

Urban Form, Heritage, and Disaster Prevention: What Do They Have in Common?

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Abstract—Based on the hypothesis that disaster risk is constructed socially and historically, this article shows the importance of keeping alive the historical memory of disaster by means of architectural and urban heritage conservation. This is illustrated with three examples of Latin American World Heritage cities, where disasters like floods and earthquakes have shaped urban form. Therefore, the study of urban form or "Urban Morphology" is proposed as a tool to understand and analyze urban transformations with the documentation of the occurrence of disasters. Lessons learned from such cities may be useful to reduce disasters risk in contemporary built environments.

Keywords—Conservation, disaster risk reduction, urban morphology, world heritage.

I. INTRODUCTION

HISTORIC buildings have had a dynamic modification of use and adaptation. Intervention and modification allow them to "stay alive". However, that intervention should allow observing and understanding previous historical periods, in this particular case, the evidence on how a disaster has an impact on the building. In this way, heritage conservation reminds people that risks persist and mark signals to understand current disaster risks. Nevertheless, this is also a dilemma: the challenge of incorporate disaster understanding without affecting the natural transformations of the building, but at the same time following the principles of architectural conservation. Besides, building conservation is difficult to achieve if there is no guarantee that buildings will continue functioning. Here arises the question on how interventions allow or disable the analysis of the building. Another serious dilemma is that many cities may transcend its historical moment and remain "frozen" because of a disaster, as happened in Pompeii, Herculaneum, and Antigua, Guatemala. These cases have certainly left static pictures of historical moments that are very useful for this discussion, but are not recurrent cases, because the city and architecture evolve according to their social historical moments.

Monuments worship is a modern one [1]. In the past, people engaged in physical and functional recovery without involving abstract values as authenticity, historical value, etc. Before the

cult of the city and architecture as monuments, we have numerous examples of cities with a need for greater security that were moved. In those cases, the ancient city was abandoned without any form of consideration as to the value of the city, especially in cities with an emerging consolidation in the areas of infrastructure, economy and others. In other cases such as Mexico City after the flood of 1629, consideration for move already took into account these factors and they decided to recover the semi destroyed city, instead of moving it to another location. The question is, if hundred years before the decision had been the same.

Musset [2] documents a collection of cities that for various reasons moved. We can consider that this will always be more common in territories in process of consolidation without old urban structures, since the location of cities was also evaluated in relation to the experience and factors such as disasters. Such disasters are not noticeable until they happen and can be only predicted until a recurrence indicates that a site is unsuitable. If the city is already consolidated, and the move is not feasible, the inhabitant develops adaptive techniques that are observable and analyzed in the architecture and in the city, where conservation (circumstantial or official) permits it. The memory of the inhabitant facing disasters requires physical referents and physical benchmarks; architecture is one of the better referents, and on a larger scale the city is the other reference.

The International Committee on Monuments and Sites (ICOMOS) arises with the Charter of Venice. This Charter takes into consideration some concerns arising from the war at the time of reconstruction of Europe. This reconstruction also comes to architecture and urbanism. This way, some cases of reconstructions emerge that could be qualified as emotional, and perhaps in other contexts would be heavily criticized as the case of Warsaw, or other German cities. Along with this trend of literal reconstructions, we might even make a classification according to the degree of elements considered for conservation, i.e. a true copy of the original to evoke the disappeared building with a contemporary element. In all cases, that architecture is evidence of a disaster. Therefore, the dilemma here is how we may "read" the disaster in this type of architecture. Here come into play the tools of survey and documentation to know if a building is new or if it is a historical building and/ or a city with modifications.

II. THE STUDY OF URBAN FORM

Understanding the origin and evolution of the shape of cities has been a constant concern that eventually led to the

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formation of a field of study in which urban and architectural heritage occupy a central figure.

Due to its nature, built heritage not only represents a certain time and space of humanity; it equally represents a kind of segments for understanding historical continuity and reconstruction of a memory, in this case, the memory of a city. That is to say, that from reading the characteristics of assets, it is possible to approach the embryonic stages of a city, as well as its subsequent steps, which in many cases are deduced from the same transformations of the building or urban area.

