

Resilience Reconnaissance | Housing

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Introduction

The 2010 M8.8 Maule earthquake had devastating impact on housing in Chilean regions V, VI, VII, VIII, and XI. After the earthquake it was estimated that 370,000 homes were damaged, and of those 220,000 housing units would receive government assistance, among which half would be repairs and half would be rebuilds. These repairs and rebuilds included a wide range of types of housing, with a mix of adobe houses in historic areas, social housing, rentals, and occupant owned, so the plan to rebuild would have to have parallel paths. Chile already had strong programs in place for subsidized housing before the earthquake, which served as the framework for completing rebuilding after the earthquake. Common among the various approaches was a 4-year reconstruction plan, which included stages of planning, implementation, and execution. Many methods of repair were used, including contracted work by larger companies, local subcontractors, and do it yourself repairs/rebuilds. Regardless of the method, most approaches were organized by the central government, especially subsidized solutions, and then carried out through the help of local communities/officials.

Housing is at the core of community resilience, since the loss of housing can lead to permanent migration from the community, having cascading effects on business, health care, and education. The purpose of the EERI Learning From Earthquakes (LFE) Resilience Reconnaissance study in Chile is to attempt to track the level of resilience in communities affected by the 2010 earthquake seven years later, as compared to the state just prior to the earthquake. This involved gaining an understanding of the various responses to the earthquake and their level of success in maintaining strong communities that are better prepared for the next disaster. This was done through informal interviews with people living in affected communities in the period of January 14 to 18, 2017. Admittedly, this is a very small sample of opinions that is associated with just one point in time, but it serves as an important data point and a model for future, more comprehensive resilience reconnaissance studies.

Three main locations were studied in depth: Santa Cruz, where social housing was rebuilt in a location that previously had a social housing project; Lolol, a national heritage district with buildings of historical interest but vulnerable construction; and Constitución, an area twice devastated by both the earthquake and the subsequent tsunami. For each of these three locations, a brief overview is provided of what happened in that location before and during the earthquake, and of what the official response to the earthquake was. This is followed with summaries of the information gained through interviews with residents in these locations.

Methods of Data Collection

The information presented in this report is based on interviews with approximately 15 different individuals in January 2017 by the authors of the report. As a result, opinions expressed are those of the individuals interviewed and not of the authors themselves. Interviews were conducted primarily with residents in each location, as well as with local officials from SERVIU (Servicios de Vivienda y Urbanización) where possible. Effort was made to talk to as many residents as possible at each location, while interviews conducted with officials were limited to those who the resilience reconnaissance team was scheduled to meet with as part of the program.

To obtain the largest possible sample size of interviews in the limited time available in each location, the interviews were kept short and to the point. Additionally, to yield candid and honest responses from the interviewees, interviews were conducted in a conversational style rather than using a consistent script. However, all interviews attempted to obtain the same basic information:

- Where were you living when the earthquake occurred and how was your home affected?
- What recovery options were you offered or were you aware of?
- What are some of the differences between your home before the earthquake and your home after the earthquake?
- How has your community changed between the time prior to the earthquake and now?
- What can you tell us about the process of reconstruction after the earthquake?
- What are your recommendations for improving the process of reconstruction in the future?

For data collection in the field, the team used Evernote on a combination of iPhones and Android phones. Each team member was able to create automatically geotagged notes that could contain a combination of text data, photos, and recorded audio data (which was used to record interviews when permission was given). The geotagged notes on each device were automatically synchronized to a shared notebook, meaning that all team members had access to all of the geotagged text, photo, and audio data from each team member as soon as their phones were able to synchronize over WiFi.

Community Observations

Santa Cruz

History

A social housing complex of approximately 20 blocks of apartments on the edge of Santa Cruz experienced significant physical and emotional damage during the 2010 earthquake. One of the buildings' first floor completely collapsed, causing the second floor to fall on top. This resulted in two deaths. Approximately three other buildings had significant damage. Due to the fatalities during the earthquake and the extensive damage to the buildings, the government decided to demolish all of the existing buildings and build new social housing for the community (Figure 1).



