Assessment of the wave attenuation capacity of a mangrove forest based on its age and the incident wave conditions

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Although mangroves reduce annual flooding to millions of people there is not a methodology to implement these solutions and it is still difficult to estimate the protection provided by them under different environmental conditions and ecosystem properties. To move forward in the consecution of an engineering approach when implementing these solutions for coastal defense, the first step to make is to better understand and parameterize the basic physical processes involved in flow-mangroves interaction. With the aim of getting a new formulation for wave decay provided by Rhizophora mangrove forests based on flow and ecosystem properties, an experimental campaign was carried out where both wave attenuation and forces on mangrove individuals were measured under different wave conditions. Both, the hydrodynamic conditions and the mangrove forest, were scaled according to field conditions for short waves. The detailed wave attenuation and drag force measurements obtained in these experiments allowed to obtain new formulations of wave decay produced by the forest depending on the flow, i.e.: water depth, wave height and period, and on the forest characteristics, i.e.: individuals submerged solid volume fraction and density. These formulations are used to get attenuation rates under different flow and ecosystem conditions. The resultant curves provide with the wave decay produced by a specific Rhizophora forest subjected to the defined wave conditions. The forest is defined on the basis of its age, considering the differences in individual trees depending on their maturity and the density of the forest as the number of trees per unit area. Wave conditions are defined by the root mean square wave height and the peak period and water depth is also considered. The obtained curves allow to estimate the width of the forest necessary to reach a certain level of protection considering the local flow conditions and the forest age. This can assist in the inclusion of nature-based solutions in the portfolio of coastal protection measures.