

## BEYOND THE APPEARANCE OF HERITAGE: Reconstruction of Historic Areas Affected by Earthquakes in Chile

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### Abstract

*Earthquakes have progressively destroyed Chilean built heritage over the years, not only due to the initial devastation they produce but also due to the applied reconstruction approaches that follow, which has been addressed using non-specific instruments such as social housing subsidies. Moreover, it often aims only to recreate the previous built form, dwellings that look 'as before', but using contemporary materials and building techniques, losing the progressive and sustainable culture that used to characterize their buildings. This raises the question of authenticity and its social and normative corollaries. The objective of this paper is to explore this issue by discussing reconstruction projects that have been built in heritage areas after the 2010 earthquake, considering their formal coherence in relation to the previous architecture, as well as their applied building techniques and the inhabitants' perception of the reconstruction process. The results indicate that the sustainability that used to characterize dwellings is not present in their replacements. This paper follows the idea that heritage should be reconsidered as a sustainable way of designing, going beyond formal approaches.*

**Keywords:** earthquakes; re-construction; heritage; building techniques; sustainability.

### INTRODUCTION

Chilean built heritage has always been at risk to natural catastrophes. Poorly maintained buildings, scarce funding, loss of technical knowledge and lack of social valuation are among the causes which, when combined with a destructive event like an earthquake, produce a significant impact in the amount and quality of preserved heritage buildings.

This study looks beyond the widely addressed topic of monumental heritage, to consider housing in heritage settlements. In Chile, dwellings in historic areas are characterised as sustainable answers to climate and environmental conditions, using vernacular building techniques. They are economically efficient in their use of resources, giving place to their inhabitants' way of living and embodying their cultural expressions. They comprise a representative set of anonymous constructions, which are generally related to public spaces through porticos and continuous facades (Fig. 1 & 2). Some authors have described them as a:

*Collective product, anonymous, a modality that should not be compared to educated manifestations because its inspiration has other basis. Its merit is in the group and in the considerable achievements obtained despite the use of modest means, (...)*  
(Guarda, 1988, p. 37).

### Social perception of built heritage in Chile

Social perception of Chilean built heritage is not always in favour of its conservation, which increases the fragility of it. One of the reasons for that is the regulation concerning built heritage, as the responsibility and the funding for the preservation of historic buildings rely on the owner. As an attempt to study social perception of heritage areas in Chile, before and after reconstruction, interviews to the inhabitants in three historic areas affected by earthquakes were carried out: *Tarapacá*, *Zúñiga* and *Lolol*, data collected during a fieldtrip in Chile in January 2013.

In the first case, the reconstruction was finished after the 2005 earthquake affected the area. The 2010 earthquake affected the second and third cases. This paper will only focus in the case of *Lolol*, as in *Zúñiga* the reconstruction had not started yet -by the time of the fieldwork-. *Lolol* has the most advanced status in the reconstruction process of all heritage areas affected by the 2010 earthquake in the country, as it was taken as a priority case, which allows having a preliminary evaluation of the reconstruction process.



Figure 1: Continuous façade in *Zúñiga*, Chile, 2011  
(Source: Author).



Figure 2: Use of porticos in *Lolol*, Chile, 2011

Even though these areas have historical value, the Council of National Monuments of Chile has only protected some of them in current regulations, declared as '*Typical Zones*'. Yet this declaration does not engender special funding or benefits; on the contrary, it imposes a set of obligations and restrictions on owners to preserve their built heritage, where the Council evaluates every modification, construction or alteration to be made to the buildings. In practice, this means that within the heritage areas, the public perception of this declaration is not always favourable, as many feel that the freedom to modify their own property has been restricted and that construction processes are prolonged, a particularly problematic issue after an earthquake, where the emergency demands quick solutions. For example, in *Lolol*, inhabitants are divided in opinion over its designation as a *Typical Zone*, but 67% of those interviewed do not see any direct benefit from it.

In this context, when a large earthquake occurs, like the Maule earthquake on February 27th 2010 in the central-south area of Chile, measuring 8.8 on the Richter and Mw scale, all previous issues in relation to heritage areas are intensified. Those who disagree with the designation of a *Typical Zone* will see the earthquake as an opportunity to change, which can involve unnecessary demolition even in protected areas, as the scale of the disaster produced less possibility to supervise heritage regulations.

Heritage areas experienced different levels of damage, depending on the quality of their constructions and the distance to the epicentre. For example, in the VI Region, the least affected villages include *Zúñiga*, *Lolol* (Fig.3) and *Paredones*; and the most heavily affected include

*Pumanque* (Fig. 4) and *Peralillo*, last of which was particularly damaged by indiscriminate demolition in the aftermath.

