Smart Climate Hydropower Tool: artificial intelligence for effective hydropower production forecast and management

Paolo Mazzoli[1], stefano Bagli[1], Jaroslav Mysiak[2], Francesco Dalla Valle[3], Davide Broccoli[1], Valerio Luzzi[1], and Arthur Essenfelder[2]

[1]GECOsistema Srl
[2]CMCC@Ca'Foscari
[3]Enel Green Power S.p.A

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Abstract

Smart Climate Hydropower Tool is an innovative web-cloud-based service that implements a set of data-driven methods for river discharge. An application for two catchments in South America is discussed (test cases), where management of hydropower plants can benefit from knowledge of incoming discharge forecasts up to 6 months in advance. SCHT has been developed inside H2020 project "CLARA - Climate forecast enabled knowledge service" and exploits several Artificial Intelligence algorithms, evolving by R&D activity to test new available ones. Although tangible results using AI have been published (i.e. Callegari, et al., 2015, De Gregorio et. al 2017) challenges remain for seasonal lead times and rainfall dominated catchments, where forecast of meteorological variables plays a critical role. In this contribution we show results of application of different AI algorithms (from supervised learning regression techniques, to artificial neural networks). Each algorithm is trained over past decades datasets of recorded data, forecast performances are then evaluated using separate test sets with reference to benchmarks (historical average of discharge values and simpler multiparametric regressions). Major operative advantages of AI with respect to mechanistic hydrological models include limited to none a priori knowledge of involved physical phenomena, high level of flexibility when managing heterogeneous sets of variables related to discharge, and quick setup time of the forecast. Major efforts are requested to identity informative input features ranging from earth observation to gauging stations data, to public meteorological forecasts (i.e Copernicus Climate Change Service-C3S). Using AI techniques many combinations of features can be tested together, to predict river discharge to the reservoirs, choosing the best performing one and tailoring the service to the catchment of interest. Once trained, each algorithm just needs to retrieve online data to perform forecasts, with limited maintenance (i.e. annual re-training to consider new available hydrological data). For demonstrational purposes we prototyped a cloud-based service, for immediate visualization, through a common browser, of both past and forecasted data, and get on fly performance metrics calculation of the forecasts.

Climate forecast enabled knowledge services

AGU 100 FALL MEETING

Smart Climate Hydropower Tool (SCHT)

Artificial Intelligence for effective hydropower production forecast and management

Paolo Mazzoli [1], Stefano Bagli [1], Jaroslav Mysiak [2], Francesco Dalla Valle [3], Arthur Essenfelder [2], Davide Broccoli [1], and Valerio Luzzi [1]
(1) GECOsistema Srl, R&D Unit Bolzano, Italy, (2) CMCC@Ca'Foscari, (3) Enel Green Power S.p.A.

Why applying AI to discharge forecast?

To reduce **uncertainty of hydropower production** due to natural inflows variability

To Forecast expected deviation between **budget producibility** and final production and undertake the most advantageous corrective actions.

To Built forecast on **Globally available** data (i.e Copernicus **C**limate **D**ata **S**tore seasonal forecasts) and **scalable** forecast techniques

To **Customize** forecast on user own data and needs

To **Avoid** need of mechanistic models to be fed by field data

To Deploy final service through open-source **web-cloud-based service**

How to set it up?

