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Governance, resilience, and justice. A conversation with the Chilean earthquake engineering community

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ABSTRACT

This article explores the space that a justice narrative has within the earthquake engineering community (EEC) in Chile. Following a set of semi-structured interviews, we discuss the understanding that the EEC has of seismic risk governance and its relationship with disaster risk management. As such, it partly provides a self-reflection of the EEC about its historical development, current challenges, and future directions. Preliminary results show that the narrative of resilience appears as the current challenge to rethinking earthquake engineering practice, pushing for a paradigmatic shift from lifesaving to damage prevention. Topics beyond the traditional scope of engineering practice such as the political dimension of technical decisions and the concept of *seismic justice* are understood as relevant and valuable, yet its practical application remains unclear and therefore distant.

Keywords: governance, seismic risk, disaster justice, engineering

OVERVIEW

In this article, we summarize some of the main points raised by the Chilean earthquake engineering community (EEC) regarding our conversation about local earthquake risk governance and its relationship with disaster risk reduction and management (DRR&M). The concepts guiding the discussion are those of governance, resilience, and social justice in the context of (earthquake-triggered) disasters.

This article contains preliminary results of ongoing research that aims broadly to assess the consistency between the narratives and practices for seismic and disaster risk governance, and the space in them to explicitly address justice in its (re)distributive and participatory dimensions. Later stages of the research will focus on assessing these issues amongst expert communities related to other hazards (e.g., flooding), other disciplines (e.g., architecture and urban planning), and other stakeholders (e.g., civil society, local authorities).

BACKGROUND

The Chilean territory hosts frequent high-magnitude events associated to natural hazards such as earthquakes, tsunamis, volcanic eruptions, mudslides, and wildfires, exposing more than half of its population to three or more of them simultaneously (Dilley et al., 2005). Out of all these hazards, the seismic peril is by far the most important natural trigger of disasters in terms of casualties, economic costs, political pressures, and needs for emergency management, recovery, and reconstruction.

The importance of addressing the seismic condition of the territory led to the creation of the National Seismological Service two years after the devastating Valparaíso earthquake of 1906. This gave birth to earthquake monitoring and advocacy for building codes that would restrict the materials and building typologies used in construction. These practices were rapidly adopted as the earthquakes of 1928 and especially

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the one of 1939 showed the effectiveness of earthquake-resistant construction in reducing damage and the overall impacts of earthquakes. Thus, the solution to an earthquake-prone territory was rooted in technology.

The success in coping with earthquakes in this manner has unintendedly prevented a historical development of a more holistic understanding of disasters—especially of earthquake-triggered ones—in their social, natural, political, and technological nature and complexity. This has biased the local understanding and, therefore, management of risk and disasters towards low frequency, high-magnitude (intensive) hazards and technical solutions or *technological fixes*.

However, disasters are much more than the occurrence of physical damage that can be prevented by adequate design and delivery of *safe* infrastructure. Disasters are socially constructed phenomena that, once they unfold, reveal the underlying vulnerabilities incubating by the normal functioning of society (Blaikie et al., 2004). Hence, whilst successful in dealing with earthquakes and their physical impacts, addressing disasters predominantly from a technocratic perspective provides only a specific and partial response to a broader problem. This approach results flawed and incomplete, as it presents a conceptual disagreement between problem—root causes and (social) vulnerability—and solutions (technical fixes).

Our conversation with the EEC starts here. We aim to explore the meaning that the EEC gives to these ideas and the space for closing the conceptual gap described above. We also probe the concept of social justice and the role of, and opportunities for, engineering to address it in the context of seismic design and earthquake-triggered disasters.

METHODOLOGY

Data was collected by means of semi-structured in-depth qualitative interviews (McCracken, 1988) with members of the EEC of Chile. The community is defined as experts in the fields of earthquake engineering, seismic construction, and seismic risk assessment.

Seventeen interviews were conducted remotely (online) between January and March 2021, with an average duration of 75 minutes. Interviewees consisted of professionals with vast experience in teaching, research, building codes development, and delivery and review of structural design projects. The interviewees represent academia (11 interviewees), private (3) and public (1) sectors, and professional associations (2). This distinction acknowledges that interviewees have a main activity, but almost all of them are or have been involved in teaching, research, consultancy, and/or leadership positions in professional associations simultaneously at some point. Although their expertise is mainly local, most of them have participated in research and practice in international contexts.

