The growing impact that natural events have on cities has increased the interest in the design of cities capable of resisting them. However, resisting is not enough: it is also necessary to adapt and improve existing structures. In countries with high-risk potential – such as Chile – risk management has an important effect in reducing levels of vulnerability and poverty, given the strong correlation between disasters and development (UNEP; UNDP, 2009). Along these lines, the Sendai Framework for Action contributed to the shift from a culture of reaction to one of prevention, which implied a change from disaster management to risk management (UNISDR, 2015). The intervention to reduce risk is primarily based on the concept of resilience of hard infrastructure (i.e. physical structures such as levees, dams and buildings resistant to hazards) while basing the long term on concepts of preparedness to better rebuild (‘build back better’), recovery, and rehabilitation (UNISDR, 2015). Therefore, the conceptual and strategic approaches to face these challenges require going beyond resistance, incorporating risk management, adaptation, and resilience.

The concept of resilience, initially associated with ecological and social ecosystems, has been recently incorporated into the study of disaster risks. Simin Davoudi (2014:74-75) distinguishes three perspectives of resilience: one engineering, one ecological, and the other evolutionary. The first is based on the design and
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materiales con mayor resistencia, y estabilidad contra cambios externos. Consecuentemente, la resiliencia es la capacidad de un sistema para retornar a su equilibrio después de un evento, que se mide a través del tiempo que toma completarlo. En la ecología, se enfatiza en la capacidad del sistema para adaptarse para permanecer dentro de sus límites cuando se ve enfrentado a eventos. Esta teoría de sistemas equilibrados ha sido interpretada como un ‘normalidad’ a la que deben retornarse los sistemas. En otras palabras, no sólo se deben identificar vulnerabilidades, planificar emergencias, y gestionar riesgos, sino también buscar oportunidades de restauración y transformación, apuntando hacia el desarrollo sostenible en el futuro. Sin embargo, en términos de desarrollo urbano, esta normalidad no siempre es deseable, ya que usualmente es la causa de vulnerabilidades. Por lo tanto, un tercer enfoque es la resiliencia evolutiva, que no se basa en el equilibrio, sino en entender el mundo como un sistema complejo, caótico, incierto y no predecible.

Esta perspectiva sugiere que los sistemas no deben resistir eventos, ya que son parte de los procesos evolutivos que se realizan a través de ciclos espaciales y temporales (Berkes, Folke, 1998). Los cambios en las estructuras y funciones de un sistema deben seguir cuatro fases: explotación o crecimiento, conservación, descarga o destrucción creativa, y reorganización. Esta visión sobre resiliencia encuentra potencial transformador, trayectorias alternativas, y oportunidades de adaptación en un evento (Wagemann, Greene, 2019:320). Por eso, después de un cataclismo, la planificación urbana no solo debe resistir o retornar a la normalidad, sino evolucionar hacia algo mejor.

Desde otro perspectiva, tan pronto como en la década de 1970 se identificó una descontinuidad entre las actividades de emergencia y las que se dirigían hacia el desarrollo del periodo de reconstrucción y planificación pre-catastrófica (Wagemann, Moris, 2018). Así, un modelo lineal (emergencia-rehabilitación-desarrollo) fue posteriormente propuesto, aunque resultó rígido e imposible, sirvió para dar paso a un concepto más dinámico conocido como el ‘contiguum’ donde actividades a corto y largo plazo tenían que ser integradas e implementadas en un simultáneo e interfuncional.
manner. Despite its interest, it was a complex model to implement; therefore, the phases are not currently integrated and are carried out consecutively. On the other hand, after the 2004 Indian Ocean tsunami, the ‘build back better’ concept – focused on a recovery that allows change towards development, reducing the underlying causes of the disaster – became global.

For its part, the National Commission for Resilience against Natural Disasters (CREDEN), taking common concepts from various sources, defines resilience as:

The capacities of a system, person, community or country exposed to a threat of natural origin, to anticipate, resist, absorb, adapt and recover from its effects in a timely and effective manner, to achieve the preservation, restoration, and improvement of its structures, basic functions and identity (CNI-D-CREDEN, 2016:4).

Accordingly, resistance is only one of the resilience components since, in order to face future events, it is necessary to modify existing practices and guide them to real adaptation and anticipation. In this line, what interests us is urban resilience, at the infrastructure level, understanding the ability to anticipate, resist, absorb, adapt and recover in a period of time that includes four moments: pre-catastrophe, during the catastrophe, emergency, and post-catastrophe (reconstruction).