In spite of the various models of thought to analyze the form of a city, usually they can all be grouped into two approaches: the synchronic and the diachronic approach [3].

The synchronic approaches explore the existent relationships between the different elements that make up the shape of a city: the plot, the street, the built environment and the open space. Making an analogy with linguistics, syntax is like exploring a set of words, i.e., the principles and processes that enable the construction of a language. Academically, these studies have been grouped in a field called Urban Morphology.

Morphology, or the study of forms, was a term originally used by the German poet and philosopher Johann Wolfgang von Goethe in the eighteenth century. He was also interested in the field of aesthetics and used the term to refer to the study of forms. The term morphology was later used in life sciences, and after that, it began to be used in the field of sociology. The sociologist Emile Durkheim used the term to explain that the society was a product of its morphology. Durkheim explained Morphology as the set of spatial forms in which individuals were grouped together as a social structure [4], a structure that according to Durkheim should be considered by sociologists.

In line with the proposal of Durkheim, the geographer Carl Sauer argued that just the combination of the "social" with the "natural" would permit to do a reading of the "landscape morphology" which, according to Sauer, was the central subject of geography [4]. Following Sauer, this landscape and its forms were not static but they evolved over time, with some elements that Sauer considered constant. Other authors such as Vilagrassa [5] identified four major topics of attention for the morphologist: the plane; the plot (subdivision) as part of the plane; the building; and the urban image as a perception phenomenon [5]. On the other hand, diachronic studies focus on the evolution of the shape of human settlements over time. This led to other geographers in the 1960s to develop new analytical tools, especially with a heavy quantitative vision. Thus a new term called "morphogenesis" ("the origin of form") was born, a term which, again, was taken from the evolutionary biology to describe the transformation of the shape of the cells.

Today, the study of the evolution of form and structure of cities is known as urban morphogenesis, which seeks to establish and understand the different processes that determine the changes in the shape of a city [6]; morphogenetic studies seek to understand the elements of permanence that reflect the social history of the urban form [7].

Morphogenetic studies do not respond to a simple and fully consensual classification, but these have been identified and grouped according to a variety of approaches, themes, schools of thought, disciplines involved, or even the direction and priority that each country gives to morphogenetic studies. Just as a sample, and because of the limited space, here only some of the most representative examples will be mentioned.

Levy [3] distinguishes three approaches as morphogenetic study. A first approach explains the changes in the form of a city and it is based on the identification of constants, or historically persistent elements in the urban fabric. As an example Rossi [8] in his theory of permanence and monuments defines the urban plan and monuments as the primary elements that will define the successive steps in the form of a city. That is, that while buildings can be replaced, streets and cities remain.

A second approach focuses on the influence of certain typologies in the urban fabric over time, or inversely, the way urban fabric defines certain types of buildings. For example, the effect that star shaped urban structures had in Paris, resulting in triangular shapes of the blocks that were formerly rectangular [9].

A third approach consists on the study of different urban plans that are superimposed each other historically, either by invasion or because of ordinances for specific purposes, as in the case of typical Spanish town in America, designed to dominate and exploit [10].

For other authors as Vilagrassa [5], the understanding of the evolution of urban form requires an understanding of the process of accumulation and circulation of capital and its impact on the construction of the city, i.e. the study of sociocultural and economic contingencies that may explain the transformation of urban landscapes.

We find also another group of more quantitative studies that measure, for example, the evolution of the city calculating the perimeter/area ratio in different periods of evolution, or they identify patterns in the arrangement of different urban and green spaces, built-up areas and the structure of the communication routes [11]. Within these approaches, this group of researchers not only try to quantify the evolution of urban form beyond a purely economic perspective, but they also search for more subjective explanations aspects of urban form, as the phenomenon of self-organization [6].

Morphological studies, regardless of their approach are also strongly influenced by the country where these studies are produced. Some countries have a much older tradition of morphological and morphogenetic studies than other countries. This reflects in the existence and specialization of its publications and in the specificity of the topics. One example is the International Seminar on Urban Morphology (ISUF, for its acronym in English), created in 1994 in Birmingham by British urban geographer JWR Whitehand. This Seminar includes architects, archaeologists, geographers, historians and those disciplines that have a link to the urban form.

