

Simulated Hydropower Production Under Climate Change Scenarios at Torrão Dam, in Northern Portugal

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Abstract

Climate conditions have a significant impact on energy demand and production. The project CLIM2POWER, completed in 2021, aimed to develop a climate service at European scale for the planning of the power infrastructures operations using seasonal forecasts and long-term climate projections. This work presents part of the project and focus on assessing the climate change impacts on hydropower production of Torrão Dam. Torrão reservoir is located on the Tâmega river, a tributary of the Douro River in northern Portugal. The long-term (2016-2100) climate data used is obtained from the EURO-CORDEX simulations, on a daily time scale. Two different combinations of regional and global climate models for scenarios RCP 4.5 and 8.5 (four combinations) were used: ICHEC-EC-EARTH-CLMcom-CCLM4 (CCLM4) and ICHEC-EC-EARTH-DMI-HIRHAM5 (HIRHAM5). Long-term precipitation data was bias-corrected using the multiplicative shift method, and for rainfall-runoff simulation, HEC-HMS model was used. The results showed that 30-years total annual precipitation for future periods (i.e., 2016-2040, 2041-2070 and 2071-2100) was 3.4%-28.1% lower than the historical one. 30-years annual total discharges of all future periods decreased for both models and RCPs (1.2%-30.2% less than the historical ones). Regarding future 30-year annual average capacity factors, there was reduction (1.8%-24.8%) with respect to historical one, except in two future periods for CCLM4 model of RCP 4.5 scenario i.e., 1.2% increase in the period 2016-2040 and 1.5% increase in the period 1971-2100. This suggest that hydropower production is not only dependent on future precipitation trends but also on the hydropower production procedures.

Keywords: Hydropower production; Climate models; Hydrological modelling.

1. INTRODUCTION

Climate and weather conditions not only strongly influence energy demand but- with the strong development of the renewable energies - also increasingly electricity generation. The changes of the European energy mix together with ongoing climate change raises several questions on the adaptation of the energy supply system to its environment. To address these issues, CLIM2POWER project completed in 2021, aimed to create a bridge between complex scientific model-based knowledge and targeted usable information for end-users by developing a web-based climate service, at a seasonal and long-term timescale, to estimate how climate impacts hydro, wind and solar power operation, electricity demand and the whole power system. The web-service connected climate data, hydrological models, renewable energy sources power simulation tools and energy system and electricity models in an interactive user-friendly layout to produce added value data on hydro, wind and solar resource availability, power demand changes and shifts of the entire power system to adapt to natural resource availability. These data are valuable to support decision-making of both private (e.g. Companies in the power market) and public end-users (e.g. Power market regulators, and water & environment authorities), as well as market based water energy services providers.

The present study describes part of the project, addressed at forecasting the environmental outflows and hydropower production of Torrão Dam, in northern Portugal. Daily precipitation data for the historical (1976-2005) and future periods (2016-2100) of two climate models for the scenarios RCP 4.5 and 8.5 were used after bias-correction. HEC-HMS model was implemented to simulate historical and future runoff. 30-year annual total precipitation and runoff values for the future periods (i.e., 2016-2040, 2041-2070 and 2071-2100) were