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Long-term strategies of climate change adaptation to manage flooding events in urban areas

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Heavy and sudden rainfalls regularly affect the Mediterranean area, so a great number of people and buildings are exposed to the risk of rain-generated floods. Climate change is expected to modify this risk and, in the case that extreme rainfalls increase in frequencies and intensity, this could result in important damages, particularly in urban areas. This paper presents a project that aims to determine adaptation strategies to future flood risks in urban areas. It has been developed by a panel of water companies (R+i Alliance funding), and includes the evaluation of the climate change impact on the extreme rainfall, the use of innovative modelling tools to accurately forecast the flood risk and, finally, the definition of a pro-active and long-term planning against floods. This methodology has been applied in the city of Barcelona.

Current climate models give some projections that are not directly applicable for flood risk studies, either because they do not have an adequate spatial and temporal resolution, or because they do not consider some important local factors, such as orography. These points have been considered within the project, when developing the design storms corresponding to future climatic conditions (e.g. years 2030 or 2050). The methodology uses statistical downscaling techniques based on global climate models predictions, including corrections for extreme events and convective storms, as well as temporal downscaling based on historical observations. The design storms created are used in combination with the predictions of sea level rise and land use evolutions to determine the future risk of flooding in the area of study.

Once the boundary conditions are known, an accurate flood hazard assessment is done. It requires a local knowledge of the flow parameters in the whole analyzed domain. In urban catchments, in order to fulfill this requirement, powerful hydrological and hydraulic tools and detailed topographic data represent the unique way for a local estimation of the flow parameters (flow depth, flow velocity, flood duration, etc.). If urban floods are caused by heavy rainfall events and a quick hydrological response of the catchment, the approach to elaborate a flood hazard assessment study should take into account the drainage system capacity, too (in terms of effectiveness of surface drainage structures, as well as storm sewerages). In these cases, the hydrological modelling of the involved subcatchments should be linked to the runoff propagation 2D modelling on the urban surface and the hydraulics of the storm sewers (dual drainage modelling) through a coupled 2D/1D approach.

The design storm created and the 2D/1D modelling approach have been used to simulate the future flood risk in the city of Barcelona. From the simulation results, it is possible to understand the flooding processes and the risk associated. It is therefore possible to develop some long-term adaptation strategies to reduce the flood risk for current and future climatic conditions, such as structural measures (e.g. improvement of the stormwater network) and non-structural measures (e.g. enhancement of the flood warning system).