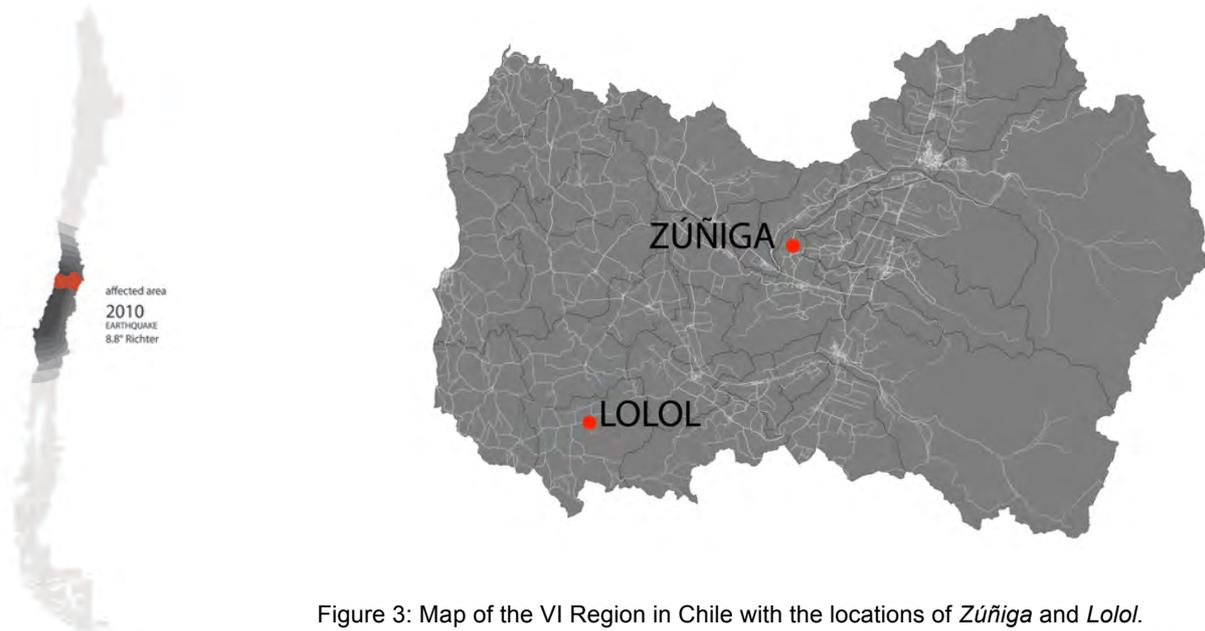


Figure 3: Map of the VI Region in Chile with the locations of *Zúñiga* and *Lolol*. (Sources: Tarapacá Project and Ministry of Housing and Urban Development of Chile).



Figure 4: Dwelling severely affected by the 2010 Maule earthquake in Chile. *Pumanque*, Chile. April 2010 (Source: Author).

It is important to remark that, as Chile has experienced several earthquakes in its history, even the most powerful one in the world's recorded events in 1960 - occurred in Valdivia with a magnitude of 9.5 in Richter scale -, lessons have been learned and the number of fatalities is low in comparison with similar events occurred in other parts of the world, which allows focusing in the destruction of the built environment, as emergency issues are mostly covered already.

## RECONSTRUCTION AFTER THE 2010 EARTHQUAKE

Chilean government did not create a specific institution to assist with reconstruction after the 2010 earthquake. Instead, each existing Ministry was in charge of their area, for example, housing reconstruction was dependant on the Ministry of Housing and Urban Development, in which heritage areas were included. This institutional arrangement meant that they were not treated as a group or heritage set, but according to each individual building. In this research, reconstruction has been studied from the public policies perspective, which impacts in a major scale. However, there are several independent and private initiatives related to reconstruction that might be addressed in future studies.

In that framework, reconstruction of housing in heritage areas has been adapted from non-specific previous policies, such as the one used for social housing. After the 2010 earthquake, a Heritage Reconstruction Programme was created as a more specific approach, although based in the same subsidy tool, always considering the reconstruction to occur in the same sites were the previous dwellings were located. Even though the programme considers funding for the design of each dwelling as an individual project, it is not enough to cover it, so the repetition of the same design is used in practice to cover that, which produces the construction of new dwellings with replicated heritage elements.

