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**Sustainable Architecture and Social Engagement for Flooding
and Drought Resilience**

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Smart and Healthy within the 2-degree Limit

Sustainable Architecture and Social Engagement for Flooding and Drought Resilience

Double-blind review process

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ABSTRACT: Climate change is disrupting our planet's natural cycles and the steep socio-economic growth together with rapid urbanisation are increasing the uncertainty of its effects. During the last decades, frequency and impact of flash floods and droughts in Mediterranean and Middle-East regions has substantially increased and will continue to rise due to these new variations. Therefore, buildings and local architecture in these areas must be adapted to avoid future damages. However, disaster prevention will not be truly effective until the 'human factor' is considered, based on actual evidence instead of theoretical assumptions. Better research into how communities are affected by disasters and how they re-act with new architectural solutions is urgently needed.

In 2007, one Spanish town was tragically affected by the Girona River flash-floods and its population and buildings were severely disrupted. This case study was chosen as the main testing ground within this research, whose main aims were: a) to identify environmental retrofit strategies to increase resilience and adaptation to flooding, while improving comfort and living conditions; and, b) to present the proposed strategies to the affected local population. The project revealed insights in the increased level of acceptance and understanding of innovative solutions by local inhabitants when greater communication and participation is achieved.

KEYWORDS: Sustainable-architecture, social-engagement, communities, floods, resilience

1. INTRODUCTION

Historically, humankind's need and desire to control natural forces to preserve life and improve their lifestyles has been present all around the world [2].

Today, not only are more people under threat compared with 50 years ago, but also building in floodplains and other high-risk areas has increased the likelihood that a periodic natural hazard will become a major catastrophe [3].

Flooding has caused the majority of disasters between 1994 and 2015, accounting for 43% of all recorded events and affecting nearly 2.5 billion people. Similarly, droughts affected more than one billion people between the same period, despite the fact that droughts accounted for just 5% of disaster events happening during this time [3].

At the same time, across the world many governments have invested significant resources in trying to raise awareness not only of flooding, but many other natural hazards, to make populations understand the importance of adaptation to future scenarios; however, these initiatives are rarely as effective as hoped [2].

This research paper is focused on one Mediterranean town located in the Valencian Community (Spain) and called El Verger. It was severely affected by flash-

flooding in October of 2007 and almost ten years later it was taken as a case study to develop strategies for sustainable architecture [6]. Additionally, these methods and their results were approached one year later to the affected citizens during an important and successful social event in order to make them understand the actual threat of the situation.

All this process took more than two years from its start to the end, and its resilient architecture results as well as the actual community engagement will be analysed on the following sections.

2. FLOODS & DROUGHTS

Every year more and more areas are adversely affected by changes in their hydrological cycle and precipitation patterns, resulting in serious droughts and flooding. Also, it is a fact that climate change will certainly exacerbate these adverse impacts in the near future across Europe and its neighbouring countries [5].

2.1 Flash flooding

Flash flooding is one of the worst natural hazards which causes catastrophic damage and reduces income and economic opportunities in many countries around the world. And, while most of the fundamental causes lie beyond human control, decisions on where to locate

houses and businesses or how to build them, can reduce significantly the loss of property, income, and even lives [6].

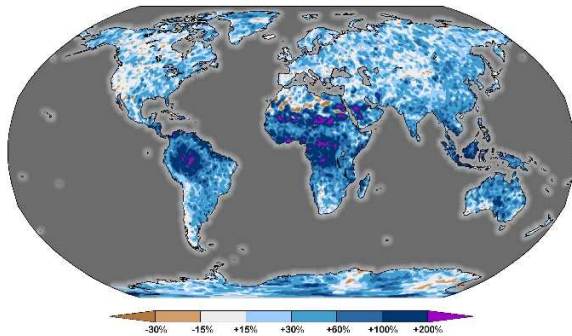


Figure 1: Change from the late 20th to the late 21st century in the average amount of precipitation occurring during the five wettest six-hour intervals (equivalent to the worst flash floods) in reference 47-year periods. Source: European Centre for Medium-range Weather Forecasts (ECMWF) (based on the A1b Scenario of the IPCC)

2.2 Droughts

On the other hand, every year more and more areas are adversely affected by serious droughts. Over the past thirty years, droughts have dramatically increased in number and intensity in Europe and Middle-East regions. Reduced water availability has a direct negative impact on citizens and essential economic sectors such as agriculture, tourism, industry and transport, affecting its internal market's competitiveness [3].