In the case of Germany, Heineberg [12] distinguishes seven topics of morphological studies. They range from "classic"

morphology studies around the city plan and its buildings, urban growth, regional types of cities, types of cities at the continental and subcontinental scale, urban change and preservation, and the destruction and reconstruction and urban landscape studies as a basis for planning.

Finally, it is noteworthy that the morphogenetic approaches, either qualitative or quantitative will be contextualized by many factors that are present in the origin and development of cities, for example spatial and physical factors (geographical location, accessibility, resources) political, economic, demographic, social, cultural and technological factors, among others [13].

III. DISASTERS AND HERITAGE CONSERVATION

In the following three historic cities will be described in terms of the urban and architectural strategies developed to reduce disaster risk. These three cities are World Heritage Sites and are located on flood and earthquakes prone areas. After several visits to the place, observations on such strategies were identified. This information was further complemented with historical maps and historical photographs.

A. The Case of Campeche

In México, two of the most important coastal cities of the Mexican Gulf are Veracruz and Campeche, because of their commercial function. The first one was and still being the most important port of the Mexican territory. It was an entrance and exit door for communication towards the, -then, Viceroyalty of New Spain.

The other port, Campeche, is located on the Yucatan peninsula territory. It worked administratively as a captaincy during the Viceroyalty stage; through this port, some precious woods and cacao were extracted. Both cities were fortified to protect their population from the pirate's attacks. In this way, the Crown was protecting the city and the port, and the merchandise could be temporarily stored waiting to be moved. [14].

Campeche's origins go back to the Granada agreements. Granada agreements were contracts hold with the land tenants to consolidate the territorial occupation of the peninsula. Part of those agreements considered the construction of fortresses. One fortress was built in the Campeche's port and the other one was built inland. From the second fortress mentioned there are only remnants and an interior Wall; the city disappeared almost totally by the XX century, depriving the city of a unique inland architecture fortress example. The fortresses built in the XVI century in the Campeche's coast is the most complete fortified system core of the New Spain. Campeche's fortress is the best and well conserved fortress in Mexico and one of the most complete examples in America, that's why it was declared World Heritage Site by UNESCO in 1999.

Just as many ports, this one had several pirate attacks since XVI century, Montoya registers twelve [15]. The most important Works related to the Wall started in 1686 and were finished eighteen years later with a 6.00 m height and 2.5 km

perimeter; eight bulwarks and two fortresses plus reinforcements and a tinderbox [15]. The fortified system remains complete until XIX century, and in this century, the wall started to be demolished because of health reasons.



Fig. 1 Elevated sidewalks in Campeche city

Today, just a half of the walls (canvas) on the side of the Town Gate survive [16]. However, Campeche's population is identified with the pirate topic and the wall and the bulwarks reconstruction has been a recurring conservation measure in the last decade. This contributes in turn to an easy urban reading. This perceptible configuration is part of their heritage values. For example, the current surrounding street follows the ancient fortress line. Another important element is the extramural neighborhood urban plan that has been conserved.

The region is located in a warm and sub-humid climate with an annual rainfall of 1,138 mm. This requires an efficient evacuation of water, especially during hurricane seasons. Those who founded the city noticed this aspect. Therefore, they built the city following the watercourses and the natural drainage flows. They also adapted the blocks so that the most important of these flows coincided with a street, giving rise to the 14th Street, known by the locals as "Calle honda" (The deep street). The inhabitants of Campeche know that they should not park cars on this street because the flow is so strong that it may drag the cars.

In the city the inhabitants have been also developing mechanisms to drain and protect from the water, for example, high sidewalks, earth roads and drains constructed in the canvas of the wall (the canvas are the straight parts of the wall between the bastions). The rainwater that falls in the roofs of the buildings flows inside of the wall and have an outlet to the stream at the floor level. The houses also have increased their floor average between 60 and 70 cm, so that water does not get into the houses.