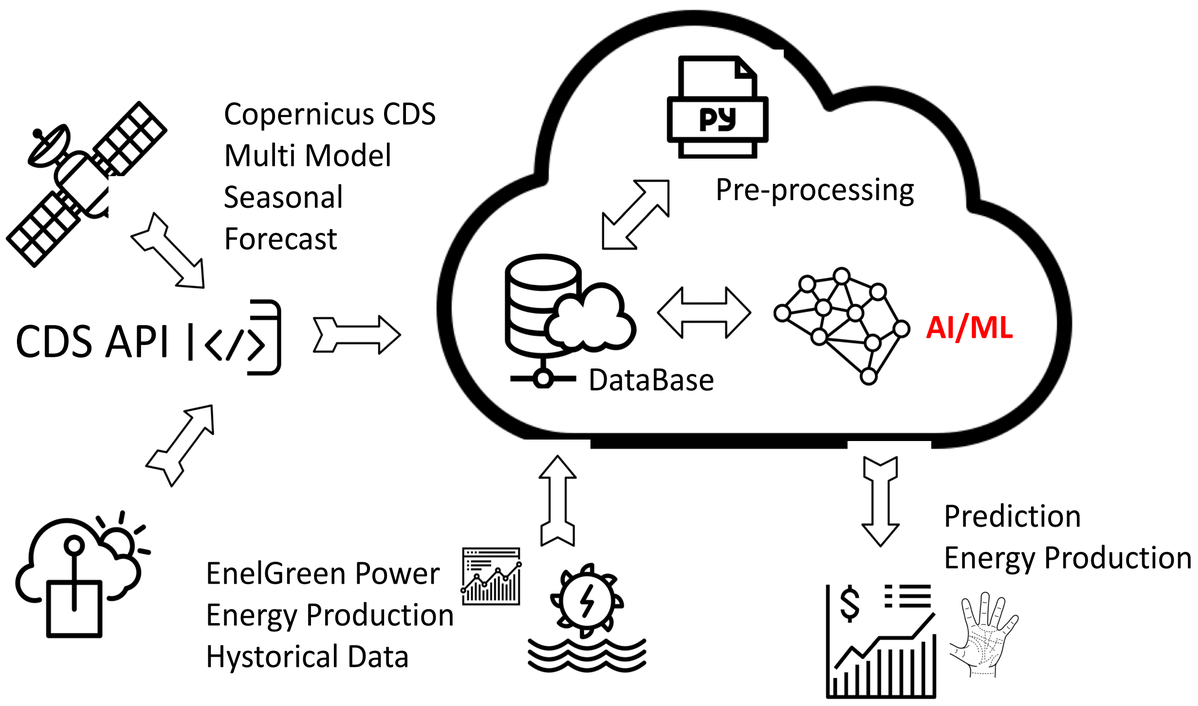


Fig 1 –Setting up the forecast service

Working prototype for EGP in Colombia

Interaction and performances

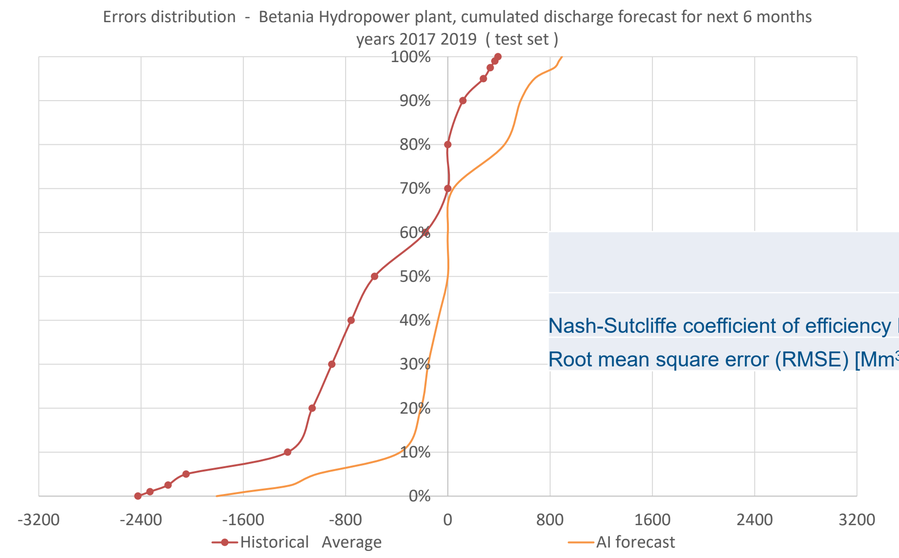
A **WEB SERVICE** that

Retrieves CDS Precipitation and Temperature seasonal forecasts & EGP discharge data

Runs trained AI algorithms

Shows an interactive web page with forecast and performances

A **SUBSTANTIAL FORECAST IMPROOVEMENT** over reference benchmark (Historical monthly average discharge)



	Historical Average	AI forecast
Nash-Sutcliffe coefficient of efficiency NSC	0.55	0.84
Root mean square error (RMSE) [Mm3]	998	572

Fig 2 – Error distribution [Mm3] for 6-month forecast- Betania HPP

www.clara-project.eu
GECOsistema srl
Stefano Bagli – Paolo Mazzoli
www.gecosistema.com

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