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

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In this technical note we describe Smart Climate Hydropower Tool, an innovative open-source web-cloud-based service that implements a set of data-driven methods for river discharge and energy forecasting. 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. This application has been developed inside H2020 project CLARA - Climate forecast enabled knowledge service. Currently SCHT exploits several Artificial Intelligence algorithms and is continuously evolving by R&D activity to test new ones for enhancing forecast. Although tangible results using AI have been published in the past (i.e. Callegari, et al., 2015, De Gregorio et. al 2017) challenges remain, particularly 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 generation, and quick setup time of the forecast system. On the other side major efforts are requested to identity input data (features) related to target variable. Such features range from earth observation products to on site gauging stations data, to public meteorological forecasts (either output of single models or ensembles), increasingly available from seasonal to sub seasonal and daily lead time (i.e Copernicus Climate Change Service-C3S). Using AI techniques many combinations of spatially distributed and monitoring networks features can be tested together, to predict target variable (i.e river discharge to the reservoir), choosing the best performing combination and tailoring the forecast service to the catchment of interest. Once trained, each algorithm just needs to retrieve from online repositories the required data to perform forecasts, requiring limited maintenance operations (i.e. annual re-training to consider new available hydrological data). For demonstrational purposes of such approach we implemented results of test cases in SCHT cloud-based service, for immediate visualization, through a common browser, of both past and forecasted data, and on fly performance metrics calculation of the forecasts.