the urban environments through the liberalisation of urban land markets, as well as *Dynamic Pressures* associated with the lack of permanent building restrictions in hazards prone areas, the lack of appropriate regulations of the local land market, or access to social and affordable housing, which are also influenced by *Macro-Forces* such as rapid urban growth and speculation of real estate investment (Sabatini & Arenas, 2000; Boano & Vergara-Perucich, 2017; Navarrete-Hernandez & Toro, 2019). On the other hand, several *Unsafe Conditions* are also associated with the existing urban land-use regulatory framework, such as poor connectivity and evacuation systems, exposed

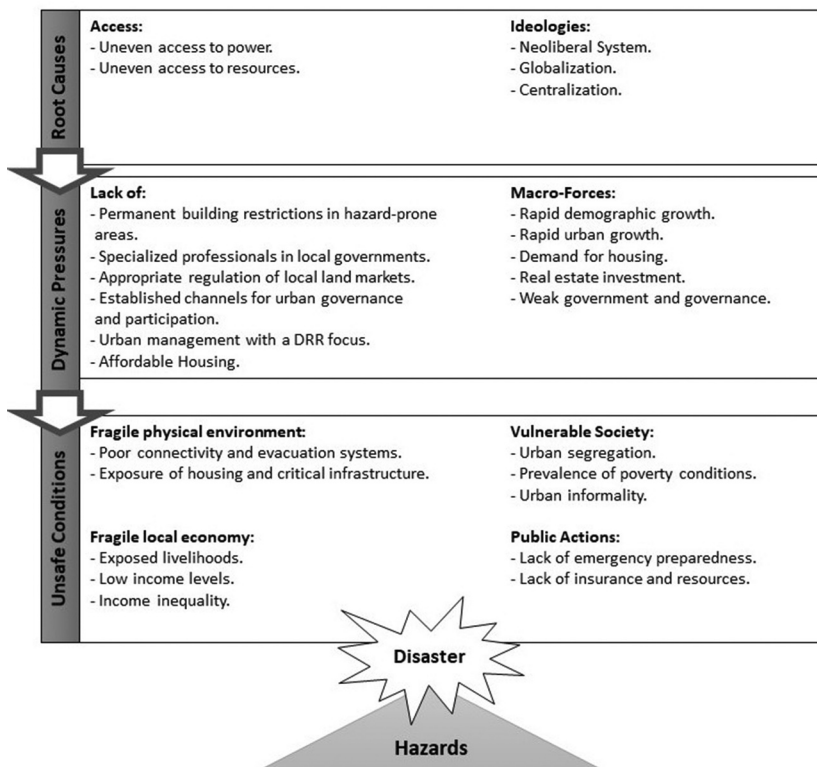


Figure 1. Disaster risk construction in urban settlements in Chile.

livelihoods, urban informality, among others (Castro *et al.*, 2015; Sandoval & Sarmiento, 2018; Moris *et al.*, 2017).

In this regard, a considerable amount of literature has argued that urban LUP has a potential role for reducing tensions between coevolutionary processes of disaster risk construction in urban areas (Castro *et al.*, 2015; Jaque *et al.*, 2017; Moris *et al.*, 2017; Yamin *et al.*, 2013; UNISDR, 2005; 2015). In fact, it has been highlighted that ‘effective land-use planning in areas that are subject to, or potentially subject to, natural hazards can significantly reduce the increase in disaster risk and enhance the resilience of existing and future communities’ (AIRD, 2020, p. 7), where its ‘effectiveness’ should consider ‘collaborative approaches across a range of sectors and capabilities’, confirming the pivotal role of practitioners and communities in the planning process (AIRD, 2020, p. 1).

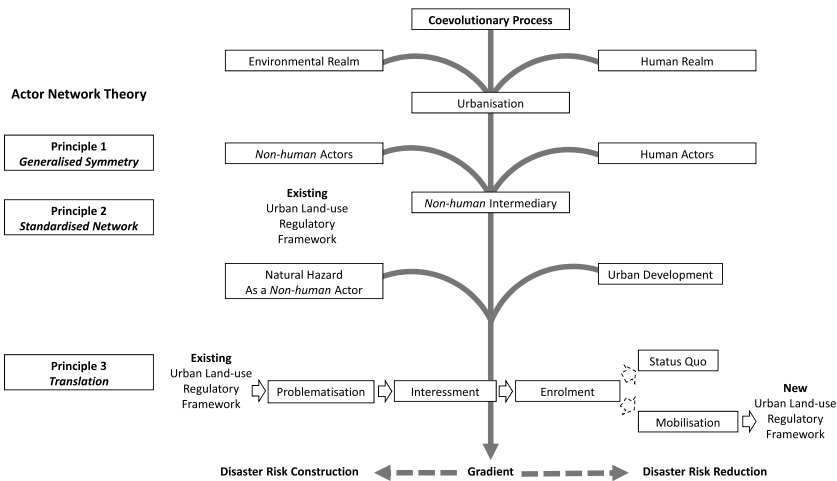
Nonetheless, the extent to which LUP contributes to DRR has been questioned both in research and in practice. Mertens *et al.* (2018) have brought attention into the limitations of LUP as a precautionary measure, recognising that ‘there is still little understanding of internal constraints that hamper land use management for DRR in the Global South’ (Mertens *et al.*, 2018, p. 78). Moreover, research has also recognised the need to challenge the planning rationalities that have been imported from the Global North to the Global South, where ‘master planning, zoning and visions of urban modernism are still the norm’, and which generally lack consistent considerations of the inherited institutions and the increasing complexities experienced by the communities which they seek to intervene (Watson, 2009, p. 2260).

