Impact of hydrological and marine extreme events on coastal systems. Adaptation strategies and community resilience

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Context and Motivation

Motivation: Presently about 40% of the world's population lives within 100 km of the coast. A large fraction of that population concentrates in the low-elevation coastal zone (defined as less than 10 meters elevation); this population is hence exposed to marine extreme events, to hydrological extremes and to the combination of both.

Timeliness/urgency: the reasons to place coastal systems on the top of the agenda:

- Population density and economic activity in the coastal zone are increasing, and so is the effect of different stressors acting on coastal systems (e.g. coastal erosion, land cover change, pollutant loads, introduction of invasive species).
- Extreme values of crucial parameters are presently increasing due to climate change and are expected to accelerate in the near future. Sea level is perhaps the most significant parameter (because it is global and because mean sea level rise affects other parameters), but also hydrological extremes and marine heat waves will be very relevant.
- The combination of both, increasing climate extremes and increasing human pressure can lead to irreversible impacts if action is not undertaken.

Key research questions

The research questions pointed out in the following are arranged following the logical sequence that goes from knowledge to action:

- **What are the actions needed for a better understanding of present day extreme events and to increase the reliability of the uncertainties associated with climate change projections?** Uncertainty is considered one of the major obstacles for stakeholders to take action.
- **How can the impacts on coastal systems be properly quantified?** This relates to the need of an integral analysis of the problems and hence to the need of some metrics that goes beyond single-disciplinary parameters.
- **How can we evaluate the capabilities of the systems to adapt (e.g. vs. collapse) and what can be done to increase resilience of coastal systems?** There is an increasing demand to integrating physical, environmental and socio-economic components.
- **What to do to improve the tools of prioritization/taking decisions?** How to integrate the lessons learnt and how to mainstream adaptation in short-, middle- and long-term plans?
- **How can the effectiveness of warning systems be increased? In particular, how can the temporal and spatial scales of the warnings be optimally constrained?** This is a paradigmatic issue regarding the need of a two-way interaction between scientists and stakeholders.

Expected methodologies and disciplines involved

- **Continued monitoring of the climate (both its variability and change) and other environmental and socio-economical parameters.**

- **Modeling of the interaction between the different components of the systems (physical – ecological - socio-economical) and hence of the impacts from global to regional/local scales.** Progress in the development of single-disciplinary process models is still also needed.
- **Participatory approaches and communication strategies (including both local and global agendas) that facilitate a two-way interaction between scientists, stakeholders and social agents.** This includes all stages from the co-design of the research to dissemination techniques.
- **Socio-political / governance methodologies** such as adaptation tipping point analysis and risk assessment techniques**.**

Stakeholders involvement needed

The list of stakeholders is case-to-case dependent (we identified lists for different case studies). An important issue is to identify the stages in which each stakeholder must be involved, i.e., which ones should participate in the first stages (co-initiation and co-design of the research), which should follow the development of the research (co-implementation) and which are mostly end-users or just participate in the outreach.

At present the involvement of stakeholders is often reduced to end-users and therefore the efforts should go in the direction of the co-engineering of the research. This is a complex process that requires additional funding and additional time.

Promoting the feeling of ownership of the research by stakeholders is probably one of the best ways to achieve their involvement. Another way is to determine from the beginning the direct benefits for stakeholders to participate in the proposal process.

Relevant scale / regions

The topics pointed out here (both the research questions and the methodologies) are important at all scales. They are of global relevance, as marine and hydrological extreme events are expected to increase worldwide. However, specific applications are very case-to-case (local) dependent.

The logical sequence would be: developing general methods - local scale application - feedback of results/methodologies into global methods.

Expected societal impact

The outlined questions are relevant for many societal aspects. Under the overall topic of a sustainable use of coastal systems and their resilience to climate change we can expect benefits in the fields of: safety (for human lives, housing, infrastructures), ecology (more resilient coastal ecosystems), economy (tourism industry, aquaculture, shipping industry), social (wellbeing), etc.

The envisaged benefits of co-designed research projects are: i) better targeted projects from the societal point of view; ii) increased trust in the outcomes of the project; iii) willingness to take into account of the results of the research in the decision-making process and to apply the proposed measures. [These benefits are probably general, anyway, not particular of coastal systems.]