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Ecosystem Services to Enhance the Resilience of Coastal Regions and Communities to Flood Risks in a Catchment to Sea Perspective

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A b s t r a c t

An overview of the recently financed Water4All Joint Transnational Call 2023 project "Ecosystem services to enhance the resilience of coastal regions and communities to flood risks in a catchment to sea perspective (EcoC2S)" is given, highlighting innovative points, and challenges that the involved parties aim to address in the next years. EcoC2S is a joint initiative of six partners, specifically the University of Granada and the University of Santiago de Compostela (Spain), the Marche Polytechnic University (Italy), the Lusófona University (Portugal), the Institute of Geophysics PAS (Poland), and the Karlsruhe Institute of Technology (Germany).

1. THE ECOC2S PROJECT

1.1 Background

Globally, and in Europe in particular, coastal floods are one the most common natural hazards with major economic, social, and ecological impacts on communities (Vousdoukas et al. 2020). Coastal systems support biodiversity and provide critical ecosystem services (ES), including flood protection. The effects of climate change (CC) enhance hazards in such flood-prone areas and place additional physical pressure on ES, while also adding pressure to the social system, by interfering with people's socio-cultural and socio-economic valuation of such places, with potential consequences to their place identity and their motivation, emotions, cognitions, and behaviours associated with them. This creates an urging need for reliable risk assessment, management and communication methods (Parlagreco et al. 2019) and innovative community engagement approaches through stakeholders' co-design methods, towards reducing vulnerabilities, protecting what people value, and enhancing socio-physical systems adaptation towards building resilience (Gaspar et al. 2019).

The lack of reliable methods for a holistic evaluation of flood risk is hampering progress. Many catastrophic floods have a compound dimension, where the interaction of multivariate and multiscale drivers usually exacerbates their effects. This is particularly true for estuarine cities and regions (Brocchini 2024) and calls for a holistic approach to flood risk management, combining both physical and ecological drivers and feedback.

1.2 Objective and methods

To address the above-mentioned knowledge gaps, EcoC2S aims to co-develop a holistic flood risk assessment approach (Fig. 1) to quantify the contribution of natural systems and blue-green infrastructure to flood protection in transitional and coastal areas and the co-creation and further implementation of resilient pathways based on ES. Such an approach will allow for:

- Reliable and affordable assessment of flood risk jointly considering geophysical and societal preconditions and relevant flood drivers, with their dependencies and interactions.
- Estimating the contribution of meteorological, eco-morphodynamic and human drivers to flood impact.
- Valuation of water flow regulation by inland and coastal ecosystems spanning the water continuum.
- Assessment of the functionality of ecosystems and blue-green infrastructure within a CC context, including coastal ecosystems' resilience and geomorphic adaptation under SLR.
- Assessment of the socio-cultural and socio-economic value of ES for local communities, the determinants of such valuation (behavioural, motivational, affective, and cognitive), and if perceived past, present and future changes in ES, change its perceived value and predict (non)acceptance of ES solutions.
- Engagement of local communities and stakeholders in the co-identification of research gaps and needs, and the co-design and co-implementation of ES, with a focus on overcoming barriers to these.
- Promoting resilience pathways towards sustainable development under CC, which are based on ES and are multifunctional, flexible, gender-responsive and adaptive to account for multiple uncertainties.

The project will focus on five different topics:

1) Co-identification of knowledge gaps and ecosystem services valuation, following a participatory approach. Use of counterfactual analysis to assess the key flood drivers and their contribution to flood risk based on previous flood events, and to understand human preferences and perceptions of ES, and their value.