These coincide with the fact that LUP in Chile presents significant challenges when interacting with historical processes of disaster risk construction, when addressing the vulnerability of the communities, when preventing the exposure of urban settlements, and when implementing land-use restrictions, among others, revealing the limitations of the existing normative and institutional framework that supports it (Camus *et al.*, 2016; Lagos *et al.*, 2008; Organization for Economic Cooperation and Development – OECD, 2013). In this regard, this research contributes to explore the role of the existing urban land-use regulatory framework in disaster risk in Chile, which has been rendered by planning experts and practitioners, as a central dimension to be modified in order to advance towards DRR.

## Actor Network Theory as an Analytical Framework

This paper draws on Actor Network Theory (ANT) as it provides a novel analytical framework to explore the role of *non-human entities* such as the existing urban land-use regulatory framework in the processes of disaster risk construction, complementing the idea of disaster risk as a coevolutionary process between human and environmental realms. The use of ANT in this study is used to unpack the pivotal role of the existing urban land-use regulatory framework and land-use plans as *non-human* intermediaries within disaster risk construction and DRR (Figure 2).

ANT provides three relevant principles for analysing the relationship between the existing urban land-use regulatory framework and disaster risk. First, the principle of *generalised symmetry* contributes to understand the social phenomenon as a ‘co-construction of natural and social entities’, assuming that both human or *non-human*, natural or technological entities could constitute actors with direct or indirect roles in the construction of the social (Callon, 1986; Justesen, 2020; Murdoch, 1997; 1998, p. 740).



**Figure 2.** Actor Network Theory as analytical framework for DRR.

Thus, the principle of *generalised symmetry* between the human and *non-human* allows us to conceive the existing urban land-use regulatory framework as a *non-human* intermediary with an important role (here after referred as *agency*) in disaster risk construction and DRR (Miles *et al.*, 2012; Rydin, 2012).

On the other hand, ANT allows to interpret the existing urban land-use regulatory framework as a *standardised network*, characterised by spaces of prescription and norms, which determines and conditions the existing planning practices. As well, the process of *translation* provides a systematic approach for the analysis of the existing innovation process towards a new urban land-use regulatory framework (Arnaboldi & Spiller, 2011). Thus, these principles complement the concept of disaster risk, emphasising the *agency* of *non-human* entities in disaster risk construction and DRR, such as the existing urban land-use regulatory framework and natural hazards (Kennry & Phibbs, 2015; Salter, 2019).

One of the main analytical tools in the Actor Network Theory is the process of *translation*. *Translation* refers to the processes of negotiation by which roles and identities are defined resulting in the processes where networks are assembled and re-assembled (Callon, 1986; Rydin, 2012). For this research, the process of *translation* is used to characterise the innovation process of the existing land-use regulatory framework. Finally, it is important to highlight that ANT has been used both in planning (Rydin, 2010; 2012) and disaster risk studies (Kennry & Phibbs, 2015; Miles *et al.*, 2012; November & Laenza, 2015), and thus, this paper constitutes an attempt to further complement the analysis of both urban LUP and DRR through an ANT framework, expanding the application of ANT as an analytical approach (Salter, 2019).

## Materials and Methods

### Data Collection

Collection of primary data was conducted through semi-structured in-depth interviews and a focus group. In-depth interviews provided the flexibility to inquire on predefined topics

and engage in new topics raised during the interview (Flick, 2007; Seidman, 2006). A total of 16 interviews were conducted during June and July 2016 with planning experts and practitioners at national, regional and local levels, all representatives from diverse sectors such as central government, academia, private sector and local government. Topics discussed comprised the role, limitations, and advantages of the existing urban land-use regulatory framework and its associated planning practices for DRR, as well as for the proposed modification. Even though interviews were conducted in 2016, the conditions of the existing urban land-use regulatory framework in Chile has not experienced significant changes.

A focus group was conducted in the community of Alerce in March 2017, particularly with local leaders from a broad range of neighbourhoods within Alerce. The focus group was designed as an opportunity to share concerns regarding the urban transformation of Alerce, recurrent natural-hazard events that affect the community, as well as the strengths of the community towards DRR, providing an opportunity to observe and explore collective argumentation regarding urban transformations and disaster risk construction (Steyaert & Bouwen, 2004).

### **Data Analysis**

Data analysis was conducted through thematic analysis of the interviews and focus group, which consists of “a method for identifying, analysing and reporting patterns (themes) within data (Braun & Clarke, 2006, p. 79). In this context, the analysis of qualitative data was conducted through iterative reading, identifying emerging themes (Fereday & Cochrane, 2006). The analysis of data was inductive, also known as data-driven, where ‘the researcher carefully reads and rereads the data, looking for key words, trends, themes, or ideas in the data that will help outline the analysis’ (Guest *et al.*, 2012, p. 7). Results obtained were incorporated systematically into the analysis.

Considering the potential limitations of a qualitative methodology based on in-depth interviews with planning experts and practitioners, as well as on a focus group with the inhabitants of Alerce, it is important to mention that the results demonstrate considerable consistence. On the one hand, the inhabitants that participated in the focus group expressed significant concern regarding their exposure to natural hazards due both to recurrent flooding events, as well as to the recent occurrence of a volcanic eruption which caused high distress among the population. On the other hand, in order to lessen potential biases, we interviewed planning experts and practitioners with a recognised professional career and expertise at national level, with vast experience in planning.