The method for selecting the interviewees combined purposeful sampling (i.e., sample was intentionally selected for the needs of the study), snowballing (i.e., participants suggest names of new potential interviewees), and convenience sampling (i.e., according to availability of participants considering the COVID-19 sanitary situation and the online format of the interview).

Out of the 17 interviewees, only 3 were female. Also, only one of the interviewees does not reside in Santiago, the capital of Chile. This distribution echoes somehow the gender bias of the local EEC and the geographical concentration of expertise and of those involved in building codes development. We are aware of how this demographics can bias the outcomes of our conversation. However, in this initial stage of the research we intend to understand the EEC's perspectives as currently composed.

During the interviews, the following subjects were addressed: (i) the understanding that interviewees have of disasters; (ii) the perceived relevance of earthquakes in Chilean history, culture, and identity; (iii) the consequences of (earthquake-triggered) disasters in Chile; (iv) the identification of the main stakeholders and disciplines involved in seismic risk governance; (v) the relationship between earthquakes and DRR&M; (vi) the future directions of earthquake engineering; and (vii) the challenges and opportunities for addressing issues of social justice and vulnerability in earthquake engineering practice.

THE CONVERSATION

This section presents some of the results of the qualitative data analysis. These are presented into four topics, namely *the Chilean seismic culture*, *earthquake risk governance*, *resilience*, and *justice*. The statements of this section are supported by the interview data, with quotes provided as examples to illustrate the main ideas in it. Due to interview confidentiality, the quoted person is not directly identified, but the gender and the stakeholder the interviewee represents are.

The Chilean seismic culture

The first topic of the interview addressed the presence and relevance of earthquakes in Chile. Interviewees perceive earthquakes as a major factor shaping the development and practice of engineering and construction, but also as a fundamental component of Chilean identity. This comes from the high frequency that large earthquakes have had throughout the Chilean territory, making it an omnipresent condition that everyone will experience at least once in their lives; experiencing earthquakes in Chile is thus normal and quotidian. Unlike other more localized hazard events, such as mudslides or wildfires, earthquakes affect everyone in the territory. As such, they become something that cannot be neglected and should be addressed by preventing damage.

There is no agreement amongst the interviewees on what *seismic culture* means or implies, and the concept is interpreted in different forms. The most relevant is about its meaning for the engineering profession. The interviewees mention how, in Chile, structural and seismic engineering are synonyms, implying an investment in education, training, and research which is not that straightforward elsewhere. Also, one of the most relevant implications of the seismic culture implies the sustained practice of using specific structural systems that have proven to work well in the local context through time. Specifically, the traditional use of systems with high density of shear walls for residential structures (see e.g., Lagos et al., 2021).

Overall, the EEC understands earthquakes as a problem mostly solved. This also concedes that the country has today other needs that may be more urgent, justifying that attention to earthquake risk is reasonably falling in the list of priorities:

> *"In general, [Chile] is a country with lots of earthquakes and little damage relative to other countries. That generates that they are given importance, but not that much, because most of the problem is solved. […] We don't appear in any ranking of losses in infrastructure, economy, or lives, despite we are undoubtedly the country with the most released energy and rate of events worldwide. But it doesn't have consequences, and in that sense, we have other demands that are more severe. Don't even think in the pandemic. But the drought will affect us more than the earthquakes in terms of economy, the country's development, and sustainability." [Academic #6, male]*

Earthquake risk governance

The second topic of the interviews referred to seismic and disaster risk governance. Governance is defined as "the system of institutions, mechanisms, policy and legal frameworks and other arrangements to guide, coordinate and oversee disaster risk reduction and related areas of policy".[2] Simply put, governance refers to how the country organizes to cope with its hazardous territory. In the interviews, we discussed both a general perspective about disaster risk governance, and the specific case of earthquakes with the purpose of assessing any difference in narrative and practices.

Regarding disaster risk governance, interviewees identify the National Emergency Office (ONEMI)[3] as the most relevant actor and main coordinator for disaster emergency, preparedness, and response. One of the most relevant ideas that the interviewees refer to about governance is how the country has essentially developed good emergency response capacities, but a lack of them in other stages of the risk management cycle:

[2] United Nations Office for Disaster Risk Reduction, https://www.undrr.org/terminology/disaster-risk-governance

[3] After the publication of law 21,364 in August 2021, ONEMI is transitioning into the National Service of Disaster Prevention and Response (*Servicio Nacional de Prevención y Respuesta ante Desastres*, SENAPRED).