Moreover, even when subsidies were adapted to comply with heritage areas, they were primarily created to meet economic requirements, as their aim is to fulfil the habitation deficit of those people that cannot afford a dwelling by themselves in regular situations, thus not designed as an post disaster tool. An application is required, adding extra bureaucracy and making subsidies a very inaccessible and inefficient tool in a post disaster situation, as only a part of the dwellings in heritage areas can be reconstructed or retrofitted through it. Indeed, from the cadastre of damage done after the earthquake in the VI Region of Chile, 5571 buildings were identified in heritage areas, of which 75% were houses. However, only 33% will be repaired or reconstructed via housing subsidies, mainly due to the inflexibility of the instrument. As for the other houses, some are repaired by owners, sometimes just superficially; some are left abandoned, and some are still inhabited; a potential danger in forthcoming quakes.

In summary, there are three main issues concerning reconstruction in heritage areas that continue to persist. First, the indiscriminate demolition that immediately follows disasters, affecting the designs of new projects. Second, the lack of an integrated approach that can cover the reconstruction and repair of the entire heritage area. And third, the design of reconstruction projects as new 'heritage' dwellings, which superficially imitate the appearance of old houses. It is on the final issue of design that this paper will concentrate.

### ***Building techniques used for reconstruction of heritage villages after the 2010 earthquake***

The most common building techniques used originally in heritage areas are the *adobe* and *quincha*, which have adapted to fit the different climate conditions over the country. *Adobe* is a type of masonry made of mud and straw bricks, which are sun dried, obtaining usually thick walls of about 50 to 80 cm. In the best cases, it is built using timber reinforcements. *Quincha* is a wood panel structure that is filled with cane as vertical elements and clay, reaching usually 10 to 15 cm. of thickness. In the northern area, most buildings have light roofing because there is almost no rain, and the thermal mass of the clay is perfect for the high daily temperature oscillation. In contrast, at the central-south area of Chile there is constant rain, so dwellings usually have heavy roofing, porticos, and plinths, which are used for adapting to terrain inclination as well (Devilat, 2012). All of these elements protect the adobe walls from the rain, and also collaborate with their structural behaviour, so they perform better during earthquakes (D'Ayala & Benzoni, 2012). However, the most affected buildings were those built in adobe (27%), mainly due poor maintenance, followed closely by timber constructions and those made using reinforced brick masonry (Ministry of Housing and Urban Development of Chile [MINVU], 2011, p.16).

Structural meshes and timber reinforcements are currently used to repair affected houses. After uncovering the plaster in adobe walls and taking out doors and windows, the walls are repaired with clay mortar and reinforced using *geomesh* (plastic structural mesh) (Fig. 5a), which add flexibility to the adobe walls (Torrealva, 2009). With the same principle, walls are being reinforced using metallic structural mesh (Fig. 5b). Both systems should be applied in each side of the wall and then connected with steel or timber pieces, and the mesh should be completely covered by clay plaster in order to reach its full resistive capacity. Other method involves carving the walls to insert timber reinforcements in both vertical and horizontal ways, which should be connected by steel pieces, after which a mesh is applied (Fig.5c). Roofing and ceiling structure is reinforced with timber elements when needed, although it is mostly recycled from before. Tiles are usually installed using traditional weaving techniques, which are safer during seismic events as they would not fall and injure people. In some cases, a concrete beam is also installed in the interior of the dwelling, added to the inner part of the wall in order to reinforce the foundations.



Figure 5: Reinforcements techniques. From left to right: a) *geomesh* used in *Almahue* (Source: author); b) metallic mesh in *Lolol* (Source: author); and c) timber reinforcements in *Olivar* (Source: F. Pérez, MINVU).

In new projects, contemporary techniques are generally preferred, both by inhabitants and designers, as adobe buildings are not included in the current Chilean regulations and are not considered earthquake resistant. However, it is possible to use adobe as a building technique if the responsible professional refers to international regulations, and only if an independent validated reviser supports the structural design.

Yet, it is important to remark that most of the historic buildings would have experienced less damage if they had been correctly retrofitted and maintained throughout time. For example, there are several monumental *adobe* buildings, which resisted structural damage, such as *San Pedro de Alcántara's* Church, retrofitted just before the 2010 earthquake, or the *Casona Lo Contador*, a 17<sup>th</sup> Century building in good condition as it has been well maintained over time (Fig. 6 & 7).



Figure 6 & 7: *Casona Lo Contador*, currently used as the School of Architecture of the Pontifical Catholic University of Chile. Photos taken one day after the 2010 earthquake, in which only superficial cracks can be seen.  
 (Source: Author).

In addition, there is a lack of expertise in designing, repairing and maintaining earthen buildings. The first buildings made of *adobe* and *quincha* were built with timber reinforcements, with good quality roofing structures, careful with the amount and type of material used and with a constant revision during the construction process by the owner (Guarda, 1988). As time has passed, some of these processes have been abandoned, resulting in several adobe houses not as resistant as the first. Also, there has been no dissemination of specific knowledge on how to maintain and repair adobe building, until very recently.