## **Results**

### **Exploring the Knowledges and Perceptions of Planning Experts and Practitioners**

#### **The Role of the Existing Urban Land-use Regulatory Framework and Disaster Risk**

The existing urban land-use regulatory framework in Chile can be interpreted as a *standardised network* composed of laws, norms, and procedures which frame the existing urban land-use and planning practices. The existing regulatory framework is composed by the General Law of Urban Development and Construction – LGUC and its General Ordinance – OGUC (Gobierno de Chile, 2005; 2016). This framework defines

a set of statutory LUP instruments, also known as LUPs, with different scales and regulatory competencies, as well as documents, procedures, actors and institutions which frame the existing planning practice. LUPs set the land-uses and construction regulation norms at local-municipal and inter-municipal levels.<sup>1</sup> In this opportunity, the research focuses on the case of local-municipal LUPs, also known as *Planes Reguladores Comunales* – PRCs.

Regarding the incorporation of DRR into the existing urban land-use regulatory framework, one of the main contributions is the Article N°60 of the LGUC. This article introduces the idea that LUPs can define areas where permanent buildings are restricted due to their nature and location, which is detailed in the Article N° 2.1.17 of the OGUC. These zones are defined both as ‘areas where building is restricted’, or ‘risk-areas’. The first refers to areas for the protection of hazardous infrastructure, and the second, to areas where certain kinds of buildings are restricted due to safety reasons. ‘Risk-areas’ are defined by a ‘risk study’, based on a list of predefined ‘risk conditions’. At the same time, the Article N° 2.1.17 of the OGUC enables the implementation of mitigation measures to authorise the localisation of buildings in risk areas. In this case, the request for a building permit must be accompanied by a ‘risk-founded study’ prepared by a specialist and approved by the competent authority to determine the actions to be implemented for its use.

In the following section, we address the knowledges and perceptions of planning experts and practitioners, regarding the relationship between the existing urban land-use regulatory framework and disaster risk. It is possible to perceive the role attributed by practitioners and planning experts to the existing regulatory framework as a *non-human intermediary* between urban development and natural hazards.

### **Disaster Risk within the Urban Land-use Regulatory Framework**

Practitioners and planning experts consider Article N° 2.1.17 and LUPs as an opportunity for DRR, but only if the identification of natural hazards is combined with adequate land-use regulation norms. At the same time, Article 2.1.17 and LUPs are considered as the only legally binding instrument that incorporates the concept of risk into urban development at national and local levels.

*(Regarding Article 2.1.17) ‘... I think it is a great contribution to use the concept of an area that might be susceptible (to a natural hazard) ... if you were only to consider the geology criteria you are already doing a great contribution in terms of disaster risk reduction, as you are saying that in the worst case scenario, you could experience certain losses ... it is very valuable, as on this basis, planners can reduce disaster risk in terms of land-use ...’ (Expert in Natural Hazards)*

*‘... from the point of view of prevention, it is the only instrument that could impose a restriction to private property, the rest is just good practice ...’ (Urban Planner-A)*

However, practitioners and planning experts highlight two main problems regarding the definition of risk in Article N° 2.1.17. First, the concept of risk used in the OGUC, is not really disaster risk, as it only refers to the spatial identification of natural hazard, providing general notions of exposure, but not considering other variables such as vulnerability or adaptation. Second, the existence of risk-areas does not impose a restriction to urban development as they can be mitigated at any time. In fact, LUPs



provide land-use regulation norms for the risk area to be applied once the 'risk' is mitigated, raising concern regarding those areas where risk cannot be mitigated.

*'... by definition, a risk-area is restricted to urban development that can be used under certain conditions, as long as the user ensures that the risk will be mitigated, but the risk-area does not disappear ... it will depend on the LUPs which conditions sets for the use of risk-areas ...'* (Planning Expert-B, Ministry of Housing and Urbanism -MINVU)

*'... there is a use for the land, you have to define it, you cannot just define the risk-area, that is why I say that the concept in the legal framework is that risks are always mitigatable, and that is not real, not all risks are mitigatable ...'* (Urban Planner-B)

On the other hand, practitioners and planning experts mention that Article N° 2.1.17 lacks specificity in two relevant aspects. First, it does not provide a clear definition of the role and responsibilities of the specialist that defines the risk-area or conducts risk assessments. Moreover, it does not define the basic content to be included in the risk assessments conducted to set mitigation measures, nor the review process, including the composition of the review's competent body. Second, the existing classification of natural-hazards is too broad compared to the existing methodologies for its assessment, which imposes further methodological challenges when defining risk-areas and potential land-uses.

### **Limitations to Planning Practice and the Role of Local Governments**

In this context, planning practice has been confronted with a problem when dealing with disaster risk due to the lack of a formal methodology for both risk assessment and for the definition of land-use regulations in risk prone areas. Regarding risk assessment, there is lack of a formal methodology for defining risk prone areas, which in general, is only based on the definition of natural hazard, adding up to a limited scope of the assessment, and thus, leaving the definition of the 'acceptable risk' to the expert's criteria.

*'... there is no regulation or guidance to tell us which methodology to follow ... the scope of the assessment (of natural hazards) is one of the major problems, which has to do with the scale of analysis, and to set the criteria of what sometimes is called the "acceptable risk" ... this is related to the maximum probable event that you will make the planning regulation responsible for ... until now, it is something completely subjective, left to the expert's criteria ...'* (Expert in Natural Hazards)

On the other hand, practitioners also mention that the lack of a defined methodology or technical criteria for the definition of the land-uses in risk prone areas, to be applied once the mitigation measures are approved, makes the process very subjective and subject to political influences at the local level.