Figure 1. Location 1: Santa Cruz (VI Region O'Higgins)

Response

A set of 8 blocks of apartment buildings were built at the same site of the original social housing units. Each building is 4-stories tall, and was built with base isolation to ensure safety during a major earthquake. Base isolation was chosen for seismic protection due to the poor soil conditions on site. The base isolation system consists of a combination of rubber lead isolators and sliders. The units in the new buildings are twice the size of those in the demolished buildings, allowing significantly more room for families. The units were granted to the residents by the government, giving them full ownership of their units. Within the complex, a park, a soccer field, and a memorial to those who died in the earthquake were built to add a sense of community. Residents of the new buildings consist of residents of the previous social housing on site mixed with new residents.

Transition Period/Rebuilding Logistics

It took about three years to build the new social housing complex. During this period most of the families were relocated to emergency camps. These camps were tents that were situated near the complex, provided by the municipality. A general sentiment from the residents of the community was that this took too long, and this was the strongest voiced complaint during interviews. Not all residents of the previous buildings chose to stay and live in the new buildings; about half of the community left permanently, with new families from outside Santa Cruz occupying the remaining units. This is in part due to the fatalities that occurred, and the memories associated with them.

User Sentiment

In general, users felt satisfied with the housing solution presented to them; however, some complaints were expressed. The previous buildings were in very poor condition before the earthquake, and the units were considered too small for the families residing there. However, the new buildings have helped to improve the quality of life for many of the residents due to the good condition of the buildings and the size of the units. In some cases, multiple families were residing in one unit before the earthquake and were granted multiple units in the new buildings. Residents understood the purpose of the base isolation and appreciated its presence. The residents appeared appreciative of what the government had done for them post-earthquake, but did mention that sometimes the process was not as transparent as they would have liked, especially when it came to timelines. Complaints were expressed about the aesthetics of the new buildings, even comparing the appearance of the buildings to a local prison. Additionally, there were complaints of construction quality. Some apartments were leaking during the winter. These buildings have experienced minor seismic activity since they were built and residents felt safe and comfortable during these events. The residents felt that the sense of community in the complex was strengthened after the earthquake, for reasons that included the smaller size of the community, better quality of life, and recreational facilities added to the complex.

Concerns

Concerns have been expressed about the project by both the designers and SERVIU that can serve as insight to future plans should another earthquake occur. A resident and director of the community identified an issue that while residents owned the units they were living in, because these housing units were granted to the residents, they were not necessarily taking care of them as if they had purchased them. This is often a problem identified in subsidized housing, but the government's intent was that ownership would help to avoid neglect. Additionally, the designers identified that a base-isolated system requires some maintenance that likely residents would not be able to provide. Maintenance mostly consists of periodic inspection of and education about the buildings' base isolation system. Because the buildings are now privately owned, the designers and SERVIU do not have the right to inspect the buildings. They cannot confirm that nothing is being built that would block the isolation system from

working effectively during an earthquake. Finally, some of the apartments have not been occupied even two years after they were completed.

Lolol

History

Lolol is a national heritage area due its large stock of traditionally-built adobe buildings, featuring continuous facades facing the street (Figure 2). This building style is perceived as the stereotypical design of homes in rural Chile and has had significant tourism appeal in Lolol. During the 2010 earthquake, many of these adobe homes were significantly damaged or completely collapsed due to weak materials and poor construction standards, especially in the historic district of Lolol. Only housing that featured a timber frame within the adobe blocks remained repairable, compared to those buildings that lacked a timber frame, which had to be demolished.



Figure 2. Location 2: Lolol (VI Region O'Higgins)

Response

Homes were rebuilt by the government in the historic colonial style, but with structural upgrades. Timber frames were used to support the adobe blocks, and the adobe bricks were made with straw to act as reinforcement throughout the wall. Some houses were wrapped in light steel mesh as an alternative to using straw in the bricks. In either case, the walls were covered with adobe finish to give them their traditional appearance. All roofs were wood-framed with clay tile. Some houses were repaired or retrofitted with these improved methods, but most were rebuilt completely.