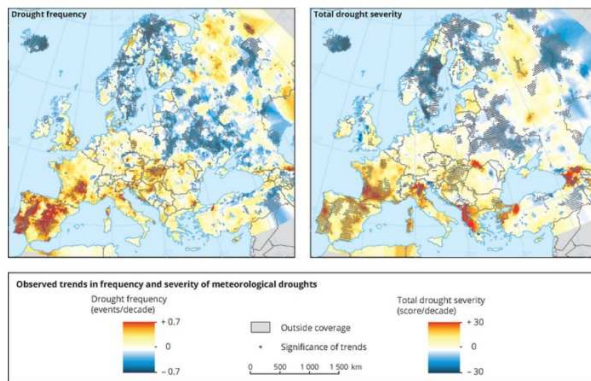


Figure 2: Trends in frequency and severity of meteorological droughts between 1950 and 2015 (accumulated over 12-month periods). Source: European Environment Agency

3. SOCIAL ENGAGEMENT THEORY

Social or public engagement is widely interpreted as any opportunity for the public to be exposed to, become aware of and appreciate architecture, and even contribute to any architectural project as much as possible [11].

At the same time, sustainable architecture involves a balance of three primary aspects: economic,

environmental and socio-cultural. Although there is minimal current action being taken to address the socio-cultural aspects.

Hence, the concept which comprehend all these aims is participatory design, which can be defined as an approach that attempts to engage everyone in the process and also ensures that everyone in the community can transform their environment [6].

This methodology entails that when the necessary studies and their outcomes are obtained, a pre-planning and design-stage consultation (often known as *charrette*) will be conducted. Other alternatives are organisation of pre-testing and larger social events, as it was the case conducted in this particular occasion.

The main goal in all cases will be to hammer out acceptable solutions which satisfy the local community, but also influence the design of the final architectural solutions.

During the following sections, the main architecture techniques applied to flood affected houses as well as the social event organised and its final outcome will be explained.

4. SUSTAINABLE ARCHITECTURE TECHNIQUES

4.1 Girona River Case Study

As already introduced on previous sections, very strong and torrential rain fell into the upper parts of the Girona river basin (East of Spain) due to the Cold Drop phenomenon in October 2007. The river overflowed in the floodplain area where El Verger is located [7].

This town is positioned very near to the river mouth and the consequences were catastrophic. In total, more than 1,500 houses were severely damaged, one person was killed, and the water level rose to 3 m height in most cases. Physical and personal damages were countless, and hundreds of people lost their homes [7].



Figure 3: Pictures of Girona river's floods: river overflowed (left) and citizens' damaged belongings outside the houses after the catastrophe (right). Source: Author's pictures.

In 2016 a postgraduate research project showed how to retrofit and adapt the houses affected by this flash flooding from a sustainable perspective [6]. After complex analysis and simulations applied to the most representative building typologies, this research

developed two main design strategies: a) Flood Resilience and b) Flood Resistance.

4.2 Flood Resilience Strategy

These techniques are advised for those high-risk flooding zones, which might encounter flood water levels of 1.5-3.0 m height. In this case, the water is allowed to come inside the buildings GF, which functions as a multi-functional semi-open space during the period when there is not any flooding event.

Permeability of the ground will be considerably increased again if all houses inside these zones would apply a gravel drainage system. Additionally, all the interior courtyards, which most of them are currently paved, will be converted into green areas with gravels or natural ground too.



Figure 4: Virtual images of flood resilience design applied into a terraced apartment building, with and without flood water. Source: Final MSc Thesis Project, Puchol-Salort, Jose.

4.3 Flood Resistance Approach

This option is suitable for those cases with 1.5 m flood water height or less, otherwise water pressure might be so strong and endanger the structural stability of the building. The main strategy on this occasion is to create a shell around the house and raise the GF level by two steps into a suspended floor.