An interesting example is that after the 2005 earthquake, occurred in the north area of the country, a special *Adobe Commission* was created to discuss about this issue. It concluded that the use of earth as a structural material, like *adobe*, was not recommended, and that other mixed technologies, such as *quincha*, should be studied further in its seismic behaviour (Comité Adobe, 2005). After the 2010 earthquake, the scale of adobe-affected buildings makes evident the necessity of rethinking these conclusions, as at least 50% of the buildings were built with that technique, so a new specific regulation for heritage was created. It establishes that adobe could be used only if it is combined with new buildings technologies such as timber or meshes, conforming a new and more efficient structural system (MINVU, 2012). However, a strong view against earth as a building material persists, even among professionals.

For new houses in the reconstruction process, it is possible to group applied building techniques into three categories. The first corresponds to reinforced brick masonry with timber roofing structure, covered with clay tiles, in some cases recycled and in some cases using new industrialised tiles. This is one of the most common building techniques used in general in Chile in new dwellings (Fig. 8a).

The second includes mixed techniques that incorporate earth and clay in the walls or as plaster. Some designers include the use of clay as a raw material as a way to address the value of building techniques in the previous dwellings, yet they do not use it in a structural or traditional way as the *adobe* construction. For example, earthen-made plasters on a timber structure filled with polystyrene as isolation are commonly used in reconstruction projects after the 2010 earthquake. However, they are not efficient from a thermal perspective in the central-southern area of Chile if they are not within thick walls necessary for isolation purposes. Whereas thermal

mass of adobe is perfect for the desert climate of the northern area, it is not useful as such in the central-southern zone, yet as insulation because of its thick walls. Thus, it is not enough for the required isolation of that Mediterranean climate to use only 10 cm. of isolation and clay within the wall structure. Moreover, some of those projects include shaping the walls in such a way that they would be recreating the thickness of the old adobe walls (Fig. 8b).

Finally, the third is based on a timber frame structure with two types of walls. The public façade of the house is filled with straw bales, giving good insulating properties. Their local availability and low cost also make them a sustainable alternative. However, as the other exterior walls, made of timber and clay, are thinner (10 cm), the insulating properties of the straw bales are not as effective (Fig. 8c).

Unfortunately, there is no data available to dimension how many dwellings are being built using each building technique. The Reconstruction Programme operates by selecting a group of professionals that will design their proposals for a determinate area, both for repair and reconstruction. What is currently happening in the VI Region, for example, is that each group have the same generic base proposals for heritage dwellings that are being repeated in the historic areas in which they are working. Thus, it is possible to find the same housing type in *Lolol*, in *Chépica* and in *Paredones*, as it is the same professional team designing the reconstruction dwellings, as a strategy to maintain low design costs, as the funding for the design process are not enough.

In addition, because of the tight budget, some design decisions may affect the perception of reconstructed historic areas. For example, the use of clay tiles is almost compulsory, but as the budget is rarely accommodating enough, industrially-made tiles resembling handcrafted clay ones are usually used, and often only on the side of the roof visible from public spaces, with steel sheets used on the interior face of the roof. These designs circumvent issues of authenticity required in heritage intervention.



Figure 8: Building techniques used in housing reconstruction for heritage areas. From left to right: a) reinforced brick masonry; b) timber structure with clay plaster; and c) timber structure with straw bales in the façade and wood panels with clay in the rest of the walls. (Source: Author).

### The Problem of the New 'Heritage' Dwellings

Focusing on new projects, reconstruction models designed for historic areas are based on a superficial understanding of heritage's concept. Those models are considered as 'heritage' as they include formal 'historic' elements using contemporary materials, even when records of previous dwellings are in many cases non-existent, and in others, when the buildings never even included such elements. They do not understand a more complex sense of heritage based in vernacular building techniques and cultural conditions, which are they base of its sustainability.

The proposal of this study is to go beyond only the appearance of heritage, in opposition of what is understood in the regulations. For example, in the general urban regulation document, the term 'reconstruction' is defined as *"to totally or partially build again a building or to reproduce a pre-existent construction, or part of it, which will formally retake the characteristics of the original version"* (MINVU, 2012, p. 27).

This vision is not only for heritage reconstruction, but it is the commonly used approach in historic areas. Indeed, it has been used after other earthquakes in the country. For example, in San Lorenzo de Tarapacá, heritage area affected by the 2005 earthquake measuring 7.9 on the Richter scale, the governmental programme considered three models of 'heritage' dwellings, especially designed for that *Typical Zone*. They recreated the formal features of just three 'typical' types of dwellings existent in the village. Only two types were built, and one with a pronounced gable roof, repeated more times. This type of dwelling has increased with the reconstruction from only 6% of the total dwellings in the village before the earthquake to approximately 40%. These new houses have a special shape in the connection between the wall and the roof, which again intends to recreate the thickness of the old *adobe* walls and, ironically causes leaks to the interior of the dwelling when raining (Fig. 9).



