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A hydroeconomic DSS for the seasonal operation of a multireservoir system for drought-risk management

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This contribution presents a methodology to build a Decision Support System (DSS) for the seasonal operation of a multireservoir system based on the economic impact of operation decisions. It combines an explicit representation of the seasonal decision-making processes in the operation of the system with an economic impact assessment of the operation decisions.

The operating rules employed in the system management are expressed using fuzzy rule-based (FRB) systems, built using expert knowledge from the system operators and historical records, for reproducing the current decision criteria. Inflow forecasts required for the seasonal operation of the system are obtained using fuzzy regression, considering the uncertainty associated with the forecast through fuzzy numbers. The economic impacts (agricultural production values) of the operating decisions (deliveries to agricultural demands) are estimated using an econometric model based on water deliveries and crop prices. Surface and groundwater sources are considered, including drought mitigation measures such as drought emergency wells. The resulting DSS offers the system operators a set of likely management decisions depending on the operating rules and the inflow forecasts, as well as the production values associated with them. It also allows them to explore the consequences of using emergency wells to cope with drought periods.

Following this methodology, a DSS has been developed for the seasonal operation of the Jucar river system (Spain), subject to severe multiannual droughts. The seasonal operating rules followed by the River basin Authority take into account the state of the system at the beginning of the irrigation season (may 1st) and inflow forecasts for the whole cropping period (may-september). According to the information given by the operators (Oficina de Explotación de la Confederación Hidrográfica del Júcar), two FRB systems were built to represent the current decision-making processes. Fuzzy linear regression was used to forecast inflows for the upcoming season based of past and present meteorological and hydrological information. Two econometric models were set for the agricultural demands of the middle and the lower Jucar river sub-basins using historical data on surface and groundwater deliveries, crop prices and production values for the 2002-2010 period. The DSS combines the FRB systems, the fuzzy regressions and the econometric models, giving the user a set of likely decisions depending on the system state and the fuzzy hydrological projections, as well as the expected production values of agriculture in response to them. Uncertainty is estimated and propagated using fuzzy numbers and fuzzy arithmetic, so the user is able to take it into account. The DSS also informs the user about the consequences of a single decision taking into account the inflow uncertainty, as well as the economic impact of using emergency wells as an alternative source of water during droughts.

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