Geophysical Research Abstracts
Vol. 17, EGU2015-1299-1, 2015
EGU General Assembly 2015

Design of operating rules in complex water resources systems using historical records, expert criteria and fuzzy logic

Manuel Pulido-Velazquez (1), Hector Macian-Sorribes (1), Jose María Benlliure-Moreno (2), and Juan Fullana-Montoro (2)

(1) Research Institute of Water and Environmental Engineering, Universitat Politècnica de València, Valencia, Spain, (2) Confederación Hidrográfica del Júcar (CHJ). Valencia, Spain.

Water resources systems in areas with a strong tradition in water use are complex to manage by the high amount of constraints that overlap in time and space, creating a complicated framework in which past, present and future collide between them. In addition, it is usual to find "hidden constraints" in system operations, which condition operation decisions being unnoticed by anyone but the river managers and users. Being aware of those hidden constraints requires usually years of experience and a degree of involvement in that system's management operations normally beyond the possibilities of technicians. However, their impact in the management decisions is strongly imprinted in the historical data records available.

The purpose of this contribution is to present a methodology capable of assessing operating rules in complex water resources systems combining historical records and expert criteria. Both sources are coupled using fuzzy logic. The procedure stages are: 1) organize expert-technicians preliminary meetings to let the first explain how they manage the system; 2) set up a fuzzy rule-based system (FRB) structure according to the way the system is managed; 3) use the historical records available to estimate the inputs' fuzzy numbers, to assign preliminary output values to the FRB rules and to train and validate these rules; 4) organize expert-technician meetings to discuss the rule structure and the input's quantification, returning if required to the second stage; 5) once the FRB structure is accepted, its output values must be refined and completed with the aid of the experts by using meetings, workshops or surveys; 6) combine the FRB with a Decision Support System (DSS) to simulate the effect of those management decisions; 7) compare its results with the ones offered by the historical records and/or simulation or optimization models; and 8) discuss with the stakeholders the model performance returning, if it's required, to the fifth or the second stage.

The methodology proposed has been applied to the Jucar River Basin (Spain). This basin has 3 reservoirs, 4 headwaters, 11 demands and 5 environmental flows; which form together a complex constraint set. After the preliminary meetings, one 81-rule FRB was created, using as inputs the system state variables at the start of the hydrologic year, and as outputs the target reservoir release schedule. The inputs' fuzzy numbers were estimated jointly using surveys. Fifteen years of historical records were used to train the system's outputs. The obtained FRB was then refined during additional expert-technician meetings. After that, the resulting FRB was introduced into a DSS simulating the effect of those management rules for different hydrological conditions. Three additional FRB's were created using: 1) exclusively the historical records; 2) a stochastic optimization model; and 3) a deterministic optimization model. The results proved to be consistent with the expectations, with the stakeholder's FRB performance located between the data-driven simulation and the stochastic optimization FRB's; and reflect the stakeholders' major goals and concerns about the river management.

ACKNOWLEDGEMENT: This study has been partially supported by the IMPADAPT project (CGL2013-48424-C2-1-R) with Spanish MINECO (Ministerio de Economía y Competitividad) funds.