Application of Fuzzy Set Theory on the Saint Venant Equations to Study Flood Wave Propagation in Natural Rivers

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Abstract. This research applies the Fuzzy Set Theory on the Saint-Venant hydrodynamic equations to study the flood wave propagation, in Natural Rivers, through the membership functions of the control variables. The model is capable to evaluating the behavior of the control variables, as membership function, related to the flow in terms of the hydraulic and hydrological parameters of the basin. The governing partial differential equations are solved with the aid of finite differences, and for the solution of the system of nonlinear algebraic equations the iterative Newton-Raphson algorithm is employed. A computer program was developed to be used in this studying to perform the simulations. The computer program is organized in a modular manner, with two main modules: the deterministic module, where the depth of the water in the river and the flow of the channel are calculated as discreet values; and the fuzzy module, based on the fuzzy set theory, where the depth of the water and the flow are calculated as membership functions. To evaluate the behavior of the control variables, several scenarios for the main channel as well as for the flood waves are considered and different simulations are performed. The simulations demonstrate that this methodology could be a strong way to evaluate flood risk analysis in natural rivers.

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