*'... there isn't a defined process to determine the best land-use regulation, until now it is only technical criteria which is influenced by a political guideline, but there is no clear procedure to say, you know what, the best land-use regulation comes from an assessment of natural hazards, and vulnerability, and this is calculated by ...'* (Urban Planner-A)

*'... there are cases when a risk study is not approved (by the local municipal council) because the risk areas are not politically convenient ...'* (Expert in Natural Hazards)

In this regard, planning experts and practitioners highlight the importance of local governments as owners of the local LUPs (PRCs), having a key role in the definition of

risk prone areas and land-use regulations to be applied, particularly when methodological and technical criteria are not defined by the existing regulatory framework. In fact, local governments are the organisms in charge of approving risk assessments studies for risk mitigation and for approving the building permits in those areas. However, there are significant differences between municipalities in Chile, particularly in terms of funding, human capital, among others (OECD, 2013; Vial, 2016), which also impacts the development of LUPs and the incorporation of DRR within urban development. It is important to highlight that Municipalities are autonomous in terms of local territorial management.

*‘... in larger municipalities it is likely to have a counterpart for technical dialogue... but in smaller municipalities that does not happen...’ (...)* *‘... the quality of interactions will depend on the size and resources of the municipality...’ (Expert in Natural Hazards)*

### **Restrictions to Innovation and Planning Practice**

Practitioners mentioned that the limited scope and outdated character of the urban land-use regulatory framework is holding back the incorporation of technical advances and innovation, such as the incorporation of new scientific methodologies for the assessment of natural hazards, or the incorporation of vulnerability into the risk analysis.

*‘... learning from these disasters has put a strong emphasis in the vulnerability of urban settlements, which we are recently incorporating within the risk-studies of LUPs, is not enough to just incorporate natural hazard... but at the end, we know that we will crash with the National Audit Office... and this is the problem...’ (Urban Planner-B)*

In this context, the National Audit Office, which is the entity that revises and enforces compliance of the LUPs with the existing regulatory framework (Article 2.1.17), reinforces the *agency* of the existing urban land-use regulatory framework in disaster risk construction.

*‘... the problem is that the plans end up being encroached when you have to approve them legally, and that is the problem, you bring a good technical foundation, but you find the norm (Article 2.1.17), which starts to cut, and cut, and cut, for it to be published and approved by the National Audit Office... we are doing urban land-use planning with advanced technical knowledge but with a “Precambrian” legal framework, and these two things are not talking...’ (Urban Planner-A)*

### **Potential Contributions of a New Urban Land-use Regulatory Framework for DRR**

The weaknesses of the existing urban land-use regulatory framework that contributes to disaster risk construction were heightened after the 2010 earthquake and tsunami in Chile. One of the major evidences was that the tsunami hazard was not incorporated as a ‘risk’ in Article 2.1.17 of the OGUC, resulting in the high impact of coastal urban settlements. Since then, the Ministry of Housing and Urbanism (MINVU) has engaged in a series of modifications of the existing urban land-use regulatory framework focusing on strengthening its role for DRR.

With the enactment of the Law 20.582 in 2012, the existing urban land-use regulatory framework was modified in order to support the reconstruction process within areas affected by a catastrophe, providing planning guidelines to accelerate the development of

local and inter-municipal land-use plans of the affected areas (Ministerio de Vivienda y Urbanismo – MINVU, 2012). As well, in 2015, MINVU published a decree which proposed further modifications to the Law 20.582 in order to improve the planning processes for reconstruction, but also, to improve the role of the Article N° 2.1.17 of the OGUC within DRR, which is the focus of this research.

In this regard, there are three central innovations proposed by the MINVU in terms of the assessment, prevention and mitigation of disaster risk at a national level towards DRR (Ministerio de Vivienda y Urbanismo – MINVU, 2015). First, to change the concept of risk contained in the OGUC, incorporating the dimensions of exposure and vulnerability. Second, the idea to return to the paradigm set in the Article N°60 of the LGUC, which states that urban LUP instruments have the faculty to restrict urban development in certain zones, particularly for risk-areas. Third, it proposes new natural hazards and establish a methodology for developing risk studies. It is important to highlight that since 2018 the innovations proposed in the decree (Ministerio de Vivienda y Urbanismo – MINVU, 2015) have been treated separately, as it was decided to make a distinction between ‘Risk’ and ‘Reconstruction’. However, the nature of the modifications to the Article N° 2.1.17 of the OGUC remains the same (MINVU, 2015).

With respect to the proposed innovations of the Article N° 2.1.17 towards DRR (Ministerio de Vivienda y Urbanismo – MINVU, 2015), practitioners and planning experts recognise them as significant improvements towards DRR. One of the most relevant improvements is that risk-areas will be understood as restricted to urban development, and that building in risk-areas will only be considered as an exception, increasing the requirements to grant building permits to discourage building in those areas.

*‘... at last we are going to start talking about the real ‘disaster risk’, as before we thought that natural hazards were the equivalent to risk, we all thought that the risk was the earthquake, the tsunami ...’ (Planning Expert-B, MINVU)*

Furthermore, planning experts mention that the definition of a methodology for developing risk studies will provide a common minimum ground, which will level out the quality of these studies between municipalities. The latter is particularly relevant considering that practitioners highlight that the uneven conditions and resources of municipalities are reflected in the LUP process, since municipalities with fewer resources tend to establish lower requirements.

