NEW CLIMATE SERVICES TO COASTAL COMMUNITIES IN GALICIA (NW SPAIN)

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Abstract

Adaptation to climate change requires the implementation of services that translate scientific knowledge into practical results, so that policymakers and stakeholders can understand the risks and increase their resilience. In the coast those risks are related to flooding, erosion or physico-chemical changes of seawater. The main aim of MarRisk project was to generate this type of services for the NW of the Iberian Peninsula, relying on the experience of a coastal oceanographic observatory (RAIA). These services have been developed based on indicators and models, through a process of co-creation. Thus, a resilience index for harbours or estimations of physical-chemical changes of seawater that can impact sectors such as fishing or aquaculture have been generated. Moreover we have calculated maps of vulnerable areas to flood and erosion. As a conclusion we highlight that the elaboration of a set of indicators together with the expertise of modelization of climate change is not enough to help coastal communities to adapt to climate change. The interaction with different stakeholders is also a needful step to create climate services.

Keywords: Erosion, Flood, Resilience, Climate Services

1. Introduction

RAIA Observatory is a consolidated transnational coastal observatory which provides marine data services and products (marnaraia.org) in the NW of the Iberian Peninsula (Eurorregion Galicia-Spain and N of Portugal) initiated in 2009 with the support of Interreg-Poctep Spain-Portugal projects such as RAIA, RAIAco, RAIAtec and recently MarRISK.

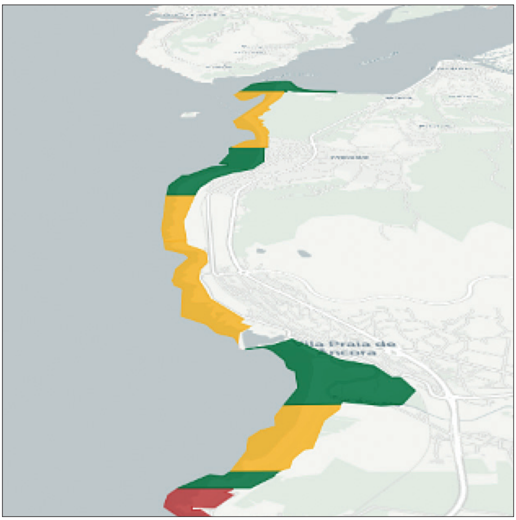
In particular MarRISK focuses on developing climate services and early warning forecasts for coastal populations in the Eurorregion. Floods, intensification of extreme events, episodes of toxic algae or coastal erosion are examples of risks analyzed in Marrisk for improving the resilience of traditional economic sectors (aquaculture) and of coastal populations (Bode *et al.*, 2019; Des *et al.*, 2020; Fernandez-Fernandez *et al.*, 2020.

To mitigate these impacts, the project has implemented different services based in indicators from in situ data combined with results of oceanographic and wave models in a process of co-creation with stakeholders. Thus, the project has provided support to coastal communities to estimate coastal flooding and increase in erosion, or to calculate physical-chemical changes that can impact sectors such as fishing, aquaculture or harbour authorities in the area. For harbours, a resilience index to climate change was computed and long-wave resonance was demonstrated. Throughout the project we have been in close contact with possible stakeholders, always with the aim that the results could be converted into useful climate services for users. Therefore the main result of the project is not the services themselves, but the fact of having covered the entire chain from global models to very specific products for local users in the area.

2. Results

2.1 Flooding and erosion

The first step to produce erosion and flood risk maps was to carry out detailed projections with wave models for the NW area of the Iberian Peninsula. With these projections, wave spectra were obtained at specific points of the coastline that served as input for the erosion models and that allow evaluating the area most exposed to this effect in the future. This study has been made all along the coast, classifying the areas in low, medium or high vulnerability (Figure 1). Moreover some calculations have been made in specific areas to know exactly which areas will be flooded (Figure 2).



Vulnerability:
- Low
- Medium
- High

Fig. 1. Map of erosion vulnerability in a section of north Portugal coast.

With these results and the classification we are able to estimate which areas of the coast may be affected by floods in the coming decades, even if storm surge does no change in the future, simply due to rising sea levels. As an example, we show the results obtained in the medium scenario (RCP4.5) for the middle of the century in a coastal area of north Portugal. We can clearly see how large areas, some of them populated, would be subject to flooding in the future in situations of coastal storm surge. In the near future we will build up a near operational system that will be able to calculate floods with several days in advance.

