TÉCNICO LISBOA

Increasing housing in post-disaster architecture: bioclimatic analysis

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Extended Abstract

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1. Introduction

The occurrence of catastrophes, caused by natural phenomenon or by social conflict, has increased sharply in the past few decades. Most of the times, the results are devastating, transforming big cities into wreckage that needs to be sorted out as fast as possible. This subject took my interest for its relevance and importance. Hence, I tried to understand which were the exact needs of the people who were harmed by the catastrophes, not only in terms of shelter, safety and health, but also in terms of emotions, and basic needs. So the question arises: “what is the role of the architect in these situations?”

Emergency architecture is often connected to temporary architecture, due to the necessity of solutions that are cheap, easy to transport and fast to build. Prefabrication can also be very useful in these situations, allowing the easy and quick assembly of the shelters. All these postdisaster interventions are dependent on the support from the government and from the NonGovernmental Organizations (NGOs). So, another important factor to consider is the cost of the interventions.

While the houses are being rebuilt, it is necessary to create temporary shelters that provide the minimum conditions of health, safety, habitability and dignity to the displaced people. There are three stages of support (immediate, transitory and permanent) that will be analyzed further in this dissertation.

The main goal of this dissertation is to understand in which way can architecture answer to post-disaster situations in the different parts of the globe, with different climates and different cultures. I tried to understand, in detail, what is the importance of sustainable architecture in post-disaster construction and, specially, in which aspects can the incremental housing be a more adequate solution in all kinds of scenario.

The research methodology used in this dissertation included an analysis of several examples of increasing houses, prefabricated houses, and so on. I also analyze different materials and constructive techniques (both modern and traditional) in order to understand which ones are more adequate in the different post-disaster situations, always with the sustainability aspect in consideration.

The dissertation is organized in four chapters: the first is an approach to some fundamental concepts directly related with the subject. In the second chapter it was referred and analyzed the responses to some of the most significant disasters that happened over time, and in which way, these responses evolved and influenced post-disaster architecture. It was also analyzed the different ways to intervene and the advantages and disadvantages regarding the use of different materials in construction. In the third chapter there is an analysis of several case studies, with different approaches that change specially according to factors like the climate. This case studies are fundamental for the formulation of the final project in the fourth and last chapter. This chapter consists in the design and explanation of an incremental housing project, designed to be used in post-disaster scenarios.

2. Main concepts

Flexible housing

Flexible housing is one of the main concepts related to this dissertation topic. It allows its users to adjust their home over time, according to their necessities and lifestyle. This adaptation may include modern and sustainable technology. There are two main concepts directly related with flexible housing: “free plan” and “minimal dwelling”.

Free plan

Free plan is a spatial organization principle inspired in traditional Japanese housing: one of the first examples in housing flexibility. There is no specification in the function of the spaces, which are separated with furniture like folding screens. In 1926, Corbusier writes “Five Points of Architecture” where he defends: pilotis instead of supporting walls; horizontal windows; roof gardens; free design ground plan and free design façade.

Minimal dwelling

The second International Congresses of Modern Architecture, occurred in 1929, in Frankfur and the main topic of discussion was: new solutions for flexible and minimal dwelling. The Schröder House, built by Gerrit Rietveld, was one of the best submitted proposals. The versatility of the interior is essential to design minimal housing, in a way that the reduced area could be used in an efficient and economical way. For example, the collapsible walls upstairs create an open space during the day and three bedrooms during the night.

Temporary architecture

Temporary architecture exists during a short amount of time and the place where it is located doesn’t really matter to the design of the project, as opposed to permanent architecture. However, temporary structures may stay in the same place for a long time and become permanent, revealing its debilities and problems, since it was not conceived for such purpose. The choice of materials and issues like transportation, size and weight of those materials need to be taken into account, hence the total costs can be as low as possible and serve the greatest number of people.

Prefabricated systems

After World War II, it was urgent to build a large number of houses in the shorter amount of time in order to be possible to relocate thousands of refugees. So, the best solution was prefabricated systems because it was cheaper and faster to build. Some of the more important examples were for example: Maison Dom-ino, designed by Le Corbusier and built with a prefabricated reinforced concrete structure, without structural walls; Stahlhaus and Copper House, both projected by Walter Gropius and Buckminster Fuller’s Dymaxion House, with a futuristic design and suspended in a central column.