B. The Case of Tlacotalpan

The urban plan of Tlacotalpan responds to urban ordinances that were implemented in the sixteenth century for the Mexican cities with the square next to the water body and an orderly urban grid around it. The city had three well defined areas: an indigenous settlement, the Spanish area and the area of the first settlement headquarters, were official powers located.

Tlacotalpan was an island in the Papaloapan River, a river that is navigable until the current state of Oaxaca. Therefore, Tlacotalpan was a port where the goods arriving from the Gulf

of Mexico were distributed to the inland, mostly to the area of Oaxaca.

Tlacotalpan became an important commercial enclave in the XIX century and a trading port with a custom. Today there are just some vestiges from this period, like a small bridge on one site of the city. The square that was used for multiple purposes is now a site for restaurants and bars. For being an example of climate adaptation and an exceptional example of homogenous architecture, this city is an example of sustainable architecture of the nineteenth century and was declared World Heritage Site in 1998.



Fig. 2 Archway in Tlacotalpan, Veracruz

Tlacotalpan has a regular warm climate and a precipitation of 1500 mm. The level of the river changed their level in a cyclical way, giving rise to an architectural and urban adaptation to the environment.

The streets are not paved, so that water is quickly absorbed into the ground, because the main characteristic of the city are the grass streets. The eviction of rainwater is made directly on the streets. People can walk comfortably on the sidewalks, as homes had an archway that generates a continuous corridor to protect from the sunlight and eventually from the rain. Likewise, doors and balconies face towards the river and fresh air gets into the houses. The houses also have high tile roofs so that hot air inside the house rises, creating a fresh environment. The floors of the interiors are made of fresh earth bricks too.

In the past, the city was surrounded by two rivers. The air run through the city in the short direction and at this junction fresh air crossed the houses, the porches and the public roads. In time, the small branch of the river was closed to turn the island into a peninsula. Today the city is no longer reached by boat, but by road.

C. The Case of Guatemala

The city of Guatemala, known today as Antigua, was abandoned in the second half of the eighteenth century because of some earthquakes. This allowed its relative conservation. In the XIX century, the city began to be occupied again and the inhabitants were accustomed to live with and in the ruins. In 1979 the city was declared World Heritage Site, which allowed an official conservation and the financial support from different countries of the world for its conservation.

The fact of being located in an earthquake prone area, generated an architecture prepared to better withstand earthquakes: short buildings, thick foundations and structures,

lightweight constructive systems, i.e. vaults made of brick, not stone. The structural reinforcements made after each quake made the walls thicker. There are no high towers, and the existing ones are very short. The majority of the buildings have just one storey.



Fig. 3 Antigua, Guatemala

The theoretical discussion concerning the positions of intervention has evolved since then. At the present it is being discussed whether the remains of collapsed buildings must be preserved in the exact spot where they were, or be removed to maximize space.

In the first case, the main buildings have only one possible use, which is to be used as a museum, possibly a theatre, as in the case of the Temple of the former Colegio de Propaganda Fide (schools for missionaries of the Franciscan order). Here the debris of the vault is still in the place when the earthquake occurred.

In the same Antigua are other temples, including the Capuchin Convent, who were cleaned from the rubble and are used for music concerts and cultural events, with the appropriate adaptations.

The two positions could be considered appropriate methodologies of intervention, however in the first one, it is argued that the debris is the evidence of the disaster, and it requires a minimal intervention. The second considers that the space can be used and was cleaned and adjusted.

A third methodology that has not much to do with the building registration is a fundamental part of conservation. In this case, the almost compulsory registration may allow the restoration of the space without deleting the vestige of what happened. The challenge is to find a balance between the conservation of the historical memory and the recovery after a disaster.

IV. CONCLUSION

Registration and documentation of historic buildings and cities should incorporate disaster analysis. For this, we must design methodologies based on an exhaustive research of the building and the city as a first instance. Urban morphology, with its techniques and methods may be a central tool for this study. After that, the analysis of the obtained data is vital for the design of an intervention; these data also provide information about the history of the surviving elements of the building and the city in the context of disasters. This would open possibilities for the design of new techniques and methods to mitigate risk. Human beings have always been

trying to adapt and survive. Architecture and the city are human products, and as such, these objects are survivors too.

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