CLIMATE ADAPTATION OF URBAN ENVIRONMENTS TO REDUCE FLOOD DAMAGE

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Climate scenarios warn of changes in precipitation patterns. A 30% increase in extreme precipitation is predicted for the end of the century (link). One of the most important expected consequences is the flooding of our towns and cities, with its consequent economic and population damage.

When talking about floods, the term floodability is used as the probability of an event of a certain size occurring in a range of years, which is called the return period. It is common to use a return period of 10, 100 and 500 years, where each of them shows a greater ferocity, representing the highest historical value recorded for the mass of water (flow) of a given river. If we focus on the Basque Autonomous Community, these flood probabilities can currently be consulted on the open Geoeuskadi website (Aguas=> Cartografía de Peligrosidad=> Calado).

For various reasons, humans have built their settlements on the banks of rivers and seas, which in itself means that most cities are threatened by these episodes. Furthermore, as land has been urbanised and waterproofed, rivers have been channelled and narrowed, and forest masses have been reduced, among other things, nature's capacity to regulate the hydrological cycle has been put in a bind, as its capacity is more easily overwhelmed.

To continue with the Basque example, memories of major floods such as the one that devastated Bilbao in 1983, or the more recent storm surges in Donostia and Zarautz, among others, immediately come to mind. As can be imagined, the economic damage caused by these events is very significant.

In recent years, the focus of flood mitigation efforts has been on the application of Nature-Based Solutions (NBS). These NBS seek to apply natural elements to provide different co-benefits, among them the improvement of the hydrological cycle and the consequent reduction of flooding in urban environments.

One of the most effective of these NBS is that of flood parks, which aims to return spaces to rivers that can be flooded. In these spaces, the rivers receive the excess flow that they carry downstream with the aim of tempering the force with which the river reaches the most vulnerable areas.

In the Basque Country, episodes of flooding are clearly becoming increasingly important and the Basque Water Agency (URA) has been working intensively on modelling, forecasting and intervention to improve the conditions for regulating river flows.

In recent years, numerous interventions have been undertaken along these lines. In the area around San Sebastián, we find actions in the Urumea, with the adaptation of areas to be fitted out as flood parks in Txomin Enea (link) and in Astigarraga (link). Also in Gipuzkoa province, the Oria river at Lasarte, where a breakwater on the river bank was also restored (link). The work in the intertidal zone and wetlands of Bakio (in Bizkaia province) is also noteworthy (link), as well as the work carried out in the Irita wetland in Zarautz (link).

Picture. The waves hit the seafront of Zarautz with force. (link)

In addition to flood parks, there are other trends in the regulation of the water cycle, such as the permeabilisation of urbanised areas through gardens and/or sustainable urban drainage systems (SUDS). These surfaces ensure that rainwater does not overload the stormwater system or increase the flow of the river, among other NBS functions. An emblematic example of these interventions in the Basque Autonomous Community is the one carried out in the municipality of Legazpi in Gipuzkoa (link).

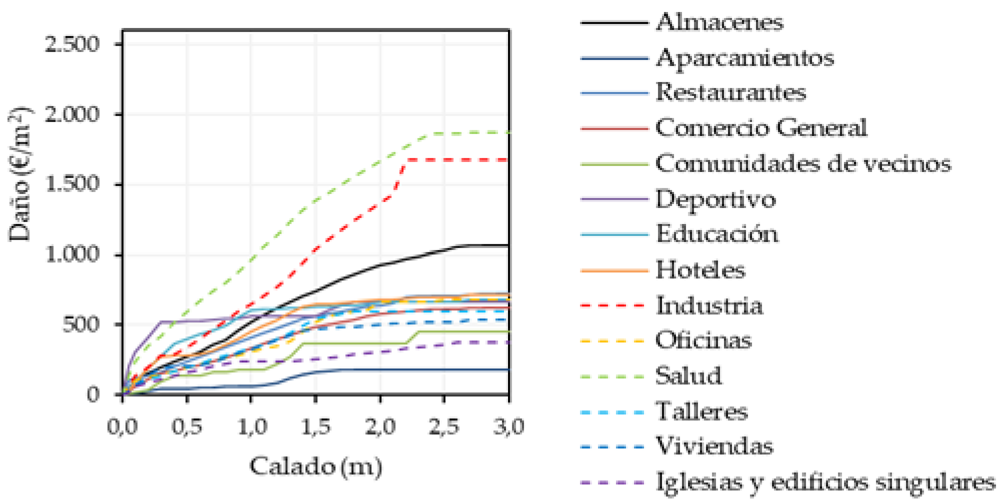

Figure 1. Flood Depth-Damage Curves for Spanish Urban Areas (link)