Learning From Experiences
Undoubtedly, Chile is a natural laboratory considering the recurring events that end in great catastrophes [Fig. 1]. The experience of the emergency and reconstruction programs have had mixed results since, despite learning, we are far from achieving resilience mainly because of our anticipation and adaptation capacities. For example, one of the key elements to improve the institutional response and its impact in the built environment includes the articulation of the various phases of the process – before and after the disaster – as noted above. This should not only allow better use of time and resources but also improve pre-existing problems. However, there is still no comprehensive vision of the cycle as a whole and of this evolutionary resilience where catastrophe is seen as an opportunity; therefore, an appropriate framework for emergency and reconstruction strategies, housing management, and urban design is required.

From the lessons obtained from large-scale disasters, regulatory and institutional changes have been generated, affecting how we build and design our cities. For example, the General Law of Urbanism and Constructions was created after the earthquake of 1928; the 1960 earthquake and tsunami originated the National Emergency Office (ONEMI); and, more recently, the 2010 earthquake and tsunami motivated
the proposal for the new National Emergency and Civil Protection System (Dipecho, 2012) and a national policy for disaster risk reduction (National Policy for DRR, 2015). On the other hand, the central and sectoral government structure – characteristic of the Chilean State – divides the responsibilities between the competent institutions (such as Onemi, Minvu, Mines, regional governments, and municipalities), which results in the loss of an integral vision of disaster risk management, since responsibilities are defined in stages, never achieving a more cohesive and coherent resilience strategy.

To understand how these disaster-processes develop after an event, two cases of the same Chilean catastrophe are presented and analyzed below: the earthquake occurred on February 27, 2010 (27F). The 8.8 Mw shake was followed by a tsunami that affected the central and southern regions of Chile. The earthquake was registered as the second most intense in the country’s history, affecting 75% of the national population, leaving 526 deaths and more than 200,000 homes destroyed or seriously damaged (Cárdenas-Jirón, 2013:1). The greatest damage occurred in the coastal areas – where ports, bridges, streets, and houses were destroyed due to the tsunami – and in some parts of the central area due to the effects of the earthquake. The government coordinated the post-disaster process in three phases: immediate emergency to assist victims and restore public order; winter emergency to build temporary homes; and

FIG. 1 Desastres registrados durante los últimos 120 años en Chile / Disasters documented in Chile during the last 120 years. Fuente / Source: CNID-CREDEN (2016). © Mariana Andrade
reconstruction to build permanent homes (Gobierno de Chile, 2013).

The cases selected here – Constitución and Chanco, located in the Maule region – have different characteristics: Constitución is the most populated coastal city in this timber region, located in its center with around 45,000 inhabitants; Chanco is a town of about 9,000 inhabitants located in the province of Cauquenes and protected as a typical area for its overall heritage value, where the main activity is agriculture. Both are represented planimetrically in four moments: the situation before the disaster, during the event, the emergency stage, and the reconstruction stage.

**27F Earthquake and Tsunami, Constitución**

Reviewing the process in the city of Constitución [FIG. 2-5] – one of the most affected by this earthquake and tsunami – allows us to discuss to what extent the efforts made by the government’s actions and programs corresponded to resistance and/or resilience. Before the catastrophe, the Chilean Navy Hydrographic and Oceanographic Service (SHOA) had identified a flood zone of vast extension in Constitución that was almost entirely built [FIG. 2]. The Regulatory Plan in force at that time – from 1988 – did not seem to consider the above information, since it indicated protection areas for beaches, rocky shores, and estuaries with very specific edges and narrow margins, without incorporating the flood zones detected by the Navy. Therefore, it is not surprising that much of the flood area was urbanized and built as part of the formal city. In addition, the Regulatory Plan indicates an urban limit that was not respected, as there are built areas outside of it.

The effect of the tsunami in this city was of great magnitude; around 80% of the city center was destroyed or demolished due to collapse danger. The flooded area [FIG. 3] was very similar to that foreseen by the Navy, countering the anticipation factor – the first aspect of resilience. This was probably the result of ignorance or lack of coordination between different organizations, which is one of the major problems that affect the improvement of territorial planning instruments. The situation during the emergency phase [FIG. 4] shows the construction of transitional houses in the flood zone without new defenses. Although families tend to pressure to stay close to their homes during this period, this indicates a lack of responsible planning, since there could have been aftershocks and new tsunamis in the short and medium term.

