Geophysical Research Abstracts
Vol. 18, EGU2016-12114, 2016
EGU General Assembly 2016

Optimal operating rules definition in complex water resource systems combining fuzzy logic, expert criteria and stochastic programming

Hector Macian-Sorribes (1) and Manuel Pulido-Velazquez (2)

(1) Universitat Politècnica de València, Research Institute of Water and Environmental Engineering (IIAMA), Valencia, Spain (hecmasor@upv.es), (2) Universitat Politècnica de València, Research Institute of Water and Environmental Engineering (IIAMA), Valencia, Spain

This contribution presents a methodology for defining optimal seasonal operating rules in multireservoir systems coupling expert criteria and stochastic optimization. Both sources of information are combined using fuzzy logic. The structure of the operating rules is defined based on expert criteria, via a joint expert-technician framework consisting in a series of meetings, workshops and surveys carried out between reservoir managers and modelers. As a result, the decision-making process used by managers can be assessed and expressed using fuzzy logic: fuzzy rule-based systems are employed to represent the operating rules and fuzzy regression procedures are used for forecasting future inflows. Once done that, a stochastic optimization algorithm can be used to define optimal decisions and transform them into fuzzy rules. Finally, the optimal fuzzy rules and the inflow prediction scheme are combined into a Decision Support System for making seasonal forecasts and simulate the effect of different alternatives in response to the initial system state and the foreseen inflows.
The approach presented has been applied to the Jucar River Basin (Spain). Reservoir managers explained how the system is operated, taking into account the reservoirs' states at the beginning of the irrigation season and the inflows previewed during that season. According to the information given by them, the Jucar River Basin operating policies were expressed via two fuzzy rule-based (FRB) systems that estimate the amount of water to be allocated to the users and how the reservoir storages should be balanced to guarantee those deliveries. A stochastic optimization model using Stochastic Dual Dynamic Programming (SDDP) was developed to define optimal decisions, which are transformed into optimal operating rules embedding them into the two FRBs previously created. As a benchmark, historical records are used to develop alternative operating rules. A fuzzy linear regression procedure was employed to foresee future inflows depending on present and past hydrological and meteorological variables actually used by the reservoir managers to define likely inflow scenarios. A Decision Support System (DSS) was created coupling the FRB systems and the inflow prediction scheme in order to give the user a set of possible optimal releases in response to the reservoir states at the beginning of the irrigation season and the fuzzy inflow projections made using hydrological and meteorological information. The results show that the optimal DSS created using the FRB operating policies are able to increase the amount of water allocated to the users in 20 to 50 Mm3 per irrigation season with respect to the current policies. Consequently, the mechanism used to define optimal operating rules and transform them into a DSS is able to increase the water deliveries in the Jucar River Basin, combining expert criteria and optimization algorithms in an efficient way.

This study has been partially supported by the IMPADAPT project (CGL2013-48424-C2-1-R) with Spanish MINECO (Ministerio de Economía y Competitividad) and FEDER funds. It also has received funding from the European Union's Horizon 2020 research and innovation programme under the IMPREX project (grant agreement no: 641.811).