Utilization of open-source data and tools for assessing hydropower generation

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1. Introduction

The net-zero climate target requires a low-carbon transition of the power system. Hydropower is an important energy supply option with large power generation and storage capacity. Pumped storage systems also store off-peak renewable electricity from solar and wind power plants. Hydropower generation is susceptible to climatic conditions related to the water cycle.

The outcomes of integrated assessment models assess the relationship between climatic indices and hydropower generation [1]. The annual and monthly surface temperature anomalies have had spatial and temporal variances in the last 30 years [2]. We demonstrate a case study in Turkey for the applicability of open-source data and tools in the energy sector.

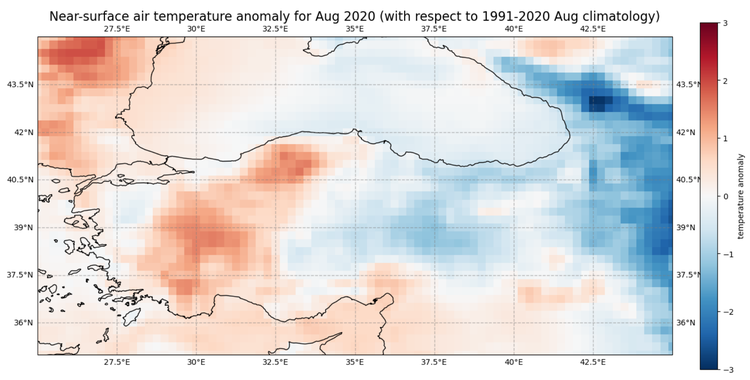

Figure 1: Monthly surface temperature anomaly in Turkey

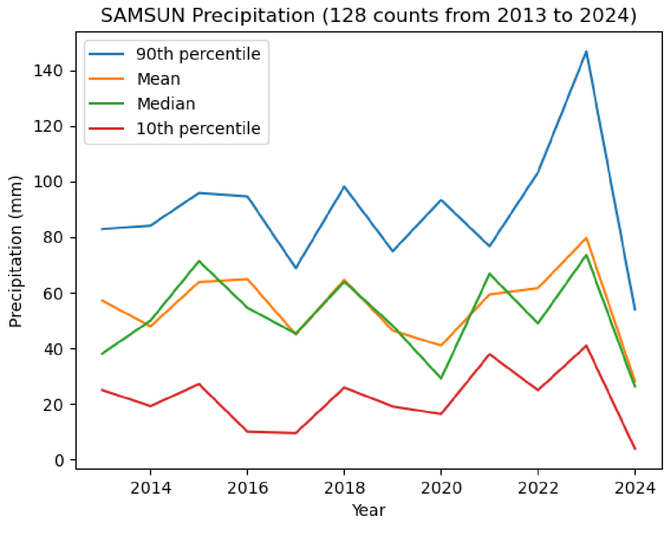

Figure 2: Monthly precipitation in Samsun Turkey

2. Methodology

The authors obtained the monthly and seasonal temperature and precipitation forecasts and anomaly maps from the Eastern Mediterranean Climate Center, established as part of the WMO VI. RCC Network in 2009 [3]. Monthly temperatures show an increasing trend for the mean, median, and extreme percentiles. Monthly precipitation is more dynamic and requires daily resolution to relate to seasonal water inflow to river streams.

The authors obtained the daily temperature and precipitation data for Samsun from the NOAA database, with 72% data coverage for the region [4]. The annual hydropower generation in Samsun is gathered from the national accounts of Turkey for Altınkaya HPP from 2001 to 2023 [5].

3. Case Study

Samsun, Turkey, hosts large reservoir hydropower plants (HPP). We selected Altinkaya HPP (703 MW) on the Kızılırmak river stream to demonstrate the correlation between climate variables and water inflow to the reservoir.