Figure 9: San Lorenzo de Tarapacá before and after reconstruction. Plane roofs were predominant before the reconstruction, which changed when gable-roofing dwellings were repeated many times.  
 (Source: Author).

These houses in Tarapacá are an example of what can happen if designers strive for an appearance of heritage rather than for a more sustainable construction. The building technique used, steel structure and concrete blocks as filling, with a plaster that includes 50% of clay, it is not appropriate for the dry/arid climate of the village, as thermal mass is needed to store the heat of the day and liberate it in the night when lowest temperatures are usually experienced, which is

a natural capacity of *adobe* constructions. The thermal behaviour of adobe buildings in the central area of Chile is also better than any other contemporary building technique in the sense of its adaptability to the seasons.

What is currently happening in the Central area of Chile after the 2010 earthquake solved many issues from that previous experience: dwellings are bigger, more appropriate building technologies are being used, architectural elements of previous houses are being maintained, such as the continuous facades and the porticos, and old materials are being recycled. In addition, 63% of the projects are designed as repairs to the existent houses, which is something completely new and important for subsidies applied in historic areas in Chile, allowing the preservation of a larger amount of historic houses. After 2005 earthquake, in San Lorenzo de Tarapacá, only new construction subsidies were applied, which means that several important and characteristic dwellings are still in ruins, or, much worse, are being currently being used even when they represent a danger for their inhabitants, as they were never repaired or reinforced.

Nevertheless, a problem of authenticity is underlying the design process for new dwellings: do we want to conserve the built form of heritage areas or the building tradition behind them? Can we as designers maintain a balance between them both? It is important to clarify that the problem is not the use of contemporary building techniques *per se*, as interesting projects can be designed with either new or vernacular techniques. The issue is with the type of design that is being reproduced and how it can change the perception of historic areas for future generations. The chosen building technique in reconstruction is also related with the construction process. Local materials are normally used when the inhabitants are included in that process, but what generally happens is that external contractors are in charge of the construction, hence imported materials are being used. This affects people's participation in the reconstruction process.

The reduction of traditional architecture to its elements has been a common approach in the related literature. There are several publications that aim to be a record of built heritage in order to preserve it for the future. These publications are usually generated after earthquakes, as a reaction to the destruction they produce, such as Guarda's book, published in 1988, three years after the 1985 earthquake that affected the central area of Chile. They are an important and unique record, noting which elements represent the values of vernacular architecture. However, these have been used as catalogues for a non-critical imitation of traditional architectural features: proportions of windows and doors, presence of porticos, pillars, etc. In addition, as particular records of dwellings before earthquakes are not available in most cases (MINVU, 2011), an average 'heritage' house is being designed for the Central area of Chile, where almost the same project, with minimum variations, is being replicated in different historic areas. This is in turn reinforced by the repetitive design strategy used by architects in the most of cases, as mentioned above.

Guidelines from the Council of National Monuments have a similar aim. Most of them were created after the 2010 earthquake, as an attempt to guide reconstruction projects in heritage areas, establishing a series of architectural elements that new constructions should include. The evaluation of projects at the Heritage Reconstruction Programme is also based on this. In the end, it is possible to have a project that conveys all the elements stated on those guidelines, but having no sense of sustainability and identity.

Certain elements, such as porticos are being maintained as architectonic elements in the new houses. One could argue that there is no need to replicate porticos if the new house is rebuilt with contemporary building techniques, as the function of protecting *adobe* from the rain and its structural stabilization is no longer necessary. However, these elements are seen as representative of this kind of heritage and are consequently repeated in reconstruction projects regardless of the structural system they have, which is very popular with inhabitants if they used to have them. Indeed, from the interviews taken in January 2013 almost three years after the earthquake, all interviewed inhabitants are in favour of new houses that include porticos, because they think they improve the appearance of the dwellings and help to preserve the tradition of the place. Besides, the porticos also offer a shaded intermediate situation connected to the public space, used by people during the warm seasons.

But to what extent is the use of these architectonic elements shaping our memory of what these villages used to be? The emerging issue in *Lolol*, and proven in Tarapacá, is the effect of our 'traditional' designs in constructing memory for the future. The 33% of progress in the reconstruction of housing in heritage areas following the 2010 earthquake has proven it is possible to build dwellings that *look like* the original ones, although they are not similar in relation to the quality of its spaces and its thermal behaviour. This relates to intervention criteria in built heritage and how it is never possible to rebuild exactly *the same*, for which it is preferred to use the term re-construction (to build again), as a distinction to reconstruction (to build as before) in this study (Devilat, 2012).

