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(In the Field of Irrigation & Drainage)

Possibility Theory-Based Programming for Water Resources Allocation in the Chah-Nimeh Reservoirs Irrigation District under Uncertainy

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Abstract

Crop water productivity (CWP) is a key measure for assessing the sustainability and efficiency of agricultural water management. Water distribution and delivery should be available in terms of time and space in accordance with the needs of different agricultural units and water resources in order to improve CWP in the agricultural sector and its optimal management in irrigation districts. Water distribution planning in irrigation districts is generally done in two different parts: agricultural units and water distribution channel. On the other hand, this index depends on various factors that are associated with uncertainty. This study aims to evaluate the uncertainty impact of these factors on spatial variability of CWP and consequently water allocation in the Sistan dam irrigation district. Analyzing the factors influencing the creation of uncertainty conditions can make a difference compared to conventional modelling methods. Also, a large number of mathematical programming models have been developed to analyze various aspects of programming and manage agricultural systems in recent decades. In this research, a new approach, integrated geostatistical and fuzzy methods based on the possibility theory is used to achieve the desired goal. The study area is wheat fields covered by Sistan dam irrigation district. The measured data include two categories: the first category is the affecting parameters on wheat production in monitoring farms, and the second category is changes in flow and flow loss in the irrigation district. The effect of spatial dispersion of production factors and flow losses in the irrigation district on CWP dispersion is investigated by this integrated geostatistical-fuzzy model (IFGM). At first, geostatistical methods such as Kriging and Cokrigaing is used to simulate CWP spatial variations. Then the role of agricultural management (ambiguous factor) and the relationship between these factors on CWP is evaluated using IFGM. The results show that the mean values for Hm, CWP, Y and electrical conductivity (EC) are ۰.۲۸ L/s/ha, ۰.۳ kg/m^{۳}, ۱٤۸٤ kg/ha and ۳.٤ dS/m, respectively. Also, CWP had the highest correlation with the volume of water enters to each farm, the inflow means and EC in farms, and it had the highest correlation with the water flow losses mean and the maximum of water flow losses in the irrigation district. Geostatistical interpolation models show that the mean value for flow losses has the greatest effect on the CWP spatial distribution, and the Cokrigaing method with the auxiliary variable of the flow losses mean has the highest accuracy in simulating CWP spatial changes compared to other auxiliary variables. However, it does not have acceptable accuracy, and the IFGM is used to upgrade it. The results of this model show that it can accurately identify uncertainty factors and simulate CWP spatial variations with acceptable accuracy. Finally, since water flow losses in the irrigation district have a greater impact than other parameters in spatial variation for CWP, better management should be considered for increasing CWP by controlling and monitoring temporal and spatial variations of the flow losses in the irrigation district.

Keywords: Crop Water Productivity, Integrated Geostatistical-Fuzzy Model, Spatial Variations, Uncertainty,