Figure 5: Long section of a single-family house with flood resistance design applied and 1 m flood water height. Source: Final MSc Thesis Project, Puchol-Salort, Jose.

5. LOCAL COMMUNITY EVENT

Close to the completion of the MSc thesis research at the end of 2016, the author aimed to approach all this technical knowledge and outcomes to the inhabitants of the affected area. In October 2017, 10 years would have passed since the Girona River floods and it seemed the perfect occasion to organise a commemorative event to remind what happened 10 years earlier, but also to offer new solutions and, more importantly, approach all these new techniques to all affected citizens.

This event was called the *10th Anniversary of the Girona River Floods*.

5.1 Promotion Methodology

Nowadays, one of the most important procedures to achieve a truly successful event is to promote it in all social media and inside as much means of communication as possible [8].

Approximately three months before the date of the event, several local and national newspapers as well as radio networks were contacted and several articles were published before and after the event.

In parallel, a group of graphic designers from El Verger agreed to altruistically collaborate and created a logo and a distinctive image for the event campaign. They were consistently used for all signs and leaflets, as well as Facebook, Twitter and Instagram posts.



Figure 7: Model of the main sign used to promote the event campaign with its logo in the middle (language: Valencian (most spoken language in the area)). Source: Author's data.

5.2 Process Description

The organisation of this event to disseminate the results of the research to the local population started in large advance. Once a specific date was agreed (the closest weekend to the floods day) a complex process involving many agents was developed. The next figure

shows step by step how this process was conducted by the author:

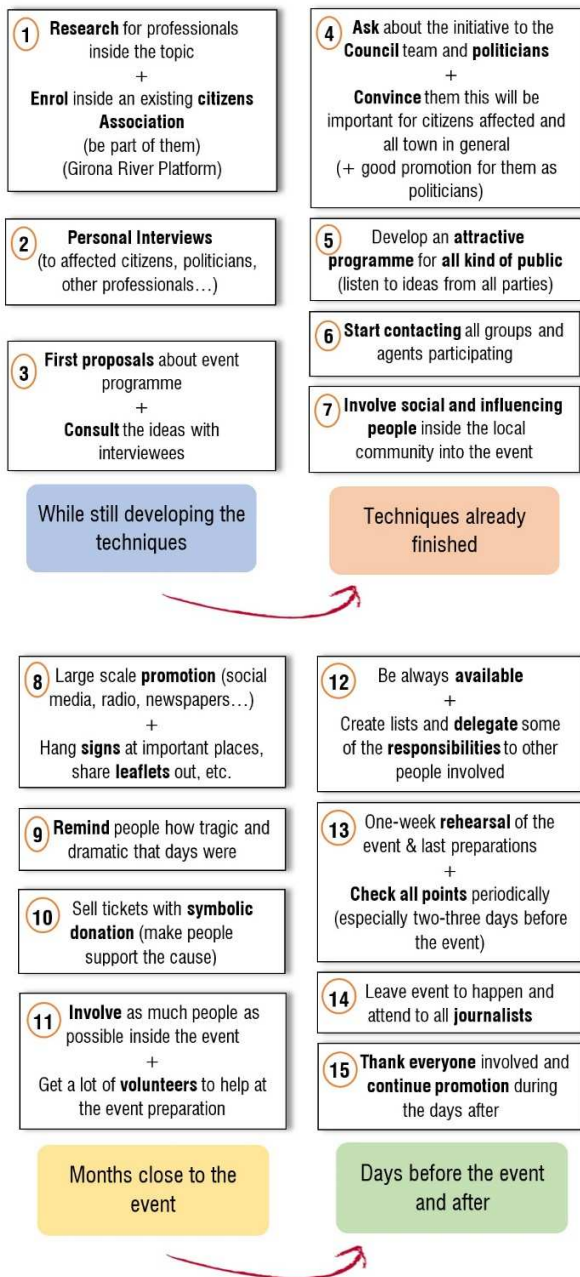


Figure 6: Diagram of the process followed to create the 10th Anniversary of the Girona River Floods. Source: Author's data.