Whether to reconstruct a building or to leave it as ruins, to restore it to its previous condition or to build something new in the same site, and how to do those interventions are issues that have been debated for many years. Nevertheless, the main difference when talking about reconstruction after an earthquake is the scale. Even though earthquakes in seismic areas are common and regular over time, destruction and reconstruction of historic areas are left out of the heritage debate, as reconstruction is considered as something unquestionable in those cases. Some authors even separate post-earthquake reconstruction from their discussion in the assumption that the existence of enough documentation is usually available: "*I have deliberately limited the argument in this way, in the hope of avoiding the confusion that could be introduced by including other types of building reconstruction. I do not consider here buildings that have been reconstructed immediately following a natural disaster or a war. These differ because there usually exists ample documentary evidence of the destroyed buildings*" (Stanley-price, 2009:33).

However, that *usual existence* is not that usual and records of historic buildings are not always available, especially if they are not monuments. Even if those records exist, is a violent change such an earthquake a valid justification to reconstruct historic buildings without a proper debate concerning its heritage value? It is the right time to reconsider the future sustainability of reconstructed houses in heritage areas.

In such context, the role of the record of buildings before (and after) earthquakes and before demolition becomes fundamental. In post-earthquake situations, technical assessment for historic buildings and dwellings is usually done in a second stage, when several things have already changed, not only because of the earthquake but also because of the first emergency actions. This has also been the author's experience with the case studies following the 2005 and 2010 earthquakes. Therefore, the perception of affected historic areas is blurred with the destruction. Sometimes the only possibility to have an idea of the damage level is the existence of previous records that, although partial, can help professionals and researchers to understand the impact of the earthquake (Fig. 10 & 11).



Figure 10: (above) Dwelling in Paredones after the 2010 earthquake. Above: before demolition.  
(Source: Muñoz, Alejandra).

Figure 11: (below): after demolition. The image above became the only record available of the dwelling before its demolition, thus the only input available for the design besides owner's experience.  
(Source: Author).

It is interesting to explore how these records may impact in the design process of reconstruction projects, considering the formal approach used in most of the cases to design reconstruction projects for heritage areas and buildings. A 3D laser scanning survey, for example, can be a powerful tool for such accurate recording method, as it combines high definition photos and a laser to build a measurable 3D model of the reality in a short period of time -in comparison with the other record techniques-.

