AQUACLEW case study progress report

Climate services for the hydropower sector

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Client Organisation: EDF

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Water management issue

The hydropower sector is sensitive to climate variables, as these directly affect energy generation and consumption. Climate services provide key information to optimize reservoir operations for hydropower production and to manage water storage to meet the needs of other users (for instance, tourism, agriculture, environmental flows). They also provide guidelines for climate change adaptation and to build strategies that incorporate climate resilience into existing hydropower facilities and the development of new projects. With many climate services flourishing across Europe, the challenge today is to develop energy indicators based on these climate services, which can facilitate decision-making at the regional and local levels.

Use of Climate Data

EDF, the main electricity producer in France, uses climate services and indicators to understand the consequences of climate change in electricity systems, foresee developments of their activities in the energy sector and adapt its power generation facilities to cope with changes in climate and its impacts on the sector. They develop tools and methods to perform studies on climate change impacts and define the best operational and strategic decisions in response to climate change. In-house expertise on climate and energy systems allows EDF to develop applied research and climate-related services in close link to their operational needs and applications. EDF climate department actively participates to European Copernicus projects, with a special interest in contributing to link users of climate services and providers.

Preliminary Workflow Results

1. **Data overview and selection of methods**: Identification of climate services that can specifically address the needs of the hydropower sector (variables provided, spatial and temporal resolutions, easiness of access and available data for downloading) and selection of existing methods (or identification of needs for the development of new ones) that link climate variables to energy indicators
2. **Climate and river flow projections and impacts**: Extraction of projections (or anomalies) from a range of Pan-European and national Climate Services Portals and application at river locations where hydropower facilities are implemented. Summary of knowledge on current and expected changes, expected management challenges and impacts on hydroelectric potential (including uncertainties).
3. **Development of local indicators**: Development of local indicators that translate large scale knowledge and quantify vulnerability to climate change adaptation in the hydropower sector.
4. **Usability and co-design feedback**: Assessment of the usability of indicators for decision making with client and feedback to their co-design (step 3)

5. **Impact on hydropower decision-making**: Analysis of the impact on making decision with and without climate services for hydropower production and planning (including uncertainties)
6. **Lessons learned and recommendations**: Summary of lessons learned and recommendations

1. Data overview and selection of methods:

A review of climate services portals was carried out to identify the available databases necessary for the development of a relevant indicator for the hydropower sector (contribution to deliverable D3.1). Six climate services (Clim4Energy, ECEM, EDgE, SWICCA, and the two portals of Météo-France, Drias and ClimatHD) were studied in detail. We evaluated the climatic variables available at each climate service provider, separated by sector of activity that is directly related to hydropower or that may influence hydropower decisions (i.e., by sectors of water, energy and agriculture), as well as the different spatial and temporal resolutions proposed by each portal. From this review, we selected the Drias portal for our work. The climate data available on the Drias portal is based on EURO-CORDEX experiments, and benefit from bias correction carried out with the CDFt method over France. The following GCM/RCM pairs were considered (8 x 8 km grid resolution): CLMcom_MPI-ESM-LR_CCLM4-8-17; CSC_MPI-ESM-LR_REMO019; DMI_EC-EARTH_HIRHAM5; KNMI_EC-EARTH_RACMO22E; SMHI_CNRM-CERFACS-CNRM-CM5_RCA4; SMHI_EC-EARTH_RCA4. We adopted three periods in our impact study: Control (1976-2005), Near future (2021-2050) and Far future (2061-2090).

2. Climate and river flow projections and impacts:

Climate data was used as input to the GR6J hydrological model developed at Irstea. The model was first calibrated based on historic time series of observed precipitation, temperature and river flows, and then applied to the climate projections to obtain the corresponding river flow projections. The study was carried out on a set of six river basins in France, where the hydropower company EDF operates. Results indicate changes to local hydrological regimes, affecting river basins differently according to their hydro-climatic conditions. Projections in snowmelt-fed river basins, for instance, indicate an earlier snowmelt, with a shift in time in the peak flows associated with snowmelt, as well as increased flow volumes in winter.

3. **Development of local indicators**.

River flow projections were applied to an impact model for reservoir management. The model was set up at Irstea and adapted to run with different scenarios of river flows as input data. It is based on operating guide curves. These curves define the minimum levels of a reservoir that are needed to operate the reservoir following its objectives or under certain constraints over one year (e.g., the minimum volume/level in the reservoir to be kept during summer). The probability or risk of non-achievement of the operating objectives was also considered. Preliminary work has been done to compute hydropower indicators based on the chain of data and models described above. First results were presented at the EGU 2019 GA and the ICEM 2019, and a publication is under preparation.

4. **Usability and co-design feedback**:

Meetings with EDF have contributed to the design and evaluation of the indicators developed, ensuring continuous feedback from them.

5. Impact on hydropower decision-making:

Work in progress.

6. **Lessons learned and recommendations**:

Work in progress.

Client perspective

EDF acknowledges the importance of having reliable hydrological projections at the catchment or sub-catchment scale. In AQUACLEW, we are working with models locally calibrated to address this issue. Additionally, since EDF operations are also linked to European energy grids, they would be interested in evaluating if the methods developed within AQUACLEW could be transferred to other regions in Europe. This issue will be addressed in future work.

Task list

We are currently consolidating our methodological steps with a sensitivity analysis and a summarized visualisation of the impacts of climate change on the hydropower indicators developed. We also want to explore the possibility of applying our methodology to different areas of hydroelectric interest in Europe. This will be explored further after we finalize the work first carried out in the French catchments of the AQUACLEW case study.