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Modelling rational water use from non-strategic reservoirs for irrigated agriculture in a semiarid region

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In water scarce regions, society has widely adopted the construction of dams as a solution for water supply. Whereas medium- and large-size strategic reservoirs store expressive water volumes during the rainy seasons, being able to supply it during long droughts, small-size farm dams are mostly intended to distribute this resource spatially. These small structures usually get empty more frequently, and thus, are inappropriate for human supply. Therefore, it is necessary to recognize the role of each structure in order to manage the system and promote a rational use of the available water. In the semiarid Northeast of Brazil, strategic reservoirs were implemented by the public sector as the main strategy to reduce the social impacts of droughts, and have been operated with 90% reliability. Complementarily, farmers and small communities have built numerous small reservoirs (up to 1 reservoir per 6 km^2) to meet local demands, however, as these structures cannot go through long periods of drought without complete emptying, the operational rules developed for the strategic reservoirs do not apply. As very limited data is available for the farm dams, they are usually underused and not considered in the water management policy. With this work we aimed to develop a method to define criteria for the rational operation of small reservoirs, focusing on irrigated agriculture, in the Brazilian semiarid region. The model is composed of three routines: i) water balance in the reservoir as a function of water inflows and outflows, weir geometry and catchment characteristics; ii) water balance of the crop considering rainfall, evapotranspiration and irrigation, and simulation of crop production; iii) economic analysis to assess the income from irrigated agricultural crops. A total of 54 surface reservoirs (storage capacities ranging from $4.2x10^5$ to $1.7x10^7$ m^3) located in the Banabuiú River Basin (approximately 20,000 km^2) were simulated using a series of climatic data from 1986 to 2014. The maize crop (*Zea mays*) was used in the simulations because there are cultivars adapted to different temperature and humidity conditions and to be one of the most cultivated cereals in the study region. The simulations indicated that the 90% reliability level applied for the strategic reservoirs is inefficient for small reservoirs destined for irrigated agriculture, and that a rational use of water in the lasts has variable operating rule, strongly correlated (Pearson R=0.85) with the water residence time of the reservoir. For all the simulated reservoirs, the maximum income is obtained with the operation around 40% reliability, and by operating any of the studied reservoirs between 36% and 40% reliability level, at least 90% of the maximum possible income is obtained. The model results indicate that it is possible to rationalize the water use of small reservoirs for agriculture purpose, by replacing the idea of storing water to store money, which is not susceptible to climatic factors. For the entire system, the small reservoirs can be used to generate income from irrigated agriculture, but preserving the strategic reservoirs for uses that require higher reliability, such as human supply.