In addition, during the project, the costs/benefits of three different adaptation strategies have also been calculated: Defense, accommodation and withdrawal. The result obtained indicates that in the long run the withdrawal strategy is the one that generally obtains the best score. This is because the other strategies involve annual maintenance that ends up being more expensive.

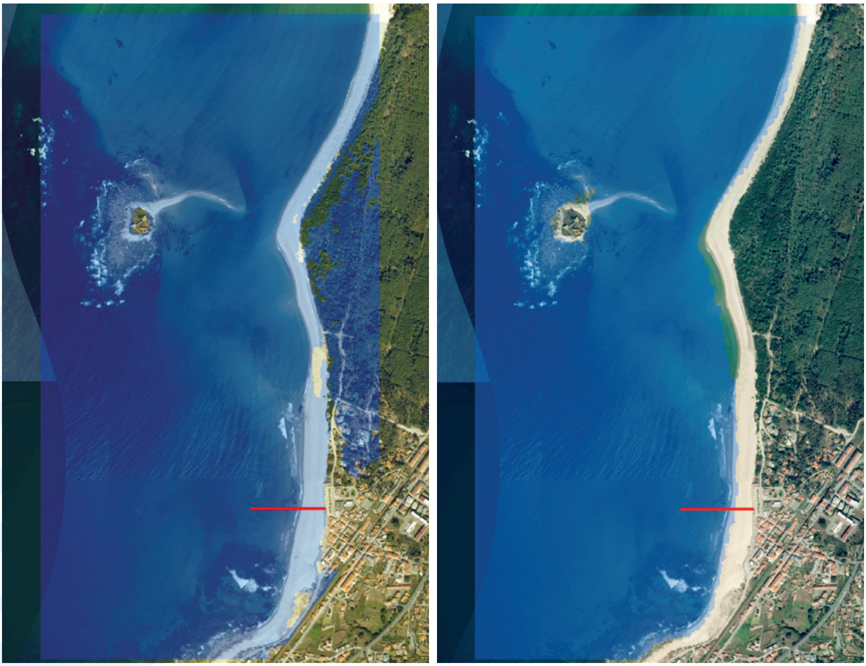


Fig. 2. Example of flooded area taking into account a wave storm in 2050 in RCP4.5 scenario.

2.2 Resilience index for harbours

To help harbours adapt to climate change, within the MarRisk project a resilience index was developed following the methodology known as Delphi in which several independent experts judge the importance of different parameters. In this case, this evaluation by experts consisted of two parts. In the first, the connection of different physical parameters (waves, wind, rain ...) with different aspects of harbour operations was evaluated. In the second round the relationship of these risk scenarios with different adaptation factors was investigated. Taking into account current performance and grouping adaptation factors, a resilience index can be calculated.

$$I_R = \beta_{FR1} FR_1 + \beta_{FR2} FR_2 + \beta_{FR3} FR_3 + \ldots . + \beta_{FRn} FR_n$$

where β_{FR} is the importance given by the experts for each of the adaptation factors and FR is the actual performance.

Having this index in mind, each harbour can improve its index and therefore its resilience to climate change, taking actions that increase the performance of adaptation factors. For example, governance can be improved; early warning systems implemented and any other weaknesses covered by this analysis can be addressed.

2.3 Long-wave resonance

Harbours located on coasts exposed to wind and wave storms, such as those located on the northwestern coast of the Iberian Peninsula, are exposed to many meteorological risks. One of the most dangerous and with a lower level of predictability is that of long-wave resonance. Within the MarRisk project we have addressed the implementation of an early warning system for these phenomena in one of these ports, specifically in Malpica. To use this early warning system we need a high resolution wave model outside the port. With the spectrum of this model, the long wave is obtained and the they are finally propagated inside the dock (Figure 3).

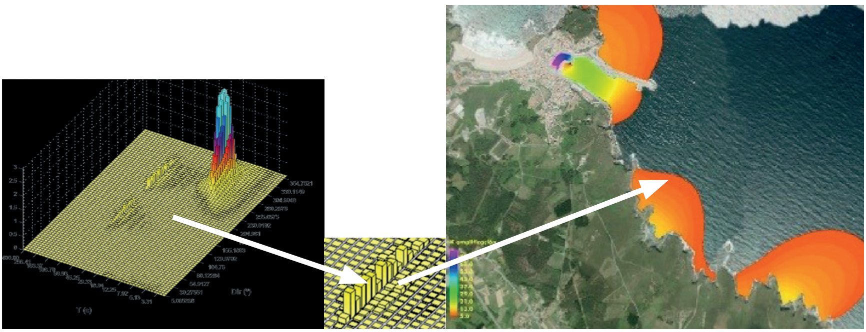


Fig. 3. Long wave spectra generated with Swan model are propagated to the inner part of the harbour.