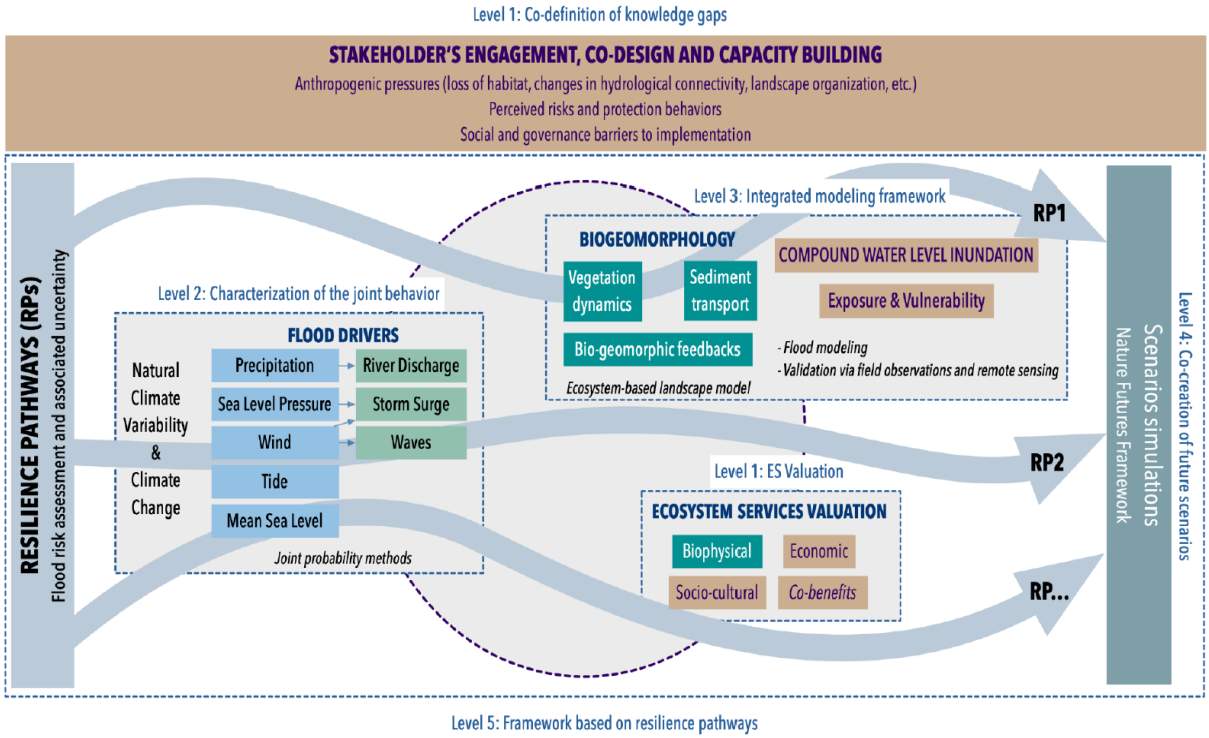

Fig. Conceptual framework of the EcoC2S project.

2) Characterization of the joint behaviour of the geophysical preconditions of the catchment with the atmospheric and marine drivers at the coast, considering the combination of multiple and concomitant variables to define the probability of occurrence of compound extreme events.
3) Integrated modelling framework that includes eco-morphodynamic effects on compound flood hazard. Physically based formulations will be implemented to consider the effect of vegetation on the flow field in areas such as tidal marshes. The long-term eco-morphological evolution, driven by the interactions between vegetation dynamics, water flow, and sediment transport (bio-geomorphic feedbacks), will be analysed with a combination of remote sensing, field measurements and numerical simulations.
4) Co-creation of plausible future scenarios for sustainable and resilient ES, bringing together different actors into dialogue and reflexive learning, to co-create and co-realize solution-oriented pathways.
5) Establishment of a framework that guides the development of long-term mitigation measures and management strategies that enhance the resilience of human and natural coastal systems to extreme events. Rather than deterministic approaches, the definition of resilience pathways allows adaptive measures considering the stochastic nature of the geophysical factors, the evolution of natural systems, and how humans interact and value the ecosystems where they live and that they use.

The methodology will be tested in two pilot case studies at the river basin level: i) Cádiz Bay in Spain, and ii) Senigallia in Italy, as both are coastal systems with compound flooding potential and highly intervened by human activity. They are characteristic of European archetypes (namely, structured approaches to classify, understand, and address compound flooding) in terms of the different contributions of the flooding drivers, ES potential, and catchment, and coastal typologies. Those case studies will be used as a framework to identify and categorize common flooding patterns and get a first estimation of the likelihood and severity of flood

events. Moreover, they will be ideal to help in the process of communication between experts, policymakers, and the public in the co-development of resilience pathways, and ultimately to facilitate the transfer to other sites.

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