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Application of a management tool based on uncertainty analysis to a reservoir in a Mediterranean watershed: Cost analysis.

Raquel Gómez-Beas (1), Antonio Moñino (2), Cristina Aguilar (3), and María José Polo (4)

(1) Fluvial Dynamics and Hydrology Research Group, University of Córdoba, Córdoba, Spain (rgbeas@uco.es), (2) Environmental Flows Dynamics Research Group, CEAMA-University of Granada, Granada, Spain (amonino@ugr.es), (3) Fluvial Dynamics and Hydrology Research Group, University of Córdoba, Córdoba, Spain (caguilar@uco.es), (4) Fluvial Dynamics and Hydrology Research Group, University of Córdoba, Córdoba, Spain (mjpolo@uco.es)

In Mediterranean basins, reservoirs constitute the main source of water supply not only for urban uses but also for irrigation and other water use demands, especially during spring and summer, and dry years. Their existence greatly modifies the natural fluvial and groundwater regime. To meet both the Water Framework Directive and water supply requirements makes it necessary to develop rigorous and efficient operational tools that provide us with an optimization of the water storage management in terms of an efficient water supply and maintenance of the environmental flow regimes.
In this work, a reservoir management model based on uncertainty analysis is presented, along with results from its application to the Rules reservoir in Granada (Southern Spain). The model inputs are the water regulation criteria, the existing water use demands and restrictions, and the available daily water input series. In this structure, the environmental flow regime is included as a restriction to the available resources for planning management, as the Spanish regulation imposes. From the results, a set of operational criteria has been defined to be used for the development of decision-making strategies based upon optimization of a minimal risk function.
The model is conceived as a tool for control and verification, where a failure arises every time a reduction in the reservoir level below the thresholds established by the planner occurs, and consequently a temporary break of the supply system due to insufficient water resources is produced, which involves an unacceptable social impact. The model has been applied to a set of synthetic water input flow series, by Monte Carlo simulation, where dry, medium and wet years are alternated following the meteorological local characterization from 1992 to 2005 measured data. In terms of demands, Rules reservoir is the regulatory element for the final stretch of Guadalfeo River, with urban water supply as its main demand, also storing the required volume for irrigation and hydroelectric power generation. The supply system constitutes an annual volume of 13 Hm3, that is, 6% of the total required water volume. The main water consumption is demanded by the irrigation system with 112 Hm3 per year, say, 54% of the total demanded water volume.
The possible failures when meeting all demands and its consequences in terms of costs, have been defined to develop the risk analysis, where the urban water supply has priority over the rest of uses, in a way that the outflow of the intakes will be reduced or even interrupted during a certain time interval, long enough to ensure the recovering of the reservoir that may guarantee the requested supply back again.
From the results obtained, a set of graphs are depicted, which constitute a tool for decision making from which the planner can select the criteria of outflow operation which optimize the management, based upon:
• Minimum opportunity cost.
• Minimum number of days when supply cannot be provided.
• Optimum final reservoir state.
From these graphs, it can be concluded that, in terms of risk, the higher costs are associated to the failure in providing the agricultural supply since urban supply has priority and environmental flow is considered a restriction; the irrigation supply would be interrupted, as average in a 10 year-period, a number of days a 30% higher than the urban supply interruption case. Also, under the current operational criteria, the inclusion of the environmental flow as a restriction involves an operational stop occurrence which averages 15 days per year, ranging between 5 and 35 days per year. The operational graphs obtained from the uncertainty analysis allow to estimate how to correct the water supply regime to minimize this number.