"ONEMI does a good job […]. But it is a system that requires a very strong coordination, which is difficult, for the different stages. Prevention, emergency, recovery. There is where I feel there are asymmetries. Risk governance is not equal in the different stages. In preparedness there are certain things, but relatively little. Emergency, response, there is a lot. In recovery there is very little. Each one scratches with their own nails. And the government takes care of public things, and privates of theirs."
[Academic #10, male]

This is relevant, as the specific case of seismic risk governance is exclusively associated by the interviewees to preparedness or mitigation, implying that all the work is done before the events, but there is nothing prepared to address the disaster once it unfolds.

For earthquakes, the EEC agrees that actions consist of adequate design and delivery of projects, which essentially comprises two equally important tasks: developing and updating building codes and enforcing their implementation. Interviewees agree that some of the key elements for the success of the Chilean case include the involvement of the industry and academia in the study and update of building codes, the existence of a critical mass of professionals and academics dedicated to seismic engineering, the legal mechanisms to make building codes mandatory, and the individual liability of designers and constructors in their projects. Indeed, Chile has been recognized internationally as one of the most seismically resilient countries (Stein & Toda, 2013). However, the success of seismic risk governance seems to lie outside disaster risk governance and management practices:

"In the case of earthquakes, the subject has been taken more by the private sector, basically by a technical community behind design, than by the public apparatus. The public apparatus participates of the technical community, contributes, but basically what we have is an awareness at the personal and professional level. […] basically, there is a technical body that functions without being nominated by anybody. These are technical groups that simply interact, are self-motivated, and produce a new generation of recommendations." [Representative of professional association #2, male]

Thus, the EEC appears as a self-regulated, self-convened body that is capable by itself of assessing the shortcomings of past and current practices and propose means of improvement. Its direction, rather than set by a public institution, grows organically from within pushed by research, professional experience, and occasionally by commercial interests. The state interacts with the EEC mainly through professional associations for the development and update of building codes in very specific cases, such as after destructive earthquakes as was the case in 1985 and 2010. Interviewees recognize the key role of the state in making the adoption of codes mandatory through different mechanisms (e.g., laws and by-laws), which carry personal and institutional penalties. If these mechanisms were absent, building codes would only be illustrative and voluntary. Building codes are thus seen as the way that knowledge and the EEC's agreements are turned into an "effective action of the state" [academic #3, male] which can be enforced, and its application, overseen.

Interviewees agree that the case of earthquakes is special. Unlike other phenomena that have a more direct urban component such as flooding or landslides, earthquakes can be dealt with at the level of individual structures. When asked about the possibility of extending the earthquake-coping practices to other hazards, interviewees in general agree that there is a lot to learn from the earthquake case, but that the logic under which seismic risk is governed is not applicable to all:

"[transferring earthquake-coping practices to other hazards] is a good idea, no doubts, but not everything can be regulated with the code, putting more steel in the edge of the wall. I'm thinking in landslides. There, you have to manage zones that used to be a ravine, and you need to leave them like that, because nature has to go through somewhere. There, you cannot solve it with the code. […] There are technical elements that can be used to prevent […] because it will occur; you cannot impede a rain of 100 mm in one hour but can have engineering works that mitigate that damage."
[Academic #5, female]

Resilience

> *"What resilience says is, what we are doing until now, forget it. Forget about using the R-factor for damage because society is not accepting damage. So, the dichotomy we have between engineers and users is that users don't accept damage, and the methods in the laboratory and the mathematical models accept damage. That is the new challenge right now. And that is why Chile has moved the needle, saying, look, people don't want damage, so we are moving towards that." [Academic #4, male]*

The topic of resilience appeared spontaneously in almost all the interviews. Although not explicitly asked about, its appearance shows how this narrative is deeply installed in the Chilean EEC. Overall, resilience appears as the current challenge to engineering practice, accelerating the paradigmatic shift from lifesaving to damage prevention and operational continuity, especially for residential buildings where this concept has been more distant, as opposed to industrial facilities. Achieving resilience is also an objective that aims to match the expectations of the Chilean population regarding seismic performance. Part of the interviewees agree not only that buildings in Chile have shown to be resilient, but that there is a real possibility to modify the building codes to deliver that in practice:

