EFFECTS OF CLIMATE CHANGE SCENARIOS ON THE COASTAL FLOODING HAZARD INDUCED BY EXTREME WAVE CONDITIONS IN THE SOUTHERN ITALIAN COASTS

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INTRODUCTION

In the era of climate change induced by global warming, it becomes fundamental to consider the long-term variation of physical parameters needed to define design loads or to perform risk assessment. In the scientific community, the IPCC provides an assessment report on climate change approaching a wide range of issues including the impact on the environment and potential mitigation and adaptation strategies, at a global level (Brasseur, 2022). In the coastal field, it is expected that climate change will influence wind patterns, sea levels, storm surge characteristics and their frequency. This will have an impact on wind-generated waves and on the variation of its synthetic parameters that will characterise coastal flooding phenomena in the near future, especially along low-lying coasts. In this context, climate change may induce modifications to wave intensity and direction so, this could have detrimental effects on coastal areas. Furthermore, it has been substantiated that the combination of rising sea levels, wave run-up and storm surge events will enhance the role of coastal flooding in the management of coastal areas and in the definition of long-term adaptation strategies (Pasquali et al., 2023; Pörtner et al., 2019). The quantitative estimation of impacts of climate change can be then identified as primary aspect to be dealt with the definition of adaptation strategies (von Schuckmann et al., 2023). The functionality of coastal and harbor infrastructures and the evolving threat of coastal flooding highlight the critical importance of investigating the potential impacts of climate change. Due to this, there is clearly a need for implementing enduring adaptation strategies, allowing to incorporate them into land-use policies and effective management practices (De Girolamo et al., 2017; Pasquali et al., 2023; van Gent, 2019).

AIM AND PRELIMINARY RESULTS

This research study is being developed as part of the ongoing RETURN extended partnership project in the Italian national context. The aim is to perform a demonstrative application focused on evaluating the increased hazard of coastal flooding caused by climate extreme events. As a result, a useful tool to effectively assess the long-term coastal hazard will be provided (as proposed by Fanti et al., 2023). An application will be carried out along a low-lying coastal area characterised by the presence of coastal infrastructures (railways and/or roads) located on the Italian Mediterranean coasts. To carry out this study, it will be necessary to compare traditional methodological approach with an innovative one, able to take into account potential future weather-oceanographic scenarios modified by climatic variations. The application methodology involves the use of the time series provided by Copernicus climate service (C3S) in collaboration with ECMWF, which reconstructed from global or regional scale wave models coupled with atmospheric models to incorporate climate forcings. The traditional approach involves the use of a reconstructed ocean wave data package in the ERA5-Reanalysis dataset (Hersbach et al., 2020), which presents a global coverage from 1940 to present (hereafter called ERA5) and, direct measurements extrapolated by exploiting the Italian national wave network (Rete Ondamentrica Nazionale - RON, ISPRA). The innovative approach, uses another time series of the coastal wave climate, based on ocean surface wave parameters computed for a European-wide domain. This dataset provides an understanding of the wave climate under the impact of climate change for the Northwest European Shelf and Mediterranean Sea. To estimate the impact of climate change on the ocean surface wave field, the SAW wave model implemented by ECMWF, has been used to perform numerical simulations for three different climate scenarios: the current climate (also referred to as historical) and two future scenarios. Historical climate, covering a period from 2001 to 2017, is represented by another product of ERA5-Reanalisys which in this study, will be called ERA5-RCP (Pörtner et al., 2019, Caires et al., 2022). While, the wave time series are projected on future scenarios based on the "Representative Concentration Pathway" RCP 4.5 and RCP 8.5, covering a period from 2041 to 2100. RCPs are greenhouse gas emission scenarios used to assess the potential effects of climate change on. These, respectively represent the most optimistic scenario (RCP 4.5), and the 'business as usual' scenario, (RCP 8.5) (Seneviratne, 2022). A case study is introduced hereafter as a preliminary result. It refers to the southern Tyrrhenian Italian coast, as shown in Figure 1 (Cetraro, Calabria region). Instead, Figure 2 presents the scatter plot of the comparison between the significant wave heights of ERA5-RCP ($Hs_{ERA5\text{-}RCP}$) and ERA5 (Hs_{ERA5}) against the ones from the RON buoy

measurements (Hs_{RON}) referring to the same geographical point (Figure 2).

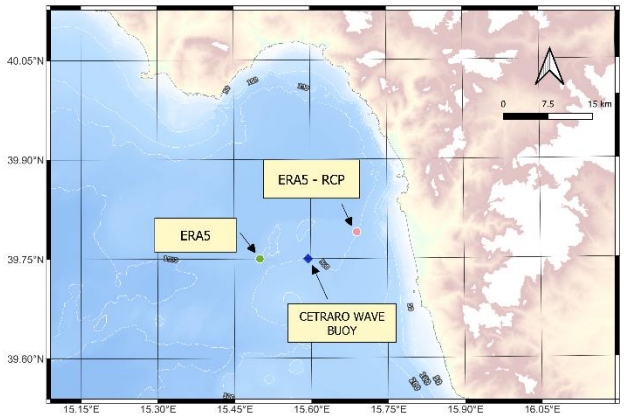

Figure 1 - Geographical setting of employed datasets

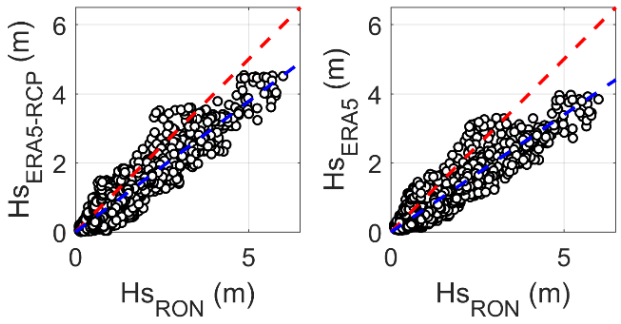

Figure 2 - Comparison of significant wave height time series (Cetraro, 2010)

In details, Figure 2 shows the synchronous comparison. In the left panel, the comparison of HsRON and HsERA5-RCP (innovative approach) while, the right panel between HsRON and HsERA5 (traditional approach). The preliminary comparison has been done for the computational points close to the geographical coordinates as the Cetraro wave buoy (Figure 1). Figure 2 shows the comparison for the year 2010.
It can be seen that the angular coefficient of the interpolating line of the wave heights values (blue dashed line) is, at least for the considered period, extrapolated from the ERA5-RCP database, closer to perfect agreement (red dashed line) than for the wave height values from ERA5.

The work presented herein is aimed to perform standard analyses (i.e., extreme value analysis, climate analysis, etc..) to the past (i.e., extracted from ERA5) and to the future (i.e., extracted from C3S) time series. The results will be used to highlighting the main differences. The approach can be interpreted as a "what if", i.e., to assess the results of standard analyses applied to different time series (i.e., to different epchocs of the analyses). It can be stressed that the assessment of the reliability of the timeseries is out of the scope of the work. The detailed results of the research work will be presented during the conference.

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