Results (Figure 4) show a good agreement between measured oscillations of sea level inside the harbour and modelled with the early warning system that takes as input operational wave models.

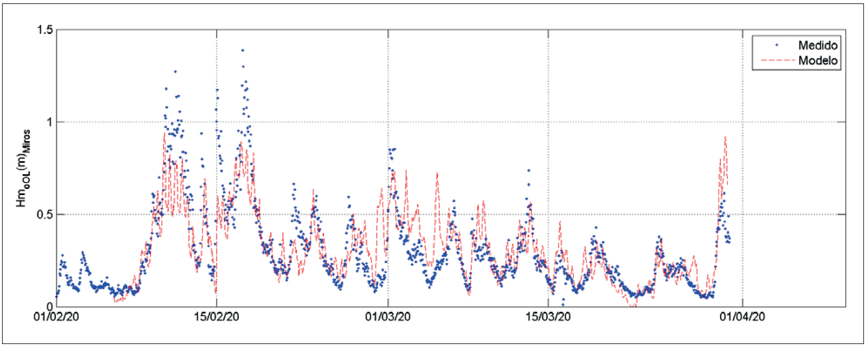


Fig. 4. Oscillation of sea level inside Malpica Harbour. Measured (blue points) and modelled (red points).

This system is now in a pre-operational phase. It is being tested by the harbours agency of Galicia. In the next year will pass to operational phase and the methodology could be extended to other harbours.

2.3 Coastal risks for aquaculture in the Eurorregion

One of the services for predicting and mitigating coastal risks in aquaculture and fisheries in the Eurorregion which has been advanced in Marrisk are HAB-risk forecasts in the Eurorregion. A demonstration of the usefulness of HAB early warning tools for managing authorities and aquaculture producers was performed in the European FP7 ASIMUTH project (Applied Simulations and Integrated Modelling for the Understanding of Toxic and Harmful Algal Blooms) (Maguire *et al.*, 2016). The early warning developments in Marrisk rely on the use of Marrisk hydrodynamic models that predict the possible transport of HAB causing advection of phytoplankton species, combined with satellite data and *in situ* HAB data from the monitoring of Marrisk partners in Galicia (INTECMAR) and Portugal (IPMA). During the project, it has been demonstrated that development of web services support the ingestion of forecast model results into early warning prototypes as well as the efficient exchange of in situ HAB data and toxins from the monitoring agencies, which increases the capacity of processing information integrated in the EuroRegion from two different national monitoring programs.

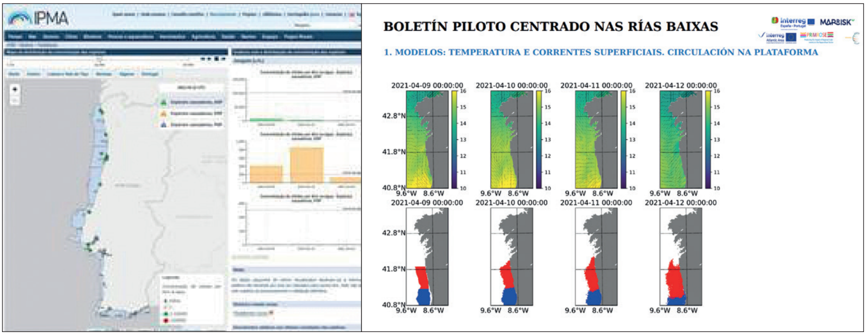


Fig. 5. An example of the Marrisk HAB services in Portugal and Galicia for supporting coastal communities. On the left, the IPMA web page showing HAB phytoplankton species distribution in bivalve production areas (https://www.ipma.pt/pt/bivalves/fito/index-map-dia-chart.jsp). On the right, an example of the model forecasts in the Galician risk assessment pilot bulletin.

3. Conclusions

In the framework of the MarRisk project we have been able to demonstrate some climate services that could be useful to make the coastal communities more resilient to climate change. In the next years those services will be extended to other areas of the coast and finally, the exploitation of results of the dynamic downscallings of climate projections with wave and biogeochemical models will allow the building of new services for providing climate advice to final users: in order to help them in the design of mitigation and adaptation plans.

Acknowledgements

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