Participatory design

The involvement of the architect and the citizen in the process of building their house allows a response to both functional and emotional necessities. The participation of the communities is fundamental in economic terms (the manpower costs are reduced) but also, because this way, the inhabitants see themselves in that space and have the need to preserve it. The architect role in participatory design is also to inform the people about the legal, economic, political and technical aspects of the project, so they can be aware of all the possibilities when they build their home. This is a dynamic process which goes along the constant evolution of the society.

Incremental housing

As a consequence from flexible housing, the incremental housing arises. The objective of this system is to adapt the house to the family's lifestyle. Incremental housing is directly related to participatory design: there is an initial module that can be expanded and improved in the long run by the inhabitants themselves, at their own pace, according to their necessities and their financial possibilities. It is important to prioritize areas like the bedroom, the kitchen and the bathrooms.

The integration of the incremental housing in the urban mesh is one of the main difficulties. It is very important to consider aspects the access to public services and basic services in order to improve the quality of life in a community.

Post-disaster architecture

Post-disaster architecture is based on the fast response to shelter necessities to victims of natural catastrophes, and social conflicts. For that purpose, the following criteria must be adopted: assembly speed; sustainability; pragmatism; local constructive techniques and integration in the context in which it is inserted. Architecture has a main role in the reduction and overcoming of the damage. So, to design post-disaster architecture is to connect all those aspects; being able to overcome the negative effects caused by catastrophes and guaranteeing not only the survival of the people, but also their fundamental needs, like privacy and hygiene.

The response time to a catastrophe was defined by UNDRO ("United Nations Disaster Relief Organization") in four stages: stage 0 happens before the disaster (mitigation period); stage 1 extends until the fifth day (immediate aid period); stage 2 is from the sixth day until the third month (rehabilitation period) and the fourth stage happens from the third month on (reconstruction period). To reach the urban development goals is important to consider the sustainability aspects in a way that the ecological footprint is reduced. This sustainability should be reached in its four stands: environmental, social, cultural and economic. Housing is one of the main aspects that determine people's safety, health and well-being. Which means, it is a fundamental aspect for a sustainable development.

Sustainable housing

Sustainable housing is not just “green buildings” or self-sustainable constructions. It is specially housing with a positive impact on social and environmental point of view. In developing countries, housing programs are really poor: the construction quality is very low and located in remote areas. Besides, these buildings develop really quickly, which leads to negative consequences for the environment. To prevent this, the government, in collaboration with financial institutions and nongovernmental organizations create strict housing rules and policies that allow the growth of sustainable housing accessible to everybody. The political interests should be tuned with the economic, social and environmental interests.

3. First steps in post-disaster architecture

After World War II, the cities were destroyed and part of the population was homeless. For this reason, prefabricated structures were developed in a large scale and in a short period of time to provide lodging to a large number of people. Besides its quick assembly, this solution can adapt to many situations and are easily transported. Some of the main emergency shelter proposals were Alvar Aalto’s Primitive Shelter, built with four individual modules around a common heating system and George Fuller’s Quonset Hut, built to protect the army and the refugees from World War II.

Two of the more important theorists of post-disaster architecture are Ian Davis and Fred Cuny. In
1978, Ian Davis wrote “Shelter After Disaster”, considered the first book written specifically about this subject. Here, Davis analyzed previous responses to natural disasters and the assistance provided by national and international organizations. According him, post-disaster architecture is divided in three acting stages: immediate stage; transitory stage and permanent stage, and for each stage there is a different type of accommodation. Fred Cuny was an American civil engineer who worked in post-disaster interventions and sustainable communities. His book “Disaster and Development”, published in 1983, is considered a reference in this area. He wrote about the planning of refugee camps and new ways to respond to catastrophe situations.

The best way to help the survivors to recover from the disaster, is to include them in the planning and reconstruction of their own houses and neighborhoods. However, this recovery is hard to accomplish without humanitarian intervention. UN-Habitat is a United Nations’ association, established in 1978 which works in favor of a better urban future. Its responsibility is to support the government against social or natural catastrophes, reducing the vulnerability against future situations and ensuring its prevention. With that in mind, they developed an action plan named “The 2030 Agenda for Sustainable Development”.