> *"Most of the people living in [the buildings that suffered damage with the 2010 earthquake] had the sensation that design in Chile was anti-seismic. Which meant that for any event, the structure shouldn't have damage. Then, the impression of an important volume of people was that buildings that suffered damage, was either because the construction company had stolen materials, or the designer was bad, and they could not fit in their heads that design was made for the structure to suffer some damage. So, going back to resilience, engineering, the most technical part, you realize that it doesn't make much sense to continue stretching the chewing gum to its limits and accept certain levels of damage, when making relatively minor changes, one can have very high standards." [Academic #2, male]*

Social equity and justice

Part of our ongoing research deals with how the narrative of socio-environmental justice can expand the traditional technocratic engineering approach to earthquake-triggered disasters. By attending to its dimensions of (re)distributive and participatory justice, a justice approach serves (i) as a guide from where to conceive a way forward not exclusively driven by more and better technical fixes, and (ii) as means to address the underlying structures and dynamics that create disaster vulnerability and risk (Rivera et al., 2020, in preparation). The final topic of the interviews was thus about exploring the understanding of justice in this context and the space that the EEC envisions for such a narrative in the practice of delivering seismic safety (for a reference on disaster justice, see Douglass & Miller, 2018).

As such, our aim in this topic was not to get straight answers about the meaning of *seismic justice*, but to probe the concept to see how it is understood by the interviewees. This intends to provide us with data to understand the potential challenges for discussing and implementing such a narrative within the EEC in Chile and, eventually, elsewhere.

In some cases, talking about equity and justice flowed easily. In others, some proxy concepts (e.g., social vulnerability, inequality) were used instead. In four interviews, it was not possible to get to this topic, as the entry questions to it were showing us it would have been taking the discussion to a point that would have made the interviewee uncomfortable with providing an answer.

The responses of the interviewees can be classified into two groups. One refers exclusively to the physical component of vulnerability and safety, the other also touches upon issues of social vulnerability, poverty, and marginality. In the first group, some interviewees feel uncomfortable with talking about seismic equity and justice, as it implies acknowledging the existence of an injustice on how safety is provided across the population. Interviewees would point that this is not the case, as safety levels in the building codes are applied regardless of socioeconomic status. Thus, inequity is not intended or by design, and therefore somehow out of the scope of the EEC. In this first group, some interviewees refer to the need of quantifying inequality first,

and/or to the idea of calculating the social return of investing in beyond-the-code seismic safety for the most vulnerable as compared to other investments, such as building more code-compliant housing units.

In the second group, responses range from engineering practice not addressing the social dimension of earthquake-triggered disasters at all, to a wider discussion about reducing social inequity as a moral obligation. Some of the ideas identified by the interviewees for changing the way technical solutions are provided in practice respond to market-based solutions such as insurances and incentives to beyond-the-code safety (e.g., seismic protection devices). Respondents in this second group refer to the need of expanding the traditional remit of the EEC by going from an earthquake- to a disaster-based approach, which still remains a challenge:

> *"What I take from our conversation is that what we know how to do well, or have done well, is minimizing building damage due to earthquakes. And that has been a combination of professional practice and normative provisions and a way of constructing shear wall buildings. But the problem of disaster risk is broader than that, and there is where we are called to make the jump, to move towards interdisciplinarity […] and there will be a challenge to open that path and effectively looking for spaces, because they are not open. This is not done." [Academic #9, female]*

FINAL REMARKS

Our conversation with the EEC provides valuable data to better characterize the understandings behind how seismic structural safety is provided in practice. Seismic risk governance is conceived almost exclusively as a preventive exercise where hazard monitoring informs the design and development of *safe* infrastructure. Learning is institutionalized and materialized in the form of both updated and new building codes which constitute "the memory of the Chilean seismicity" [academic #4, male]. The involvement of both academics and practitioners, and their close relationship, is seen as fundamental in this process.

Overall, the interviews show that topics traditionally beyond the scope of engineering practice, such as the political dimension of technical decisions (e.g., building codes development and implementation), the opportunities for addressing social justice through technical solutions, or the inclusion of social vulnerability criteria into seismic design, are understood as relevant and valuable, yet far from practical application.

Our research aims to address the meaning of *seismic justice* and the opportunities and challenges for its practical implementation. We believe that this can open a different perspective wherein the narratives of resilience and safety provision fit whilst also expanding the focus from a technological fix to the problem of earthquakes to a broader perspective about (earthquake-triggered) disasters. However, the practical ways of achieving it remain unclear. The results discussed in this article provide a first glance on how qualitative data can inform this process, and we interpret them as identifying initial entry points of this narrative within the EEC.

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