*‘... we wanted to ensure a minimum common ground... make the process more transparent and detail all the contents, in order to avoid studies that only present studies of natural hazards, because sometimes PRCs (LUPs) were only designed with that, and not including vulnerability ...’ (Planning Expert-B, MINVU)*

Nonetheless, practitioners identify certain aspects that are not being considered and that could hinder DRR efforts. These include the lack of definition of the acceptable level of risk and the criteria to assess it, and the lack of discussion regarding technical criteria for defining land-use regulation norms in risk areas.

*(The proposed modifications) ‘... do not define the levels of ‘acceptable-risk’, or the criteria to measure hazards... probably they will incorporate it after... and it does not define the scale of detail ...’ (Expert in Natural-Hazards)*

*‘... it is not discussing the land-use regulation to be applied in risk areas ...’ (Urban Planner-A)*

At the same time, planning experts and practitioners involved in the modification, consider that one of the greatest limitations has been dealing with the legal importance of private property rights, as new requirements for building in risk areas could impose further restrictions for the use of private property, which has resulted in significant delays in the approval of the modifications, in addition to a change of government in 2018. However, practitioners and planning experts continue to suggest that the proposed innovations constitute a significant improvement towards DRR, even though the advances may be achieved within a longer time-framework.

*‘... as the National Audit Office ensures to enforce the legal framework, it is also trying to protect private property rights, demanding us to be as objective as possible in defining restrictions in order to prevent any future objection that could potentially lead to a litigation related to a building permit ...’ (...)* *‘... the National Audit Office is right, but they are very concern and have being doing several modifications ... therefore it has taken longer to finish the modification ...’ (Planning Expert-B, MINVU)*

The proposed innovations also match the approval of the National Policy for Urban Development – PNDU (MINVU, 2014), as well as other policy innovations that contribute to DRR, such as the recent National Policy for Disaster Risk Management – PNGRD (ONEMI, 2014) and its associated National Strategic Plan for Disaster Risk Management – NSPDRM 2015–2018 (ONEMI, 2015), which is being updated for the 2020–2030 period. In all cases, LUP is considered as a key component for DRR.

Overall, the identified restrictions imposed by the existing urban land-use regulatory framework regarding concepts, responsibilities and planning practice, reflect the role of this framework as a *non-human* intermediary between urban development and natural hazards, as it enforces the way in which disaster risk factors are incorporated in urban areas, and it also limits the way in which practitioners can innovate regarding disaster risk assessment and the definition of urban land-use criteria. In light of this, practitioners and planning experts consider the recently proposed innovations as a significant advance towards DRR, where a new concept of disaster risk will bring the opportunity to incorporate vulnerability and exposure analysis into planning practices, as well as the possibility to level out the quality of municipal disaster risk studies.

However, practitioners are cautious regarding two relevant dimensions that are not being considered within the proposed modifications: 1) the lack of definition of the acceptable level of risk, and 2) the lack of delineations regarding the land-uses to be applied in the risk areas, which could hinder the role of urban LUP in DRR efforts. In this context, the following section analyses the extent to which LUPs have contributed to disaster risk construction, looking at the example of the urban settlement of Alerce, Municipality of Puerto Montt, Chile.

### ***The Agency of the Existing Urban Land-use Regulatory Framework in Disaster Risk Construction: The Case of Alerce***

The satellite city of Alerce constitutes an insightful case for exploring how urban planning has contributed to the construction of disaster risk in intermediate cities in

Chile, for two significant reasons. First, it was planned in order to provide a comprehensive response to the increasing pressures for urban development and housing needs of the city of Puerto Montt, but due to a series of planning and implementation gaps (Crisosto & Salinas, 2017; Surawski, 2006), its development resulted in urban segregation and an increasing social and economic vulnerability of its inhabitants (Municipalidad de Puerto Montt, 2016; Ministerio de Vivienda y Urbanismo – MINVU, 2011). Second, it reflects the role of LUPs in disaster risk construction, as it was located on a hazard-prone area despite fulfilling the requirements of the existing urban land-use regulatory framework.

The idea of developing the historic settlement of Alerce (Figure 3) dates back to 1964, when the architect Juan Leonhardt developed the concept of a satellite city in order to respond to the increasing demand for housing and urban development of the city of Puerto Montt (Monje, 2015; Crisosto & Salinas, 2017). However, the decision to build Alerce took place years later during the 1990 with the return to democracy in Chile, coinciding with the need of modernising urban development and responding to the historical lag for affordable housing at national and local levels. The dynamic growth of the city of Puerto Montt since its industrialisation in the 1990s resulted in development pressures and in the increment of land value within the city (Borsdorf *et al.*, 2008), that added to the immigration from rural areas, lead to an increasing demand for social housing demand, resulting in the governmental decision of developing Alerce, as it offered a rapid availability of reasonably priced land (Rovira, 2009).