One of the measures adopted was the foundation of GNSH (“Global Network for Sustainable Housing”): an international partnership that develops strategies to promote sustainable urban planning and to promote social housing through vernacular architecture. UN-Habitat further

developed other programs like UNHRP (“United Nations Housing Rights Programme”); PSUP (“Participatory Slum Upgrading Programme”); CRPP (“City Resilience Profiling Programme”), whose objective is to help the city to recover faster from the impact of a catastrophe; the “Global Housing Strategy”, whose aim is to ensure sustainable housing and basic infrastructure to the European Union members and the “Urban Basic Services”, whose objective is to improve water treatment systems, sanitation and waste management.

4. Materials

The construction sector is one of the main pollution sources in the planet nowadays. With that in mind, and considering that fossil fuels and even water are non-renewable resources, the choice of materials is extremely important and should consider the following aspects: availability on site; cost; transportation; extraction process; maintenance; durability and reuse. Some examples are: bamboo, haulm or timber (renewable); concrete or ceramic (recyclable); tires or plastic (reusable) and soil or clay (abundant in nature).

Timber

Timber is a heterogeneous and organic material whose properties we should know so we can benefit the most of it, like its anisotropy, the possibility of cracks to occur, contraction and dilation. However, the technological development has been reducing these problems.

There are also a lot of wood-based materials that result from pressing the wood waste and adding agglutinative. These variations have different goals like improving mechanical resistance; improving acoustics; impermeability; aesthetics and so on. Some of the most used variations are fiberboards; plywood and glued laminated timber. A good example of the use of wood in construction are the “Pallet Houses”, designed by the New York group, I-Beam.

Bamboo

As opposed to timber, bamboo doesn’t require too much care. It is a light material, easy to cut, easy to transport, it has great structural properties and a good seismic resistance, due to its elasticity. Besides, bamboo structures are cheaper and faster to build then timber, iron or reinforced concrete structures.

Simón Vélez is a Colombian architect responsible for more than 300 very diversified projects using natural materials like bamboo (very used in Colombia, specially by the poor people). Some of his most known projects are the Boisbuchet House and Pavilion, in France and the ZERI Pavillion, in Germany.

Cardboard

Cardboard is a material whose aesthetics are very similar to wood, which makes it a more familiar material and easier to accept by the people. Its tubular shape grants more rigidity and

structural capacity. Besides that, it is very cheap, light, flexible and easy to handle and to transport.

Shigeru Ban is a Japanese architect who stood out by projects built with materials that were abundant in each region, like bamboo, plastic, timber and also simple and cheap materials like cardboard. His interest in cardboard as a structural material is one of the main reasons why his projects are known worldwide, and why he won the Pritzker Architecture Prize in 2014. Ban explores the possibilities of the use of cardboard as a structural material with the use of paraffin as waterproofing, making it more resistant. Some of his best known work are:

- The Paper Emergency Shelter, designed after the Civil war in Ruanda, from 1990 until 1994. The project occurred in a partnership with UNHRC ("United Nations Human Rights Council");
- In 1995, after Kobe's earthquake, in Japan, Shigeru Ban built a temporary church in the same place where the original one was destroyed, the Takatori Paper Church;
- Besides the church, Ban also designed the Paper Log House. This project, because of its versatility and adaptability to other cultures, was also chosen to house the refugees from the earthquakes that happened in Turkey, in 2000 and in India, in 2001.

Soil

Soil was one of the first materials being used in construction. It's a recyclable material, incombustible and doesn't need too much energy in its transformation process. However, it has problems with mechanical resistance and waterproofing, which means that sometimes it requires the use of concrete and stabilizer products to meet the necessary quality requirements. There are a few construction techniques with soil that depend of its plasticity, humidity, compaction and particle size, for example: mud, adobe and compressed earth blocks.

5. Case studies

Alejandro Aravena

The Chilean architect Alejandro Aravena, together with the group ELEMENTAL, are mainly known by their projects in Chile, with low budgets, which goal is to fight the poverty in social neighborhoods. These projects are based in the partial construction of the houses by the architects, being that this house would be increased by the residents themselves, according to their needs and capacities.

Balkrishma Doshi

The Aranya Community Housing is a project designed by Balkrishna Doshi, in India. The goal was to create cheap incremental housing in one of the most critical zones of the city. Each

family received different infrastructures (according to their economic capacities), including lighting and rainwater drainage.