Finally, the reconstruction process [FIG. 5] shows positive aspects such as (1) the generation of a security line in accordance with the information provided by the Navy and the 27F experience; (2) the identification of meeting points in safe and accessible places for the population, and (3) the waterfront project as an area for distancing and protection of the coastal zone,


FIG. 5 Constitución. Tsunami 2010, período de reconstrucción. / 2010 Tsunami, re-construction period. Fuente / Source: Elaborado en base a Plan Regulador Comunal (1988); la línea de inundación definida por Oficina Nacional de Emergencia del Ministerio del Interior y Protección Civil (ONEMI, 2018); la zona de inundación definida en estudio de riesgo SUBDERE (2010) y a información de la reconstrucción del Observatorio de la Reconstrucción (2018). / Based on the District’s Master Plan (1988); the flooding line as defined by the National Emergency Office of the Ministry of Interior and Public Security; the flooding zone determined in the risk study SUBDERE (2010), and on the reconstruction information of the Observatorio de la Reconstrucción (2018). © Francisca Rocuant
which could be understood as a form of adaptation and, therefore, as resilience. On the other hand, there are also some negatives aspects, since much of the reconstruction was carried out outside the urban area and the old town, urbanizing far from the developed zones of the city, with a lack of infrastructure and little planning, which is a questionable improvement.

The reconstruction process was not without controversy due to the relocation of a large part of the affected population – in compliance with the security line – and the participation of the private sector in the reconstruction planning, which was considered a conflict of interest (Prieto, 2018). Although the Sustainable Reconstruction Plan (Pres) considered an advance in the funds destined for services and infrastructure, 68% went to the most touristic coastal area and only 3% went to the hills, where part of the population was relocated (Prieto, 2018:144-145). This generated problems regarding mobility and access to services, while also leaving a fractured social fabric (Contreras, Benítez, 2015:85). So, in the case of Constitución, one can identify a reconstruction based on the resistance to future tsunami events in the coastal zone, with planning focused on physical rather than social aspects, which led to an asymmetric development and a gentrification process, missing the opportunity to improve the basic structures and functions of the city.

27F Earthquake and Tsunami, Chanco

In the town of Chanco, the earthquake and subsequent damage and demolition management led to the loss of buildings and non-monumental complexes of great cultural and heritage value. This situation was repeated similarly in other towns across the region. Before the catastrophe, and since 1978, a large downtown section of Chanco was protected as a typical area, distinguishing a significant number of buildings of architectural and artistic interest [Fig. 6]. Although these did not reach the category of national monuments, the integrity of the adobe architecture complex, with covered corridors, handmade tile roofs and traditional finishes, constituted a very clear urban value, hence, its status as a typical area.

During the earthquake, 204 houses – out of the 407 that formed the typical area – suffered significant damage, 119 of which were destroyed [Fig. 7]. In addition to the severity and visibility of the damage caused by the earthquake, the declaration of uninhabitability made by the fire department, and the availability of heavy machinery provided by the logging companies in the area generated a wide expectation of demolition and subsequent reconstruction through public funds. This was reflected in numerous demolition requests, which the municipality granted despite their typical area status. The continuity of the public space, defined by continuous facades and corridors in several central streets and also in the buildings surrounding the main

square, was lost [FIG. 8]. The emergency and the immediate response left behind a series of gaps that alternated with some standing buildings. Being by themselves, they were not able to retain their value as buildings of historical interest that formed a typical area. Along with this, a large part of the population relocated within the town but outside the typical area, sometimes on the outskirts, further weakening the central area of the town.

The municipality established a reconstruction plan that included several strategic projects [FIG. 9]. However, some owners began rebuilding before the plan was launched on a semi-irregular basis. Additionally, through the management of the School of Architecture of the Universidad Católica Valparaíso, an important number of houses with subsidy standards were built, which rescued the traditional typologies of corridors and continuous facade as much as the limited financing permitted.

The Chanco case shows how, despite the fact that there are repair measures for most of the monumental buildings of historical value, the domestic or non-monumental heritage is neglected, even in the case of protected complexes. After a catastrophe, public attention focused on material losses, and collective efforts focused on immediate responses to the emergency. However, little attention was paid to the consequences that these early actions would have in the longer term, ignoring the potential to extend the utility of the material resources and energy invested for longer processes of reconstruction. In this case, the generalized loss of a valuable built heritage was almost unnoticed both because of the chaos of rapid demolition – typical of the state of emergency – and because of the influence of practical reconstruction priorities in the time that followed. The process does not achieve resilience, since it was not possible to preserve, restore, and improve the physical structures and, with them, part of the cultural identity of the people.

**Lessons: Anticipate, Resist, Absorb, Adapt, and Recover**

The two cases analyzed, despite being very different, show certain similarities in their processes, which failed to be resilient. In both, the search for immediate and resistance-based responses to future risks – from a material point of view – had an impact in the long term, mainly in social aspects such as equity, segregation, access to services, social fabric, and identity loss. Reconstruction, like any intervention in the city, is a political act.5 It is possible to see that both in Constitución and in Chanco, a technocratic approach was privileged, with an emphasis on repeatable solutions based on housing construction with social interest within the subsidiary system, instead of a more comprehensive vision of settlements that superimposed physical, environmental, socioeconomic, and cultural variables. Perhaps one of the most
complex effects repeated in both cases is the relocation of communities outside the city center, generating new areas of expansion and tearing the social-urban fabric, which mainly affected the most vulnerable groups. This was common in other cities affected by the 27F, mainly in coastal or central areas, where the recently vacant lots attracted interest from tourism and investors.

