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Towards Optimization of Reservoir Operations for Hydropower Production in East Africa: Seasonal Climate Forecasts (Leonardo Lecture)

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Hydroelectric generation and interconnections are the major priority areas of Infrastructure Development in Africa. A number of hydropower projects are currently being developed in East Africa in order to meet the energy demands of the fast growing economy in sustainable and climate-resilient manner. However, the performance efficiency of existing hydropower systems in Africa is much lower (about 30% in some cases) than their design capacity. This study proposes a decision support system (DSS) that integrates climate forecasts and remote sensing products into modeling and optimization of the hydropower systems in order to achieve reliable reservoir operations and enhance hydropower production efficiency. The DSS has three main components; climate system, hydrologic and water resources system, and optimization system. The climate system comprises of tools and interfaces for accessing, customizing and integrating climate forecasts and remote sensing data. The North America Multi-Model Ensemble (NMME) seasonal retrospective forecasts for the East Africa Power Pool (EAPP) region are compared with the TRMM rainfall estimates and the CPC unified gauged rainfall data. The errors of the NMME seasonal forecasts have portrayed significant spatial and temporal variability in the EAPP region. The root mean square errors of the seasonal forecasts are relatively higher for wetter locations and months. However, the skills of the NMME seasonal forecasts are not significantly depreciating with lead time for the study region. The forecast errors vary from one model to another. Here, we present the skills of NMME forecasts, the physical factors and mechanisms that affect the skills. In addition, we discuss our methodology that derives the best seasonal forecast from the NMME seasonal forecasts, and show how the forecast errors propagate through hydrologic models into hydrological forecasting.