Transition Period/Rebuilding Logistics

It took four years from the time that the 2010 earthquake occurred to the time all repairs/rebuilds were completed in Lolol. A few exceptions to this took longer due to legal ownership issues, which is why some houses still remain unrepaired in Lolol now. Temporary housing varied from household to household; some remained on their land overseeing the reconstruction process in temporary wood housing provided by the government, while others went to nearby towns or other homes that they had. Because of its historic significance, this area received more money for reconstruction than normal areas;

70% of reconstruction costs were covered by the government, leaving the balance to be covered by the homeowner. The municipality reviewed the properties and evaluated who needed help, brought in architects to evaluate solutions, and then handed out subsidies. The first round of repairs were completed by a construction company and were completed within a year and a half of the earthquake. After this, some residents were allowed to take the subsidies directly and hire their own subcontractors, working independently. Government officials had to verify correct construction procedures on all houses.

User Sentiment

Initially, residents did not want to rebuild in the adobe style. Many wanted concrete or masonry houses, which they felt would be safer and more structurally sound during an earthquake. The mayor determined that the houses' aesthetics should match those before the earthquake, in order to preserve the touristic and economic status of the town. Initially this met with resistance; one woman even knocked down her wood frame three times out of protest. However, after rebuilding began the residents seemed to be happier with the construction. Houses were built nearly the same as old houses, but with safer construction methods, and users felt the homes were nice for the most part.

Concerns

Because various inconsistent models were used for reconstruction (government contractors, private construction companies, or independent work) there were concerns about the consistency of construction quality across the board. It is suspected that not everyone followed the guidelines drawn up by the architects, meaning that some of the buildings may not perform as expected.

Constitución

History

Constitución was the area hit hardest by the 2010 earthquake, both due to proximity to the epicenter, and because the earthquake was followed by significant tsunami damage. The effect of the tsunami was pronounced in Constitución due to its location at the mouth of the Maule River, which was fully inundated by the tsunami. Many houses were located on the west bank of the Maule River near its outlet to the sea, and these houses were irreparably damaged. This area remains one of significant tsunami risk, and the government has forbidden construction in the zone.

Response

New social housing was built on the hills to the west of Constitución, well above the inundation zone. This new community, called Villa Verde, was designed by the Chilean architecture firm Elemental. The houses were designed to be built incrementally--initially a two story frame with a floor and roof were built, and half the house was finished and granted to the former occupants of the tsunami zone (Figure 3). The homeowners could then finish out the other half of the house with their own resources when it was feasible for them, and according to their own preferences. This simultaneously helped to spread the benefit of limited reconstruction resources to a larger population, while also encouraging homeowners to make the home their own, establishing a sense of ownership. Although the intent was that these homes would be exclusively for those families displaced from the inundation zone, as in other communities the resilience reconnaissance team found that many of the homes were occupied by families who lived in other areas prior to the earthquake.



Figure 3. Location 3: Constitución (VII Region del Maule)

Transition Period/Rebuilding Logistics

During the rebuilding process some residents were given subsidies for temporary housing and some were not given a temporary place to live. Those that did not receive a subsidy had to find and pay for their own temporary place, which was very difficult for many given that they had just lost everything to the tsunami. It took many families up to four years after the earthquake to get into their homes. Additionally, the plan and purpose of the social housing project was to move the whole community from the tsunami-affected region to the new community on the hill, keeping neighbors near each other, in order to keep the community as similar and close to each other as possible. Instead, families were placed in homes based on an application number, people from other areas and towns moved into the housing, and some even got these houses as second homes. Anyone who was in the tsunami region was given a house, but others were able to buy homes. Some units are still open and on the market now. Additionally some families in the area whose houses in the inundation zone survived the earthquake have since lost their homes due to unemployment after the earthquake, but the houses in Villa Verde are too expensive for them to buy now.