From a positive point of view, the 27F experience led the government to modify some existing systems and strategies – such as emergency alerts –, to improve housing standards, and to create urban plans (Wagemann, Greene, 2019). As these cases show, the reconstruction plans created as a response, sought to improve the existing situation before the 2010 event, with various results. Structural measures were implemented in coastal cities, such as promenades and elevated houses (Khew et al, 2015:329), resulting in a greater development of tourist areas, but in a false sense of security in houses that, although elevated, still are exposed to a tsunami.

Based on the experience, the standards of transitional housing were also improved after the mediaquas that were used had to be waterproofed, showing that their quality was not consistent with the level of development of the country (ONEMI et al, 2018). The new transitional houses are larger, with better materials and with sanitary modules, but they still need to include a settlement perspective, locating themselves in relation to transport routes and infrastructure, and improving their management and administration (Wagemann, Moris, 2018:523). These shortcomings are evident in the transitory houses built in risk areas – in the case of Constitución – and in how the transition period did not allow to maintain some of the main features of the typical area, losing part of its value – in the case of Chanco.

On the other hand, a greater understanding of the important role of planning for resilience and future development is still needed. Efforts were made to develop the Sustainable Strategic Reconstruction Plans (PRER), the Urban Regeneration Plans for inland cities (PRU), the Coastal Edge Reconstruction Plans (PRBC), and the emergency plans for each region and district. However, these plans are indicative and are not part of the official structure of the territorial planning instruments (Moris, Walker, 2015:107), having little effect once the rehabilitation period has passed. For example, in the case of Chanco, the lack of planning or protection of urban areas – or the lack of compliance with the indications contained in these instruments – in some cases resulted in the displacement of families from historic centers due to real estate speculation. On the other hand, a coastal law that limits construction in tsunami flood zones has not yet been defined, nor has a clear and mandatory way to incorporate multi-risk and multi-threat maps into territorial planning instruments.

Finally, the subsidy system for the construction of social housing, described as a 'demand subsidy,' has been adapted to provide housing to those affected in the

event of disasters. This system has been successful in quantitative production, but not in its urban impact, characterized by an unequal provision of services and infrastructure. As evidenced in the cases presented here, the houses built generated new areas of expansion, which do not necessarily have the minimum infrastructure; and, in the case of villages of historical interest, the capacity of these subsidies is limited by the practical priorities of the process.

To achieve resilience, you must not only plan how to resist events – which are predicted to be more frequent – but also anticipate the future. Once we have been faced with catastrophes, we must adaptively rebuild, seeking to improve the situation existing before the event, reducing future risks, but also preserving and restoring the identity of cities and towns. For this, the integration of processes is essential, where temporary pre and post-disaster solutions are part of a risk management cycle, allowing the sustainable development of our settlements. ARQ

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Bibliografía / Bibliography


KHew, Yu Ting; Joanne; JARZEBSKI, Marc; DYAN, Fatima; SAN CARLOS, Ricardo; GI, Jianping; ESTEBAN, Miguel; ARANGUIJE, Rafael; AKIYAMA, Tomohiro. «Assessment of social perception on the contribution of hard-infrastructure for tsunami mitigation to coastal community resilience after the 2010 tsunami: Greater Concepcion area, Chile». International Journal of Disaster Risk Reduction, vol. 13 (2015): 324-333. En: https://doi.org/10.1016/j.ijdrr.2015.07.012


ONEMI; MINVU; MINDES; CIGIDEN; CITRID; Fundación Vivienda; Tecnopanel; echo-Chile. «Habilitabilidad transitoria en desastres». ONEMI, 2018.


SALGADO, Marcela. «Reconstrucción de la vida cotidiana. La cara inequitativa. El caso de Pelluhue, Chile». En Learning from 27F. A Comparative Assessment Of Urban Reconstruction Processes after the 2010 Earthquake in Chile. Latin Lab, GSAPP Columbia University & Santiago Research Cell, 2015.


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2 According to concepts developed by Lance H. Gunderson, especially in his work with Crawford S. Holling (2002).

3 This concept was already pointed out in Lindahl (1996) and further developed by Lewis (2001), and Liester (et al, 2006).

4 This early recovery involves restoring the capacity of institutions and communities to recuperate and avoid relapses, as noted in CWGER (2008).

5 As stated by Berroeta, Carvalho, and Di Masso (2016), citing Salgado (2014).