Alerce meant an opportunity for ‘improving the traditional framework of social housing solutions, creating a multi-social (socially heterogeneous) urban centre’ which would ‘offer a superior quality of life’. At the same time, its location at approximately at

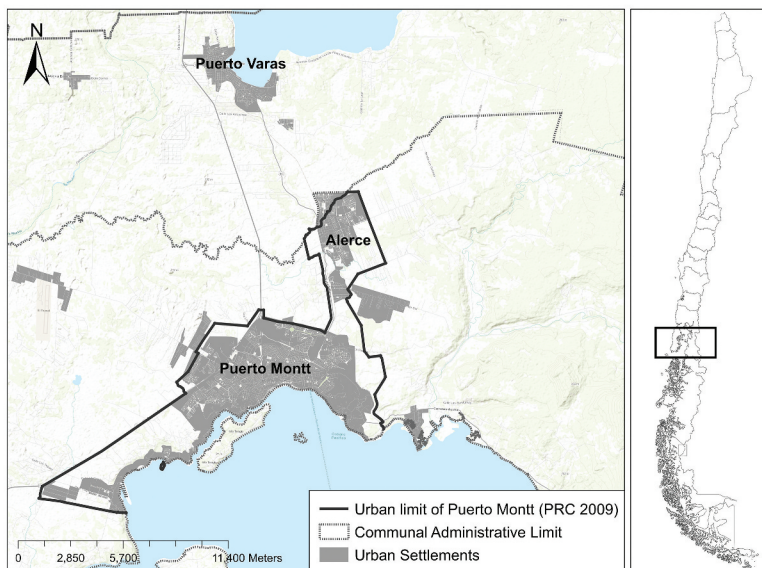


Figure 3. Localisation of Alerce.

7 km north of the city of Puerto Montt, offered ‘exceptional conditions for the development of a comprehensive and harmonious city project’ (MINVU, 1999, p. 111). Thus, this mega-urban project considered the development of both social and affordable housing, urban and social infrastructure for the provision of adequate levels of quality of life, as well as an industrial zone to provide employment opportunities and some sort of ‘independence’ from the city of Puerto Montt (Crisosto & Salinas, 2017, p. 239).

The project also considered a different governance structure, where the Direction of Urban Projects (DPU), created in 1997 to provide for a central and organic planning structure, would be articulated with private and public actors at the local level, and would coordinate the planning process and its implementation. Additionally, a public investment agenda for the City development was set-up, where different sectors would contribute in different proportions, adding to CLP 51.252 million (Crisosto & Salinas, 2017; Surawski, 2006). Through the modification of the Puerto Montt-municipal land-use plan, Alerce was incorporated into the urban area of the city in 2001 (PRC of 1990). As a satellite city, Alerce began an accelerated process of urban development (Municipalidad de Puerto Montt, 2001a; 2001b).

Since then, Alerce has experienced a significant urban sprawl and population growth. The built urban area practically tripled from approximately 125 ha in 2000 to 485 hectares in 2016, and its population increased from 2,777 inhabitants in 2002 up to approximately 42,267 inhabitants in 2017 (INE, 2019). The development of Alerce has been mainly residential characterised by the construction of social housing, as it was the destination settlement for the resettlement program conducted by the *Chile Barrio*, which relocated at least 3000 families in Alerce between 2000 and 2006 (Borsdorf *et al.*, 2008), from informal land-occupations located in areas susceptible to landslide and flooding hazards within the city of Puerto Montt, such as *Ladera MacIver*, *Ladera Lyntz*, among others, which represented a major risk for the population (Castro *et al.*, 2015; Kapital Social Consultores, 2011).

Both the resettlement program and the high concentration of social housing have resulted in the urban and social segregation of low-income households within Alerce. In fact, a study conducted by the MINVU (2011), recognised a considerable concentration of low-income households, low educational levels, and high levels of temporary or casual employment in Alerce. Moreover, within the development of the Communal Development Plans for the periods of 2011–2017 and 2017–2026, it was argued that the inhabitants of Alerce were subject to poor condition of quality of life and urban segregation due to the lack of social and urban services and the lack of a comprehensive social and economic development (Kapital Social Consultores, 2011; Municipalidad de Puerto Montt, 2016), representing a contradiction and distancing from the initial planning objective of the satellite city.

In this regard, it is important to highlight that despite the scope of the satellite city project, its novel comprehensive planning rationale, and the allocation of fresh resources for its implementation, Surawski (2006) and Crisosto and Salinas (2017), have argued that the economic rationale behind the project, the lack of a permanent governance structure (DPU) to guide the project implementation -as it was rendered obsolete after the project’s approval-, along with insufficient economic resources to sustain the envisioned planning process, have resulted in a high concentration of vulnerable population,

exposed to natural hazards, a convulsion that contributed to the high levels of disaster risk the city has nowadays.

Along with the urban development and densification of Alerce there have been increasing numbers of fluvial flooding events within the area. A recent risk study requested by the municipality of Puerto Montt (EULA-CHILE, 2016), as part of the actualisation of the PRC (Municipalidad de Puerto Montt, 2009), illustrates how flooding events started to appear in 2000, which coincides with the beginning of the urban growth of Alerce. In fact, the community of Alerce highlights that flooding is a recurrent problem, which takes place every winter and has caused considerable material and economic losses for the community. They recall the 2014 flooding as one of the major flooding events, where certain areas experienced flooding up to 20 cm within the houses, despite some existing mitigation measures such as rainwater drainages.

Furthermore, the recent eruption of the Calbuco volcano, which is located at approximately 25 km east of Alerce, has generated serious concerns for its inhabitants. This volcano has had five major eruptions over the last 100 years, the most recent in March 1961 and April 2015. During the last eruption, Alerce was among the affected areas due to ash fall, which represented a health risk for the inhabitants (Castro *et al.*, 2015). In this regard, the community of Alerce mentioned that during the emergency, the community suffered respiratory problems and had to use respiratory masks. At the same time, they highlight that due to the lack of information regarding the probability of volcanic hazard activity, as well as the lack of evacuation routes and safe areas, a significant number of inhabitants evacuated the city spontaneously, and collapsed the main connecting routes. Moreover, they recall that due to lack of information and organisation, they left the most vulnerable group behind, such as older people with mobility problems. Even though the volcano eruption did not produce any loss of life in Alerce, the community is concerned about the lack of knowledge and organisation, as the previous emergency resulted in general panic among the inhabitants.

