Water resources optimization assessment for hydro-energy production, including streamflow prediction: a case study in the southern Andes of Ecuador.

Abstract

Climate variability and change significantly impact the planet's water resources. Population growth and the consequent increase in water consumption for different activities show the need to optimize water, especially in times of scarcity. In an environment of uncertainty, optimization and prediction approaches represent a fundamental research challenge for decision-making to face effective water resource management. This study evaluates some methods of optimizing water resources in a hydraulic system with reservoirs in the Machángara River Basin, located in the southern Andean of Ecuador. Two models with three optimization functions were defined based on energy production maximization and water allocations for human consumption, environmental demand, and irrigation needs fulfillment. All models were fed with four streamflow forecasts based on Support Vector regressions (SVR) models and the average of historical flows. Optimization methods and different predictions used five years of observed data to simulate decision rules. The rules were used to evaluate the total energy produced, energy production planning fulfillment, and system management. The results indicate that the rules established with forecast models that overestimate can have the most significant amount of energy possible but low energy production planning fulfillment and complex reservoir management. On the other hand, forecast models that underestimate produce a low amount of energy and high planning fulfillment, combined with adequate reservoir management. The most accurate forecasting models do not necessarily offer the best performance in optimization. A simple forecasting model, such as historical flow averages combined with a cautious objective function, offers satisfactory results regarding energy production, compliance with production planning, and reservoir management. Therefore, the total management of hydro-energy systems must determine the tradeoff between the maximum energy produced, the planning fulfillment, and suitable system management.

Keywords: water resources optimization, streamflow prediction, hydro-energy production.