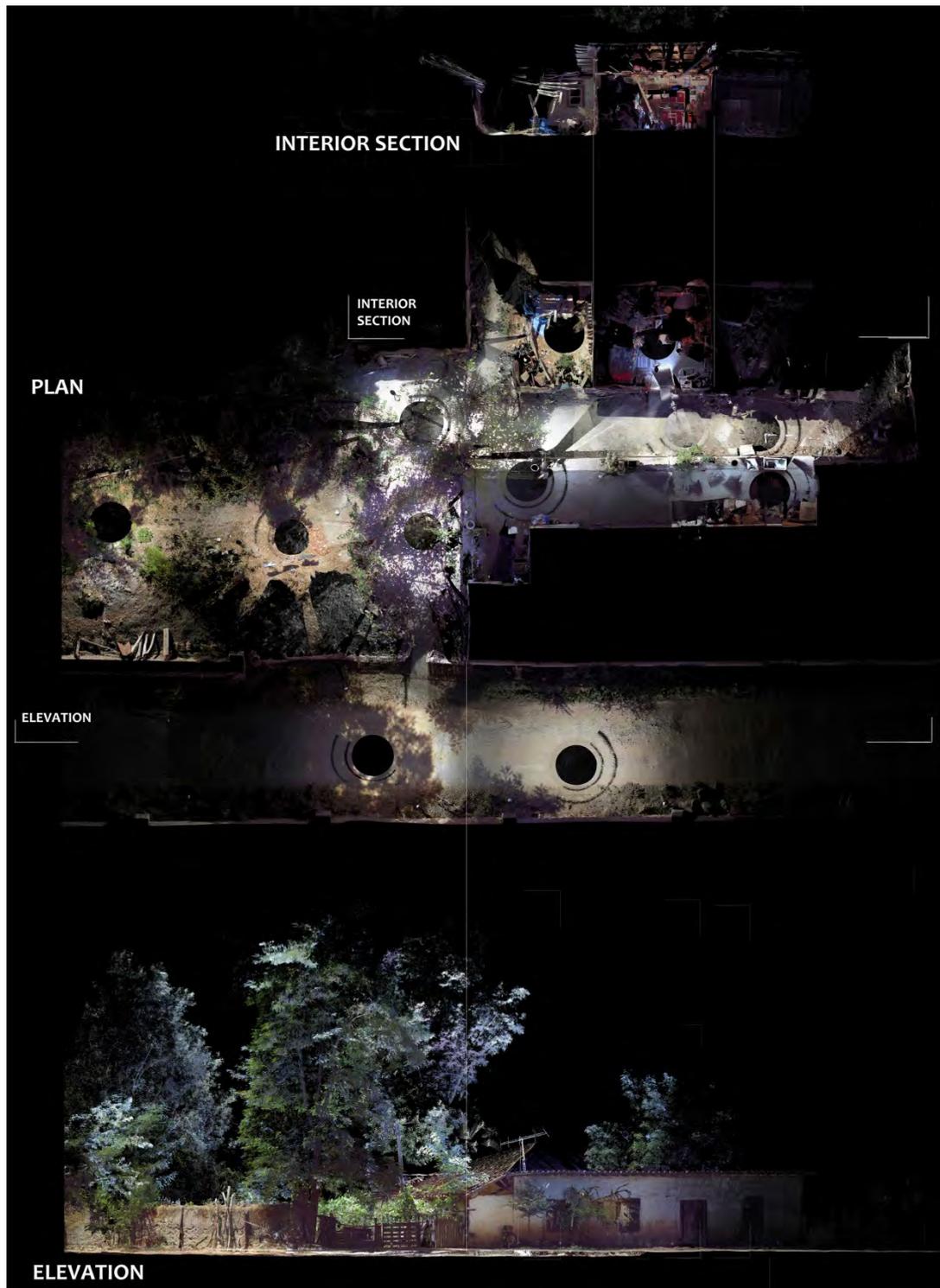


Figure 12: Section, plan and elevation of a dwelling in *Zúñiga* made using 3D digital model obtained through 3D scanning. The black circles show where the scan was positioned on site to survey (Source: Author).

3D scanning can provide a rigorous method of building information to be applied in the reconstruction projects, in order to avoid the interpretation or the creation of *average heritage* projects, as aforementioned. Related to this, it is important to mention that one of the issues that have made reconstruction of heritage areas such a slow process is the need for a survey of existing conditions in order to develop accurate designs of reparation and reconstruction of

dwelling, which usually takes a long time as is being done with traditional representation methods, such as hand and digital drawing, and photographic record. For example, to survey a dwelling with its interior, took only two hours on site (Fig 12).

The application of this tool has been used before as a post-earthquake assessment, but not to critically question the nature of reconstruction, which is being further explored within author's PhD thesis. In addition to the possibility of obtaining such accurate data, the thesis explores also to what extent it could be used as an attempt to address a more sustainable approach to the design process in reconstruction after earthquakes.

### **Building technology and sustainability**

**The Cambridge Dictionary defines something as *sustainable* when it “is able to continue over a period of time”, and as something that is “causing little or no damage to the environment and therefore able to continue for a long time” (2013).**

An interesting fact is that the value of this vernacular housing in such a way is not recent. Guarda noted José Gandarillas, a famous intellectual in the mid-19<sup>th</sup> Century, invoked traditional architecture as a comparison during a polemic about fashionable architecture at the time: “(...) *those simple examples inherited from the Spanish period, which resist temblors and earthquakes, adapting to the seasonal changes in a marvellous way, and also adapting to the uses and habits of their inhabitants in an admirable easy way.*” (Gandarillas in Guarda, 1988)

Sustainability is then closely related to the building technology implemented and how it determines spatial characteristics of the building. Some of the reconstruction projects use sustainable materials in the sense that they are cheap, local and have a good thermal behaviour, such as straw bales. However, as aforementioned, their use only in the facades seems to be with the intention to replicate the thickness of adobe walls and not as an answer to the climatic conditions of the place.

Even if it is possible to introduce straw bales as a new building technology, they might not become sustainable in the future, because inhabitants do not want to use it in their houses, as there is a strong misconception about it. In *Lolol*, which is one of the most advanced in the reconstruction process and where all the new projects use straw bales in their facades, 63% of inhabitants interviewed do not like it, as it is associated with animals, mice and insects. Most of people accepted it as no other alternative was offered, reinforced with the restrictions of the *Typical Zone*. There are some others concerned about the fire and earthquake resistance of the straw bales, and how it ages. Based on this, they might not be used by local people in the future after this reconstruction, even when they could be seen as a sustainable technique for the climatic and environmental conditions of the VI region of Chile and even when they will be continuously generated in that agricultural area.