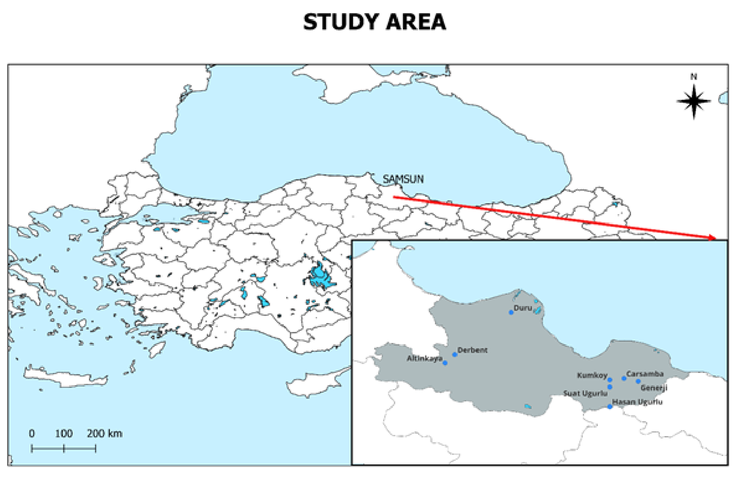

Figure 3: Study area

4. Correlation analysis

The authors used Climpact to calculate the extreme temperature and precipitation climatic indices [6]. The Pearson correlation method is used between the precipitation climatic indices and water input to Altınkaya HPP. The results show a significant negative correlation between the rainfall on very wet days (r95ptot) and water inflow to the river stream.

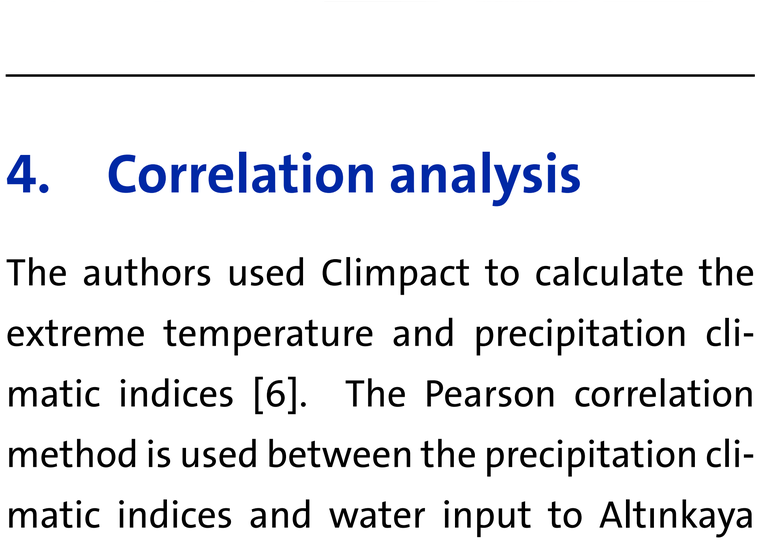

Figure 4: Precipitation-water input correlation

5. Data availability

The data and scripts are available at GitHub repository under the Apache-2.0 License.

References

[1] International Hydropower Association, "Hydropower Sector Climate Resilience Guide," London, United Kingdom, Tech. Rep., 2019. [Online]. Available: https://www.hydropower.org/publications/hydropower-sector-climate-resilience-guide

[2] H. Hersbach *et al.*, "The ERA5 global reanalysis," *Quarterly Journal of the Royal Meteorological Society*, vol. 146, no. 730, pp. 1999–2049, jul 2020. [Online]. Available: https://rmets.onlinelibrary.wiley.com/doi/10.1002/qj.3803

[3] Turkish State Meteorological Service, "Eastern Mediterranean Climate Centre," 2009. [Online]. Available: https://emcc.mgm.gov.tr/index.aspx

[4] NOAA, "National Centers for Environmental Information." [Online]. Available: https://www.ncei.noaa.gov/

[5] Turkish Electricity Transmission Corporation, "Load Dispatch Information System (in Turkish)," 2024. [Online]. Available: https://ytbsbilgi.teias.gov.tr/ytbsbilgi/

[6] "Climpact." [Online]. Available: https://climpact-sci.org/