User Sentiment

Originally many residents were against these new houses, mostly due to their location. Many of the previous residents had lived near the water close to their place of occupation. Moving that far away from their jobs would cause much longer commute times, and in some cases, cause them to quit that job. This could be the reason that many from the community did not relocate to Villa Verde. However, those who chose to move up on the hill had mixed feelings about the housing itself. While some felt that the houses were well built, nicer than their previous home, and a welcome unexpected gift, others, mostly those in the smaller homes, felt that the new housing was in some cases smaller than their previous homes. Additionally feelings were mixed about the ability to expand their housing, which was limited to certain enforced guidelines. One family complained that their financial situation made it difficult to expand, but the expansion was necessary due to their house being too small for the family. Others enjoyed the freedom associated with getting to complete their own expansion, and having a say in what their home would look like.

Concerns

One concern with the expansions is whether the new additions are being built safely. Residents were given access to plans to expand their homes, but according to a local resident many did not follow the plans, and there was little regulation from the city to check this. If residents did not follow plans, it could be difficult to determine if all of the houses would be safe during a future earthquake.

Conclusions

Though only a small data set is reported here, the following can be observed. First, the timeline that the government set for rebuilding was met for the three case studies discussed, and while displacement time was a complaint for many residents, it appears that the Chilean government did a reasonable job in rebuilding quickly and efficiently. While it is understandable that these residents felt it took a very long time to rebuild, when comparing Chile to other regions affected by natural disasters, Chile appears to have gotten more done in a shorter timeline. Along with this though, it is observed that a more consistent plan could be in place for temporary housing. Some residents received assistance during the rebuild time, while others were forced to find it on their own. Chile also did a good job in taking the opportunity to improve the quality of life of their residents. New housing was not only seismically safer, it was also improved upon in size, aesthetics, and quality giving lower-income families the space needed to raise a family.

A lack of interest in community building could be an observed flaw of the rebuild process. While much detail and attention was made in the actual reconstruction of homes, the social side of how the new homes would affect the community was not a major focus. As observed, specifically in the case of the social housing in Constitución, while the plan stated that families would be placed near their neighbors, this was not actually implemented, and residents noted that the community had completely changed.

From a resilience perspective, it is fair to say that the communities investigated in this report are more resilient now than they were before the 2010 earthquake, to varying degrees. In Santa Cruz, new social housing was built in the same location as the previous housing, but to a much higher performance level. In Villa Verde near Constitución, in addition to building to a higher performance level, new homes were built outside of the recognized tsunami inundation zone. It is clear that these communities will be better able to weather future seismic events. In Lolol, certainly the buildings which have been repaired or replaced are likely to fare better in a future earthquake, but much work remains to be done, and it is unclear whether recovery efforts have prioritized community resilience or economic recovery via tourism.

References

Mary C. Comerio (2014) Housing Recovery Lessons From Chile, *Journal of the American Planning Association*, 80:4, 340-350.

Mary C. Comerio (2014) Disaster Recovery and Community Renewal: Housing Approaches, *Cityscape: A Journal of Policy Development and Research*, 20:2, 51-68.

Appendix A First-Hand Interviews

Permission to record audio was obtained from the interviewees in the following narratives. The translation from Spanish to English was direct without any enhancements to provide an accurate sentiment of the people.

Santa Cruz

Interviewee: SERVIU employee

Formerly in this residential complex there were approximately 20 blocks of buildings different from the ones now. During the 2010 earthquake, in one of the buildings the first floor completely collapsed and the second floor fell on top. This caused a total of 2 deaths. From then, the government decided to demolish all of the buildings even though only two or three had major damage. There were new buildings built with seismic-resistant protection systems installed. This was a requisite from the people living in these residences; these same people are now living in the new apartments.

As I was saying, eight new blocks of buildings were built. With the earthquakes we've had in the past years, there hasn't been any inconvenience caused. We haven't had any problems. I understand that last year other people from SERVIU came to do a follow up to check the buildings. Everything was in observed to be in good condition. The displacements of the isolation systems noted were much less than what the systems were designed for.

Is there any instrumentation in these buildings?

No there isn't any. In the Chilean standards, there are recommendations for special structures to have instrumentation but it is not required. The instrumentation is not mandatory and the only buildings that are being monitored right now are hospitals. However, in the new provisions for seismic design of buildings for Chile in the near future, there will be instrumentation required for buildings over a specific square footage. One of the problems of putting instrumentation in these residences is that these are private. Someone would have to take care of them and we're not sure who would be in charge. For example, hospitals are public so it is easier to access these systems and monitor.