As identified in other post-disaster situations, there is a certain consensus about the importance of participation in reconstruction processes, but in practice, sometimes it presents a manner that does not reflect a real participation (Davidson, Johnson, Lizarralde, Dikmen & Sliwinski, 2007). In example, *Lolol's* inhabitants participated in some of the decision-making process during the design of the new houses, but they were only spectators during the construction, as identified by themselves when interviewed. How can current reconstruction approaches be sustainable over time if they rely on external actors and not on the inhabitants as in past generations? That does not necessarily mean that they should build their own dwellings, but that they should be involved in the process at least.

*Lolol* has been declared ‘*Typical Zone*’ because it is: “*a valuable example of spontaneous rural settlement, with a strong influence of traditional architecture from the Central Valley (of Chile), where self-support and self-building are mixed*” (Council of National Monuments of Chile, 2011, p.7). These two important aspects are no longer present in the construction and reconstruction processes. External contractors build reconstruction projects, as Government's subsidy does not permit any other possibility, with the aim of assuring quality construction standards. Self-construction is only allowed for small amounts of money given for minimal reparations in less damaged dwellings. Considering that the space recovered with subsidies is

only between 50m<sup>2</sup> and 90m<sup>2</sup>, and the previous dwellings used to be much bigger, it is the inhabitant who has the responsibility of continuing with the next stages. Then, the reconstruction process could be an opportunity for education and dissemination in relation to repair, maintenance and building techniques, which has been the approach of some organizations such as Fundación Altiplano.

On other hand, the spatiality of dwellings is something that is being lost in the new projects, as they are not designed for future expansions. The notion of drift or adaptation has not been included as well, as some spaces need to change and be improved according with the ways of life of their inhabitants. Thus, it might be necessary to go beyond the vernacular as valuable per se, because it might be insufficient for contemporary standards. Then, repair and re-construction approaches should also try to solve these issues by including new technologies, which is currently addressed in the new seismic regulation for heritage areas. Marcel Vellinga (2012) argues that the idea that vernacular is superior to contemporary is no longer adequate, and that building traditions that are considered vernacular architecture can also learn from contemporary design. Maybe the selection of building techniques for re-construction projects could be done using the same sustainable principles present in vernacular ones, such as economy, adaptability and use of local materials.

*Traditional construction practices and delivery mechanism often embody local knowledge accumulated over time through successive trials and errors. Therefore these cannot be rejected outright when deciding on the appropriate technology for reconstruction. The challenge is how to integrate positive elements of these practices into the proposed solutions. (Jigyasu, 2010, p.49)*

## CONCLUSIONS

This paper had tried to address some of the issues related to the design of reconstruction dwellings for historic areas in Chile, focusing in how the sustainability of old heritage houses is not being considered as a quality to reproduce in the design process. Advances are being made in the decision of repair existing houses when possible, but the problem continues on the new designs. The description of the building techniques used after the 2010 earthquake is an attempt to find whether they try to achieve that in the design of new dwellings. In that respect, it seems that the building technologies are used as an attempt to recreate formal features of the old houses, such as the thickness of the adobe walls, the shape and amount of openings, among others. Those technologies are not used then to make the most of them and to improve habitability, but to achieve formal conditions of previous technologies.

If reconstruction continues in that way, heritage areas will only be a representation of how they used to *look like*. If that is what the designers search, heritage appearance is easily reproducible with the new accurate recording technologies available, such as 3D laser scanning, thus the value of its shape might even be diminished over time in the future. What is the point on stating that one of these heritage villages was first built in the 1700s, whereas there is almost no construction dating from that period anymore? What about to experience not only the space and shape of heritage buildings but also its light and thermal conditions?

In the end, one could argue that there is an inevitable renovation process each time an earthquake occurs -sometimes imperceptible or one that we do not want to see-, as they have affected heritage areas in Chile many times in their history. Thus, the most important change necessary to be made for the re-construction is to use the basis of a sustainable building tradition and not the appearance of heritage. Sustainable re-construction should include the traces of the changes and events over time, so these historic areas could be seen as a rich palimpsest. They should adapt to the climatic conditions of each place in the same way that vernacular architecture originally did.

It is necessary to recognise earthquakes as regular events that trigger changes in our built environment and therefore, to recognise those changes as part of the heritage in vernacular settlements. On other hand, in terms of memory, the fact that not all the houses are being

repaired or reconstructed with the current reconstruction programme, even when implying a risk for the inhabitants, allows us to understand these places as a process and as testimony of our history.

Finally, this work seeks an understanding of vernacular architecture as a sustainable way of re-thinking and designing, rather than just a formal approach. This is related to the social and cultural role of heritage in places where earthquakes will continue to hit and where it is necessary to approach re-construction as a natural and progressive process.

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