The existing conditions of social vulnerability and exposure to flooding and volcanic hazards in Alerce can be associated with the existing urban land-use regulatory framework and planning practice regarding three fundamental aspects. First, the local-municipal land-use plan of the city of Puerto Montt of 1990 and its modification in 2001 and 2009 did not incorporate a risk assessment, which resulted in the absence of definition of risk areas. In fact, professionals of the planning office of the municipality of Puerto Montt, pointed out that the satellite-city project was only proposed as a modification to the local-municipal LUPs of the city (PRC of 1990), and thus, they did not have to comply with disaster risk studies. Thus, the modification of the local-municipal LUP did not incorporate a risk study, neither an analysis of the existing and projected social vulnerability of the area. As a response to such situation, the planning office of the municipality of Puerto Montt is currently incorporating for the first time a risk study in the current modification of the regulating plan of the city (PRC of 2009), which is currently under development.

The lack of a DRR perspective of the local government constitutes the second aspect. According to the existing normative, local governments have a key role in the definition of risk-areas and land-use regulation norms to be applied in order to foster disaster risk mitigation. Moreover, in the existing urban land-use regulatory framework, local governments constitute the 'competent institution' for approving the risk-founded study to

allow building permits in risk-areas. However, despite considerations of previous flooding and volcanic hazard events, further densification has been proposed for the development of Alerce as a way to counteract the existing urban segregation of the area and to respond to the housing demands within the city of Puerto Montt (Municipalidad de Puerto Montt, 2017).

Finally, practitioners and planning experts suggest that the lack of higher hierarchy planning instruments in the region, such as the Inter-municipal land-use plan (PRI), affects the overall planning practice at the local level and hinders the existence of a general guide to planning decisions. This applies for the case of Alerce, as the higher hierarchy PRI of the area has never been approved and its approval has been constantly postponed since 1980. Interestingly, the last reason for postponing its approval was because it did not incorporate the volcanic hazard in its risk study, particularly after the eruption of the Calbuco Volcano. Thus, the development of the mega-urban planning project of the satellite city of Alerce did not have the guidance of a higher hierarchy land-use plan which could have prevented the urban development and densification in the first place.

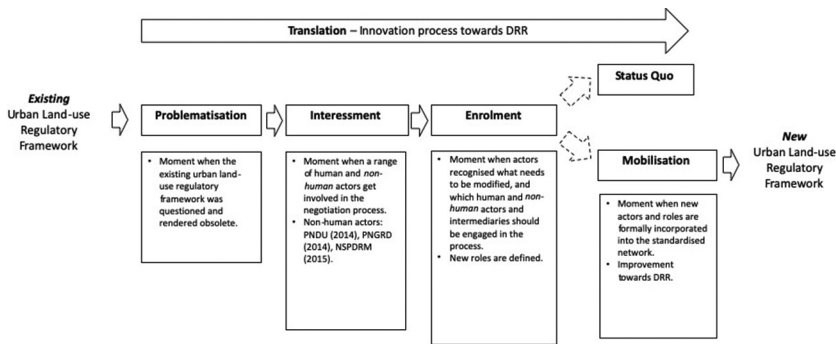
Overall, it could be argued that the series of planning and implementation gaps of the mega-urban planning project of the satellite city of Alerce (Crisosto & Salinas, 2017; Surawski, 2006), together with the lack of a systematic incorporation of the existing natural hazards into the LUPs by the local government, as well as the lack of higher hierarchy urban LUP instruments, have contributed to disaster risk construction in the urban settlement of Alerce. In fact, its inhabitants recognise that existing urban development pressures could result in further exposure of inhabitants, houses, and infrastructure, particularly considering the weaknesses of the existing urban land-use regulating framework, as further urban densification is being proposed within modification of the regulating plan of the city of Puerto Montt (PRC of 2009).

### **Interpretations from ANT: Towards a New Urban Land-use Regulatory Framework**

The existing urban land-use regulatory framework and its associated planning practices are defined as a *standardised network* which affects the way in which disaster risk is managed in urban contexts. The existence of a regulatory framework where roles and actors are defined by a national legal framework, makes it a rigid network that sets and guides planning practices, and where any modification must be proposed, reviewed and accepted by competent institutions. In this case, planning laws, norms, documents, and urban policies are understood as intermediaries, where land-use plans constitute *non-human* intermediaries between the territory and urban development (Rydin, 2012), regulating different urban land-uses with the parameters set by the national legal framework (LGUC and its OGUC). In fact, the case of Alerce shows how Land-use plans, both municipal and Inter-municipal, are relevant in setting the parameters for urban development in areas susceptible to natural hazards. Therefore, this standardised network sets the parameters for urban development.

After the 2010 earthquake and tsunami, this standardised network has been engaged in a process of innovation, characterised by a series of negotiations towards a new urban land-use regulatory framework, where it has been possible to identify what Callon (1986) defines as the four moments of *translation: problematisation, interestment, enrolment and mobilisation* (Figure 4).