Santa Cruz

Interviewee: Resident

Could you please describe your experience during process of reconstruction?

It was long. There was a long wait, especially for those of us who lived around this area by the Ciruelos. It was a very long process; very very long. We all understand that it costed a lot but it was too long. And then we received these apartments with many problems.

What type of problems?

At the beginning there were many failures inside the apartments. For example there were some that were leaking during the winter. It was complicated for people.

Before receiving the apartments, where did you leave?

Here, by the Ciruelos. We were in tents, in the 'mediaguas' that the municipality provided. But as I said, it was very complicated.

Did you live in this zone prior to the earthquake?

Yes we lived here.

What options did they offer you in terms of housing?

We had to wait. They gave us solutions but we had to wait. It took a while but the solutions eventually arrived.

How are these homes compared to your housing prior to the earthquake?

They are much superior now than before, in everything. They are better in terms of shelter and construction. The former construction was in very bad conditions. But these are definitely superior and very good. Compared to our older homes this is great.

Regarding the community, are the neighbors the same as before the earthquake?

Very few former neighbors remain. Almost half of the neighbors changed. I believe a bit more than half of neighbors are different now. People arrived that we had never seen before.

For those people who did not stay, where did they go?

They went somewhere else. Some went to Pablo Neruda for example. They went to other different existing communities. They left during the process of reconstruction.

Santa Cruz

Interviewee: Resident/director in the community.

Could you please describe your experience after the earthquake in terms of housing?

I personally lived in another sector. In that area there were various collapses. There were many components (inside) that fell. The houses were made out of adobe. Actually, in front of my former house there was a house made of adobe that fell. An old lady that was in bed lived in that house. Her granddaughter went in to help her and she was trapped by the collapse. Such things happened.

After the earthquake, management was rapidly initiated to assign housing options for all of us who were affected by it. Information from people was gathered quickly and housing projects were initiated. In this specific neighborhood there were various building complexes. In all of them basically everything inside fell. In one of the buildings one floor actually collapsed. Following the earthquake two options were presented for this area. One option was to reconstruct each apartment building in the same location and the other option was to move to a new building complex in Bicentenario. In that location there are three story residences where four families live. Some people went there but others, like us, stayed here.

One thing that the company did was to allow those of us who were going to live here to be part of the construction; this way people would make sure the homes were being constructed properly. Regardless, it was a long wait for us. We all had to find ways to make ourselves comfortable. Some people were temporarily assigned to homes while they waited during the process of reconstruction. Eventually the homes were distributed to the people. Unfortunately not all of the apartments are currently occupied. There are people who might have been given a home here but did not come because of their fear of earthquakes. There are people that are living with their sons and daughters instead of coming here. We are still in the process of filling up the spaces. These apartments were provided to us around two years ago and they are still not filled completely.

Do you know what percentage is unoccupied?

I don't know the number of apartments unoccupied exactly but there are various. Since moving in we have had some strong earthquakes while living here.

Do you feel safe in these apartments?

Well the males typically feel safe. However, the females are a bit more fearful. Since I live in the top floors we have felt significant movement but there haven't been any problems. We haven't had any damages. At the beginning people were scared so they would go outside during the earthquake. But now we realized that the seismic-resistant systems in the buildings functions properly so we continue our daily life.

Additional remarks: This individual interviewed is the director of the community. He is involved with meetings in the community where people come to agreements regarding certain issues. He explained that the community is currently trying to improve the conditions of the complex. Overall they are very satisfied with the reconstruction and the facilities. However, many of the people living here take their homes for granted since it was given to them for free. Therefore they do not take care of the apartments. He and the rest of the community members are trying to inform and educate the rest of the neighbors about how to maintain the complex and ways to prevent the conditions from worsening.

Lolol

Interviewee: Resident**How was the process of reconstruction in this area?**

This is the zone of national monument. It is protected and for that reason it had a special subsidy. It received more money than other normal areas for reconstruction.

