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A flood risk attenuation model based on sustainable detention basins: Application to critical zones in Portugal

Daniela Terêncio, Luís Sanches Fernandes, Rui Cortes, and Fernando Pacheco
Universidade de Trás-os-Montes e Alto Douro, Portugal (dterencio@utad.pt)

Floods are the most common natural disasters that occur in Europe, and in Portugal is the second natural event that causes great damage or losses of life. Facing these facts, the European Commission and the EU Council prompted to put forward the Directive 60/2007/EC, referred to as Floods Directive. The rules of Floods Directive have been transposed into the Portuguese Law through Decree-Law no. 115/2010 published in 22 October 2010. Within implementation of this legislation, 22 critical flood risk areas have been identified in Portugal. Subsequently, the Portuguese Environmental Agency elaborated the corresponding flood risk maps. The purpose of this study was to develop a flood attenuation model based on detention basins, capable to eliminate the areas classified as risky or very risky from those maps. Put another way, the goal was not to prevent floods from occurring but to attenuate their most significant impacts, usually related to the risky and very risky areas. The rationale behind this approach was to mitigate flood risk using low engineered dams.
The model workflow comprised the sequential use of engineering formulae and a zoning algorithm embedded in a Geographic Information System. The formulas allowed to set up the volume of river water to retain in a detention basin during a flood, as well as the smallest catchment area (A) producing this volume. The zoning algorithm was used to delineate all sub-catchments of area A draining runoff toward the damming structure, which is to be placed at the sub-catchment outlet. The results indicated a number of optimal places to install the detention basins within the critical zones, but revealed a huge diversity of dam wall heights, influenced by differences in topography, land use, climate, geology or occupation by burnt areas among the sub-catchments.
In some critical zones, the calculated dam wall heights were rather low (< 2m). In these cases, the attenuation of flood risk as proposed in this study could be accomplished through construction of sustainable flood detention basins. Sustainable flood detention basins are characterized by low construction costs and landscape impact, and frequently can be used to create attractive leisure areas. In other critical zones, flood risk attenuation could only be attained if dam walls were taller than 120 meters. In these cases, the construction of highly engineered structures would be mandatory. Because construction of these dams is extremely costly, the only possible way to mitigate flood risk in these critical zones would be to couple flood attenuation with hydroelectric use, or through the implementation of an extensive reforestation program in the catchment with the purpose to increase evapotranspiration and reduce runoff.