**Figure 4.** Innovation process.

The moment of *problematization*, is characterised as the moment after the 2010 disaster, when the existing urban land-use regulatory framework was questioned and rendered obsolete for DRR. Here, the different actors involved, realised that one of the main weaknesses was the outdated character of the Article 2.1.17, defining the article as a point of inflection. This point of inflection, also defined as *obligatory passage point*, enforced all actors to converge and engage in negotiations (Rydin, 2012; Miles *et al.*, 2012). In fact, it was recognised that LUPs were not fulfilling their role as efficient intermediaries between urban development and natural hazards due to the weaknesses of the urban land-use regulatory framework. Thus, to improve the effectiveness of LUPs regarding DRR, the existing urban land-use regulatory framework, Article 2.1.17 of the OGUC, needed to be modified.

Once the problem and solution are defined, the process of *interessement* takes place, when the range of actors (human and *non-human*) involved in solving the problem are recognised. In the case of modifying the Article 2.1.17, it is possible to identify both human and *non-human* actors. Regarding human actors, planning experts of the Ministry of Housing and Urbanism (MINVU) were recognised as leading the innovation process, and they convened planning practitioners to engage them in the discussion. At the same time, professionals of the National Audit Office were involved, as they guide and approve the modification. On the other hand, *non-human* actors such as the NPUD (MINVU, 2014), the PNGRD (ONEMI, 2014), and the NSPDRM (ONEMI, 2015), set the guidelines to orientate how DRR should be incorporated within the new urban land-use regulatory framework.

During the process of *interessement*, the *enrolment* stage takes place when actors identify what should be modified in the network, and which actors and intermediaries should be engaged for this purpose. In this case, there are two actors whose roles need to be modified, and a new *non-human* intermediary to be incorporated within the network. First, practitioners and planning experts found necessary to define the role and responsibilities of the ‘specialist’ in charge of conducting risk-founded studies, and second, to outline the role and responsibilities of the ‘competent institution’ that approves the risk-founded study. On the other hand, it was necessary to incorporate a new methodology for developing risk studies as a new *non-human* intermediary. Once these new roles are defined, the network will set new parameters to incorporate these human and non-

human actors and intermediaries within the actor-network. Finally, the process of *mobilisation* takes place once these new roles, actors, and intermediaries are formally incorporated within the network, which in this case has not taken place yet.

Overall, the use of ANT in this study contributed to unpack the pivotal role of the existing urban land-use regulatory framework and LUPs as *non-human* actors within disaster risk construction and DRR. This was reflected by the importance attributed by planning experts and practitioners to the normative Article 2.1.17 and LUPs within the urban land-use standardised network. ANT heightens the role of land-use regulatory frameworks as *non-human* intermediaries between urban development and natural hazards. Moreover, natural hazards also constitute a *non-human* actor, as the innovation process of the existing urban land-use regulatory framework was triggered by the 2010 earthquake and tsunami. Thus, the idea of disaster risk construction as a coevolutionary process (Pelling, 2003) could be interpreted as a coevolution between human and *non-human* actors relating with each other in continuous associations, and with human actors enrolling in their creation and innovation process (Latour, 2005). In this context, ANT contributes to inform improvement processes of regulations, public policies and research towards DRR.

## Conclusion

The existing urban land-use regulatory framework has contributed to disaster risk construction in urban areas as observed in the case of Alerce. The lack of systematic incorporation of the existing natural hazards into the LUPs, as well as the lack of higher hierarchy urban LUP instruments for guiding planning decisions at local level have contributed to increased hazard exposure of inhabitants, houses, and infrastructure in urban areas. Moreover, the lack of consideration of vulnerability dimensions within the planning process, along with an unfulfilled mega-urban planning project which did not consider the local nor the national context and inherited institutional landscape, has contributed to disaster risk construction within Alerce. At the same time, the local government, considered as the main actor in the development and approval of communal LUPs, has also contributed to disaster risk construction as it has not incorporated a disaster risk assessment in the urban LUP processes. This case illustrates how urban LUP could become an underlying factor of disaster risk construction in urban settlements in Chile.

At the same time, interviews with planning experts and practitioners allowed to unpack the limitations of the existing urban land-use regulatory framework for DRR. The predominance of a reactive mitigation approach rather than a preventing and proactive approach to avoid disaster risk construction, the lack of a holistic methodology for disaster risk assessment, and the outdated character of the legal framework which holds back the incorporation of technical innovations. Nonetheless, results suggest a turn in planning practice and culture since the disaster event of 2010, demonstrated in the interest of planning experts and practitioners to improve and standardise the incorporation of DRR within urban LUP.

Regarding the innovation process of the existing urban land-use regulatory framework, practitioners agree on its potential contribution towards DRR. However, they highlight their concern regarding the lack of a definition of the acceptable level of risk,

and the non-existence of technical criteria to improve land-use regulations in risk areas. These limitations reflect the lack of flexibility granted by the existing regulatory framework and the constraints for regulating the use private property in Chile.

Finally, even though this paper suggests that the proposed innovations towards a new urban land-use regulatory framework could contribute to DRR, it is important to highlight the need for further research regarding the role of local governments in disaster risk construction, as well as the impact that the standardisation of technical parameters for defining land-use regulation norms in hazard prone areas could have on DRR efforts. In this context, it is important to highlight the relevance of the knowledges and the experiences of planning experts and practitioners and to encourage continuous learning from their struggles in addressing disaster risk.

## Note

1. The LGUC defines different statutory land-use plans regarding the different spatial and administrative scales of application, both at inter-municipal and local-municipal levels. It is important to highlight that Inter-municipal land-use plans have a higher hierarchy, and local-municipal plans need to follow their guidelines.

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No potential conflict of interest was reported by the author(s).

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