How are the renovated houses compared to the older ones?

The conditions are the same. The funding that we received only covered 70% for repairs and the rest was covered by us, individually. Since this is a historic area we had to follow the building requirements such as maintaining the same height and using same materials. All of the houses have to follow the same construction methods and have to use the same construction materials, according to the law. They are all the same. You have to have adobe on the exterior with wood and clay roofs.

Were you living in the houses during the repair?

No, we all left. We went to another house that we have. Others went to other places. Overall, the process took about a year and a half.

Are you satisfied with the process of reconstruction in total?

Yes, I think so.

Is there anything that could have been improved?

Well these were the first houses to be repaired. We were guinea pigs. Perhaps there could have been a better optimization of resources. The first houses were built through a construction company. The company did the construction. But for example other neighbors afterwards took the money directly and they hired their own subcontractors and worked independently. This way there was no construction company that made profit out of this.

Was there any technical assistance?

Yes, the government came to verify the construction procedures.

Was there any reinforcement used during construction?

For example, those houses are made of straw bale. They built the structures out of wood and then they would infill with straw bale. They would make it the same width of the adobe blocks and therefore it would satisfy the same process of isolation. Other houses are made of adobe blocks with wire mesh reinforcement.

Constitución

Interviewees: Two married residents with children

Would you please be able to describe the reconstruction process in the community?

After the earthquake they started to build these houses and it took them a while to build them. The people wanted them to be finished quickly. After they finished building we came to live here.

Are you satisfied with the houses built that were given to you?

Well there are two types of houses, small and big. I was given the smaller house so it feels small compared to my older home. My older home had an extra bedroom. In this new house we had to add a room to the original house. There is a provision that restricts the size of the addition.

How many rooms does your house currently have?

The first phase, the original house, came with two rooms. We added one room so there are a total of three bedrooms. We should be able to add a floor on the additional area but it is not allowed. This should be permitted because families grow.

How was the process of building the addition of the house?

For me it was difficult because of my economic situation. The addition was covered by us. When you are more economically stable it is much easier. We basically lost everything and then we were living under my husband's minimum salary so it was even more difficult for us. I lost the house and furniture; we recently finished obtaining the rest of the furniture. Thank God we didn't lose anyone in our family, but it has affected us.

The good thing is that there are schools here such as nursery and primary school. However they don't have for children younger than two years, like my granddaughter (which she raises). That is something that is missing here.

The husband joins the conversation.

How long did the construction of the new addition take?

We completed most of the construction in one week. It took us a total of two weeks to finalize the addition.

How many rooms do the bigger houses have?

The large houses have four rooms and the small ones have two.

Did they give the small or big houses depending on the family size?

Yes they give the houses depending on how many children you have and so forth.

Constitución

Interviewee: Resident who converted the first floor of her home into a convenience store.

Could you describe your experience during and after the 2010 earthquake? How was the process of reconstruction?

It was slow. I didn't live the experience so 'close' because my house did not fall down. Not everyone in these residences lost their homes. For example, in my case I don't live here because my house collapsed. I have a right to a subsidy because I am a Chilean of low income. That is the reason why I have subsidized housing. We received the homes two years afterwards which was fast. While waiting, some people stayed at the houses of their relatives or in some temporary houses that they provided for those affected. In my case it was different. I lived at my parents' home and then I came to work here.

Where was the house where you lived?

In a region on the other side of the river, a 25 min drive from here towards the coast.

How was the selection process of beneficiaries of subsidized housing?

It always works by score. People who lost their homes will always be guaranteed a home.

How does this community feel currently?

I like the calmness of the area. I don't like the weather because it's too windy but I like how calm it is. You can leave your bicycle outside or the door open and you do not have to worry.

How do you feel about the proximity to the beach (since this community used to be closer to the water)?

It doesn't take long at all to get down to the water. You can even walk down the hill, it's a five minute walk down. You could be at the beach in twelve minutes total. You can also take the bus that passes nearby and it takes you straight to the beach. It's a five minute bus ride.