It is important to highlight that, as it can be seen from Figure 6, the process started with actions which involved a few people, but it gradually ended up by a complex system of activities which concerned a lot of agents or stakeholders, all of them acting altruistically.

5.3 Activities Developed & Groups Involved

The event was performed over a full-day in October 14th 2017, with a very wide programme. It involved Government and military authorities, politicians, engineers, geographers and many other professionals. It was divided in two parts, one more technical with lectures and round tables during the morning time and a second with a more social approach, with theatre plays, poetry, videos, citizens interviews, etc. during the afternoon.

Morning time had a great opening conducted by the Spanish Army Emergency Services (UME) together with the Red Cross, Firefighters, Police, Spanish Civil Guard and two important representatives of the Valencian Central Government.



Figure 8: Photos of the morning session of the 10th Anniversary Girona River Floods. Source: Author's pictures.

Afternoon time started with a poetry recited by one well-known young citizen from El Verger and followed by a short play represented by the local theatre group. Together they were the perfect introduction to catch all audience's attention.

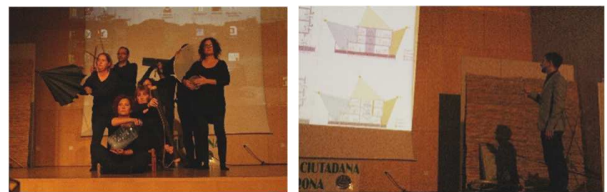


Figure 9: Photos of the evening session of the 10th Anniversary Girona River Floods. Source: Author's pictures.

Just on the middle of the session, one introductory and emotional video was projected and it was directly followed by the author's lecture. In there, all studied new techniques were explained in as much plain and easy to understand way as possible. After, the event continued with interviews to affected citizens and to one famous rock singer who mentioned climate change and El Verger floods in some of their most famous songs.

To conclude, one temporary exhibition with all this material was opened and members of the public together with the authorities started a solemn passacaglia to one Girona River's bridge.

5.4 Analysis of Audiences

Survey questionnaires and public opinion collection data are very important in participatory and community co-design [1]. At the 10th Anniversary, it was possible to analyse the audience received based on a very easy collection data method carried out during the day of the event.

When tickets were taken at the entrance, people attending were asked three very easy questions based on a survey in order to gather basic information. The data gathering followed ethical protocols and all the information was kept completely anonymous.

From early stages, the main intention of the event was to attract as much people as possible and coming from all kind of backgrounds. However, data revealed that around 70% of the audience was people affected or in some way related to any of the participants of the event and only 30% of the public had no connection to the incident.



Figure 10: Graph which shows the audiences relationship to the catastrophe happened in 2007. Source: Author's data.

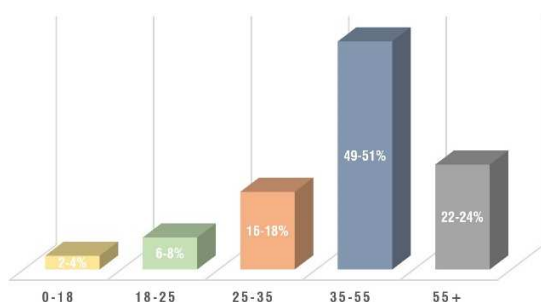


Figure 11: Graph which shows the audiences ages and the different percentages. Source: Author's data.

Finally, regarding the audience ages (see Figure 11), the most predominant age group was from 35 to 55 years old, followed by more than 55 years old band. Even trying to attract as much young people as possible (inviting the main singer of a local fashionable rock music band or promoting it in social media means such as

Instagram and Twitter) unfortunately all of this was not enough to attract more citizens inside the 18 to 25 years old range, which only accounted by 6-8% of the total audience. This is a point which should be addressed on future events because this age range represents the next generation and consequently the main target.

5.5 Event Final Outcome

In general, the event final outcome was considered as a great success. Overall, more than 2,000 people attended along the day and it was published in a lot of newspapers during the days and weeks after. Approximately, there were counted around 800 people during the morning session and 1,200 during the afternoon, though it is difficult to identify who was present at both congregations.