The aim of these actions is, after all, to reduce the floodable area (m2) and the depth of flooding ('draught', measured in metres), in the most aggressive events, in order to affect a smaller number of people, residential buildings, economic activity establishments, roads, among other assets and properties that may be damaged. For this purpose, 'damage curves' are used that take into account the activity and use of the flooded areas and have a cost per square metre and flooded depth.

With the help of these diagrams the different NBSs are applied and their effect on the flooding models is seen, from which cross-checks can be made to surface the most cost-efficient interventions.

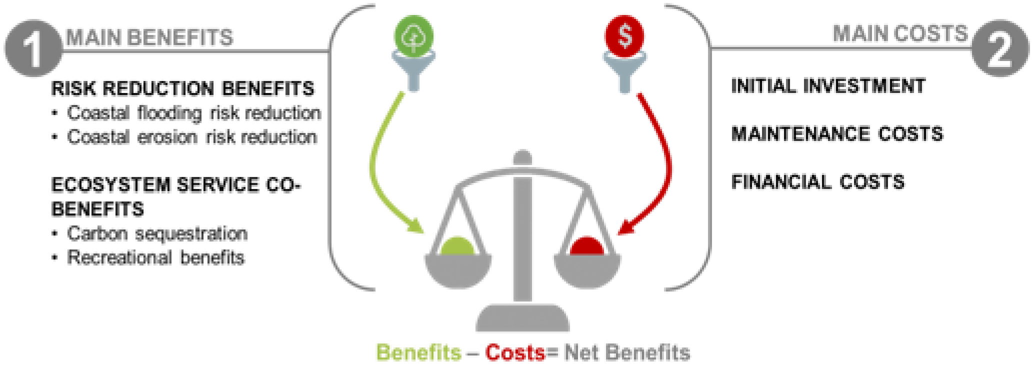

Figure 2. Methodological framework for the socio-economic assessment of adaptation measures to climate change

It is then that different simulations can be carried out to anticipate the effect of the proposed solutions and to analyse whether it is cost-effective in economic terms, i.e. whether the investment is profitable in a given period of time. *Cost Benefit Analyses* (CBA) are carried out by comparing the direct costs of the intervention with the economic benefits it provides.

Thus, different approaches applied to the flood models can be designed and their effect quantified in terms of the reduction of the floodable area and the flood depth. In this calculation, other results emerge, such as the population that would no longer be directly affected by the flooding, as well as the number of establishments flooded before and after the intervention, and thus the economic damage that would be avoided.

Picture. Herramienta de visualización para la gestión de inundaciones (link).

But that is not all. The growing trend to use *Nature Based Solutions* is also due to the fact that they provide a different set of benefits than their 'Grey Solutions' counterparts (so called because of the use of cement and concrete). In general terms, NBS can provide value by absorbing carbon, improving health by reducing noise or air pollution, but also by providing amenity and recreational areas, among others. If we apply this to interventions in river basins and riverbanks, we can see that, although their greatest contribution is the reduction of flood risk, they also provide improvements in terms of recreational areas, health improvement and erosion control.

Modelling makes it possible to anticipate and assess the effects of different adaptation and mitigation solutions. It is an effective support tool even though it is only an approximation and, therefore, reality could always behave with certain particularities that are not reflected in the simulations.

In any case, what we do know from our own experience and from international trends in climate change adaptation and mitigation is that the triangle 'flood modelling / cost-benefit analysis / nature-based solutions' is a necessary approach to consider climate adaptation while reducing the costs associated with floods and making use of technologies and innovation in decision-making.

Picture. Flood Park.