Charles Correa

The Belapur Housing was built between 1983 and 1986 in India, by Charles Correa. The project combines some of the concepts considered by the architect, as the most important in the design of a dwelling: each house would have its own outside space, which would allow a future expansion; all the houses would be low and distributed very densely, which would result in small neighborhoods with a lot of social interactivity.

Francis Kéré

Francis Kéré is known by numerous projects developed in Africa. These projects are known by the use of local materials, being low cost and by the use of a combination of modern and traditional constructive methods. His main project is Gando Primary School, mostly built in clay. Posteriorly, Kéré also built a library and six houses, which goal was to attract professors to the rural area.

Le Corbusier

In 1927, Le Corbusier was responsible for Maison Citrohan, in Stuttgart, which consisted in two attached houses, with three floors. These houses were built in reinforced concrete and according to the “Five Points of Architecture”. The project is an example of pragmatism and efficiency in housing construction. One of the main innovations in this building was the transformability of the open-space that could be divided in multiple rooms with sliding partitions.

Toshiko Mori

In 2015, the Japanese architect Toshiko Mori designed the “Artists' Residency and Cultural Center”, in Senegal. The project contains a cultural center, a residency for artists who come to visit and an exterior courtyard. This project was built exclusively with local manpower and local materials like bamboo, compressed earth blocks, combining traditional and modern construction techniques. It is also possible to store rainwater for domestic and agricultural use.

TYIN tegnestue Architects

In 2010, the Norwegian group TYIN tegnestue Architects begun the construction of Cassia Coop Training Centre, in Indonesia. This project consists in a place for agriculture and local cinnamon workers, including classrooms, offices, a kitchen and a small laboratory. The materials used for this project were bricks, concrete and timber in the exterior structure. It was built by local workers, without experience.

6. Final project

The project consists in an increasing housing module, whose area can increase in the ground floor, in the first floor, in both floors or just keep the original, seizing the left over space to use as a garage or as a space dedicated to agriculture. The project can be replicated all over the globe because it can be adapted to different climates in terms of materials.

The house is built around a core containing a prefabricated concrete infrastructure. This core includes the sewer system, water supply network and the electrical system in both floors. This infrastructure has an area of 2,60m x 3,10m and contains a kitchenette, one bathroom in each floor and the stairs that make the connection between the two floors.

The roof structure would be built in timber or bamboo and could be combined with an insulating material like haulm or a waterproof material like a zinc panel. The rooftop is continuous along all the houses, which forces the height to be constant, resulting in a uniform urban aspect.

7. Conclusion

The emergency architecture topic has been more and more approached in the last years due to the increasing number of catastrophes (resulting from natural causes or from social conflicts). Besides raising awareness to the importance of post-disaster architecture, it is important that the population gets involved in the recuperation of the destroyed places.
The development of new materials and new construction methods for the resolution of post-disaster problems are increasingly more important. There are several approaches that the architects may take regarding post-disaster architecture, but always with the same goal: providing humanitarian help to the people harmed by the catastrophes, as fast and efficiently as possible.

The unpredictability of the catastrophes demands a fast and efficient response to minimize the damage. The priority is to get a provisory place and the necessary health and safety conditions to the displaced people. Next, it should exist an urban plan to make the transition from the temporary shelter to the permanent house, creating a community.

It is important to clarify that the concepts of post-disaster architecture and temporary architecture, besides having some aspects in common, are very different concepts. The kind of architecture that exists in post-disaster situations should not be seen as a provisional project because most of the times, the relocated families remain in these accommodation for many months or even years. So, the objective is to switch as quickly as possible from the temporary shelter to a permanent house.

The first approach in post-disaster situation usually come from the NGOs that provide tents, which are fast to transport and to assemble. However, the main basic needs are, obviously, not fulfilled in this situation. This is where the architect has a fundamental role, planning and developing temporary shelter, considering factors like celerity, flexibility, sustainability and the

choice of materials according its price and its availability in the local. Besides the technical and constructive issues of the project, the architect must also care about economic, political and cultural aspects of the project.

It is essential that exists a previous study about the local and an adequate planning of the housing solutions to avoid repeating the mistakes from the past. However, this process of planning depends on the financial support that, most of the times, are very limited, which complicates this task.