CMIP6 climate projections based wave energy production analysis for Mutriku Plant in the XXI century

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Introduction

Nowadays the number of operational renewable energy plants is steadily increasing. It is necessary to analyse how it will affect the climate change in their energy production. Motivated by this need, this study analyses the Mutriku Wave Energy Plant (**Figure 1-2**), which has been operating since July 2011 and has a total capacity of 296 kW.

Data

- ECMWF Reanalysis v5 (**ERA5**) data [1]
- CSIRO wave climate projections 2015- 2100. [2]
  - **CMIP6** models: ACCESS-CM2 and EC-EARTH3 parameterizations CDFAC1.08 and CDFAC1.
  - Scenarios: two **SSP1-2.6** and four **SSP5-8.5**

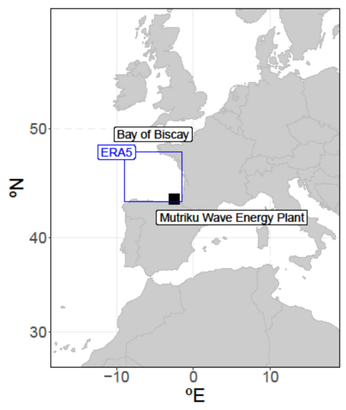

Figure 1: Mutriku Wave Energy Plant located in the Bay of Biscay. The blue square indicates the ERA5 and CSIRO-WW III data area used in this study

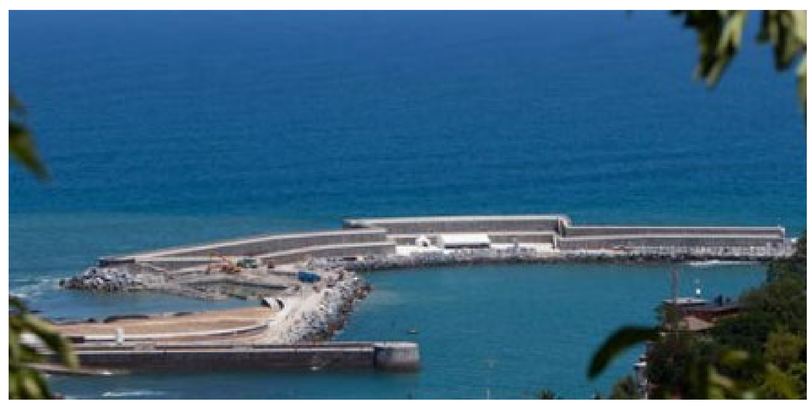

Figure 2: Aerial photograph of the Mutriku Wave Energy Plant

Methodology

- **Bias correction**
  - Multivariate bias technique based on the MBC N-pdf [3]
  - Univariate variables by Quantile Mapping [4]
- Classification of frequencies and powers of sea type has been done by self-organising map (**SOM**) [5]
- Comparison of probability distribution has been conducted using **Smirnov test** at a significant level of 0.05

Results

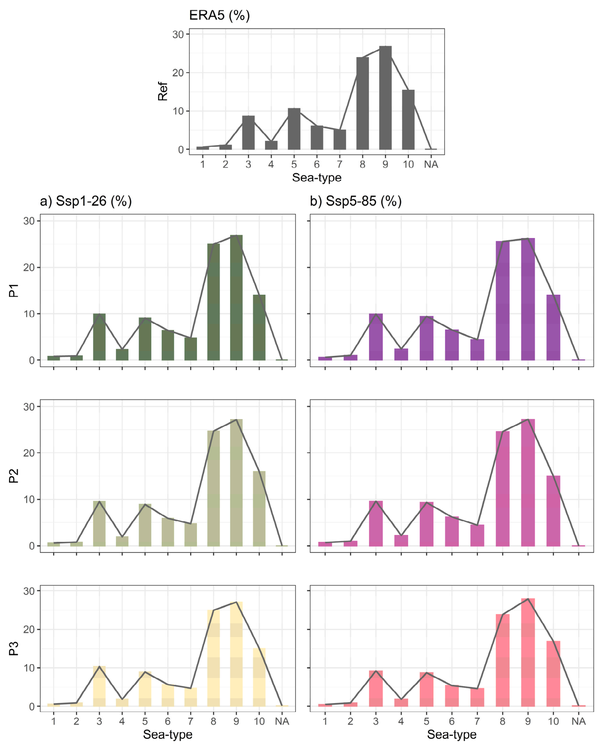

Figure 3: Sea-type frequencies in the Mutriku Wave Energy Plant in the reference period (Ref) in the three climate projections periods (P1, P2 and P3) and scenarios (a) SSP1-2.6 and b) SSP5-8.5)

- The distributions of **sea-type frequencies** between 1985-2014, derived from ERA5 reanalysis, were compared with sea-type frequency projections in the future (2015-2044, 2045-2074 and 2075-2100 periods) for both scenarios, i.e., SSP1-2.6 and SSP5-8.5 (**Figure 3**)

- **Annual Power production** PDF obtained from Ref to the same PDF for each of the three future climate projections (P1, P2, and P3) were compared (**Figure 4**)

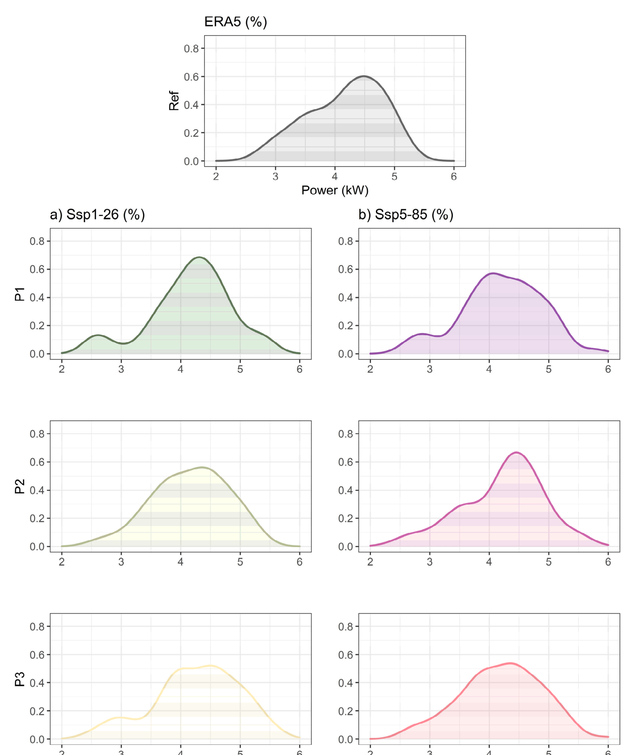

Figure 4: The annual power by period (Ref, P1, P2, and P3) in the Mutriku Wave Energy Plant for the two different climate projections scenarios of a) SSP1-2.6 and b) SSP5-8.5

Conclusions

- **Energy production** in the Bay of Biscay **remains stable** in the 21st century
- **Sea type frequencies** have shown **consistent patterns**, contributing to stable energy production.
- The **Bay of Biscay** is a **valuable source** of renewable energy both now and in the future

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