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Decision Support on the Sediments Flushing of Aimorés Dam Using Medium-Range Ensemble Forecasts

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In the present study we investigate the use of medium-range streamflow forecasts in the Doce River basin (Brazil), at the reservoir of Aimorés Hydro Power Plant (HPP). During daily operations this reservoir acts as a "trap" to the sediments that originate from the upstream basin of the Doce River. This motivates a cleaning process called "pass through" to periodically remove the sediments from the reservoir. The "pass through" or "sediments flushing" process consists of a decrease of the reservoir's water level to a certain flushing level when a determined reservoir inflow threshold is forecasted. Then, the water in the approaching inflow is used to flush the sediments from the reservoir through the spillway and to recover the original reservoir storage. To be triggered, the sediments flushing operation requires an inflow larger than 3000m^3/s in a forecast horizon of 7 days. This lead-time of 7 days is far beyond the basin's concentration time (around 2 days), meaning that the forecasts for the pass through procedure highly depends on Numerical Weather Predictions (NWP) models that generate Quantitative Precipitation Forecasts (QPF). This dependency creates an environment with a high amount of uncertainty to the operator. To support the decision making at Aimorés HPP we developed a fully operational hydrological forecasting system to the basin. The system is capable of generating ensemble streamflow forecasts scenarios when driven by QPF data from meteorological Ensemble Prediction Systems (EPS). This approach allows accounting for uncertainties in the NWP at a decision making level. This system is starting to be used operationally by CEMIG and is the one shown in the present study, including a hindcasting analysis to assess the performance of the system for the specific flushing problem.
The QPF data used in the hindcasting study was derived from the TIGGE (THORPEX Interactive Grand Global Ensemble) database. Among all EPS available on TIGGE, three were selected: ECMWF, GEFS, and CPTEC. As a deterministic reference forecast, we adopt the high resolution ECMWF forecast for comparison. The experiment consisted on running retrospective forecasts for a full five-year period. To verify the proposed objectives of the study, we use different metrics to evaluate the forecast: ROC Curves, Exceedance Diagrams, Forecast Convergence Score (FCS).
Metrics results enabled to understand the benefits of the hydrological ensemble prediction system as a decision making tool for the HPP operation. The ROC scores indicate that the use of the lower percentiles of the ensemble scenarios issues for a true alarm rate around 0,5 to 0,8 (depending on the model and on the percentile), for the lead time of seven days. While the false alarm rate is between 0 and 0,3. Those rates were better than the ones resulting from the deterministic reference forecast. Exceedance diagrams and forecast convergence scores indicate that the ensemble scenarios provide an early signal about the threshold crossing. Furthermore, the ensemble forecasts are more consistent between two subsequent forecasts in comparison to the deterministic forecast. The assessments results also give more credibility to CEMIG in the realization and communication of flushing operation with the stakeholders involved.