One of the direct outcomes and actual impact of this public engagement was to open a previously non-existing link between citizens and Administrations. Authorities came already with positive ideas and proposed some measures such as reducing Council Tax or removing Planning Application fees to those who choose to build based on these sustainable alternatives.

To sum up, this event demonstrated that it is possible to bring technical knowledge to people who is not very used to listen to technical vocabulary and, at the same time, it brought citizens and authorities closer.

7. ARCHITECTURE SIGNIFICANCE

As previously said, there is always a strong consensus inside the scientific community that public engagement with architecture is seen as any opportunity for the public to be exposed to, become aware of, appreciate and participate in the creative endeavour associated with architecture [11]. The 10th Anniversary event was the perfect example of how to approach technical and architectural knowledge to all kind of publics, although it needs to be deeply studied, repeat it quite periodically (every one or two years) and increase its global impact.

During the event's research process, the Valencian Community's neighbouring region of Catalonia was identified as having a high level of public engagement in architecture, despite a less well-developed support infrastructure compared with other countries such as the UK or Holland, where there are architecture specific centres. In this Spain's northern region, architecture-related exhibitions and conferences are held in many public buildings on a very regular basis at more than 18 locations throughout the province. This was taken as a primary example into our case and demonstrated that we still need to promote many more events like the 10th Anniversary to be truly effective in the Valencian Community.

In addition, some aims of good public engagement were recognised and achieved in our case, such as: foster sustainability in design and acknowledge in the field of architecture and the built environment, deliver broader social and economic policy goals, promote resilient and sustainable architecture inside of a regional culture and encourage greater interest and community involvement in matters of local built environment.

8. FUTURE SCOPE OUTSIDE SPAIN

Some areas around the Mediterranean basin and the Middle-East, especially found around the 36° to 39° North latitude, have been recently severely affected by flash floods despite the fact that rains are well below the annual average and end up being totally insufficient to meet their annual demand for water.

The studied Valencian region is not an isolated case and other zones around the Mediterranean basin and beyond are under very similar circumstances.

In August 2001, the worst flash flooding event of the Caspian Sea region in over two centuries claimed over 300 lives after a weekend of heavy rainfall and brought a devastating disaster in the province of Golestan, Iran [9]. This is a very dry and hot area too, which experiences periods of difficult droughts during summer months. Again: water scarcity intersected with flooding.

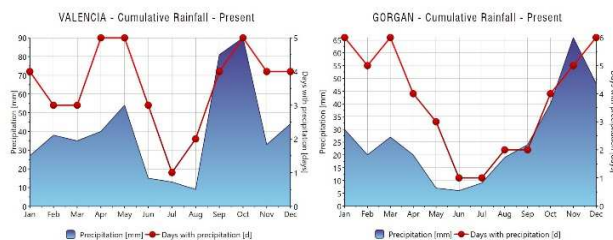


Figure 12: Two graphs of the present cumulative rainfall in two of the main studied regions: Valencia, Spain (left) and Gorgan, Iran (right). See the “dangerous torrential peak” in both cases. Source: Meteonorm software v.7.0.

Parallely, the city of Mersin in South Turkey presents a very similar situation. It is built on a coastal floodplain and uncontrolled and illegal urbanization process has been causing degradation of agricultural areas and river basins, also causing flooding in the city and its vicinity during the last decades [4].

The most dramatic regions where these same phenomena have occurred in the last twenty years are: 1) the Valencian Community in Spain, 2) the Peloponnese region in Greece, 3) the Mersin Province in Turkey and 4) the Golestan Province in Iran.

The next steps inside this research would be to find the existing connection among all these four areas and see how they can be compared with the Girona River

floods case. Some sustainable and adaptative techniques should be developed and applied to its architecture and also social events relevant to their particular societies must be organised too.

9. FINAL CONCLUSION

This experience shows that it is necessary to find more efficient strategies to approach and engage communities affected by natural disasters. Events like the 10th Anniversary of the Girona Floods proved to be very effective in raising awareness on the scale of the local and global problem and move towards the implementation of technical solutions which require public acceptance and government support.

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