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Hydro-geomorphological based solutions for geoheritage management in the 'Caldera de Taburiente' National Park (La Palma, Canary Islands, Spain)

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The "Caldera de Taburiente" National Park is placed on the island of La Palma, the north-westernmost island of the Canary Islands archipelago. Declared National Park in 1954, its 47 km^2 are located in the northern part of the island. The altitude ranges from 430 m a.s.l. in the bottom of the 'Barranco de Las Angustias' creek to 2426 m a.s.l. in the 'Roque de Los Muchachos' peak. The main part of the National Park is formed by the headwaters of the Barranco de Las Angustias, a semi-circular (8 km in diameter) basin which is a large erosive "caldera", since its morphology is actually the result of the superposition of erosive phases and giant landslides.

The National Park and its surroundings (as Natural Park and reserve areas) contain a variated geoheritage including 13 geosites of national relevance comprising Pliocene pillow lavas, pyroxenites, a dyke complex, metamorphic processes, springs, waterfalls and intense erosive landforms. Geosites also stand out paleontological sites of Cenozoic paleobotanical remains (leaves, stems, pine cones from Macaronesian tree species). Some of this paleontological remains are close to the creek bottom and exposed to river dynamics during flash floods, producing serious problems for geoconservation. As flash flood frequency and magnitude are been modified by present and future climate change and other historical human activities (tunnels for water collection, forestry and livestock management), it is necessary to improve hydromorphological flood assessments for geoheritage management and adopt sustainable risk mitigation measures.

The scarcely availability of meteorological data (rainfall data) and the absence of flow gauging data, together with a highly heterogeneous distribution of river bed sediment sizes, do not draw the best scenario for a fully hydraulic-based solution for geoheritage management. Despite this, probable peak flows related to extreme events in the basin have been hydraulic modelled with the aim to characterize flood variables (flow depth and velocity) in the surroundings of geosites. Based on these results, and depending on the location and characteristics of each geosite, hydro-geomorphological solutions were designed to reduce the erosive and sediment transport capacity of the flow. These solutions also had to take into account the geomorphologic characteristics of the

river section (slope, width, entrenchment), which limit the applicability of some of the most widely used Nature Base Solutions (NBSs). Hydrological correction check dams for channel slope reduction and regulation, channel bank reinforcement for bank-erosion reduction, or rip-rap and vegetated dikes to derive flows were used to reduce flood risk over geoheritage.

Individual or combined NBSs are been implemented into the hydrodynamic model to get the better hydro-geomorphological based solution for each geoheritage site. Finally, in base to all these results, a geoheritage management proposal for "Caldera de Taburiente" National Park has been developed for National Park managers and La Palma Island and Canary Islands Governments.

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