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Developing an Expert-Based Fuzzy Risk Assessment Model for Irrigation Networks

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Performance of the irrigation network, as the most significant water users in developing countries, needs immediate improvements due to increasing demands for crop production and competition for water allocation between agricultural and non-agricultural sectors. Making an appropriate decision and providing solutions to improve the performance of irrigation networks require awareness of abilities and challenges ahead of irrigation network. This study initially identifies the future threats, including natural, human-caused and operational hazards against the central water conveyance system in irrigation networks then presents a systematic framework which assesses the risk of irrigation network. Risk-based planning is widely used in the similar system such as urban water-supply system or wastewater collection, but so far it is not used in irrigation networks. This study at the first part has developed an integrated hierarchical structure in such a way that it is applicable for all of the irrigation districts considering different levels of operation and diversity of conveyance, regulation, and delivery structures. At the second part, assesses the risk of identified hazards including likelihood, consequence, and vulnerability as risk parameters, which are determined by using questionnaires and base on experts knowledge. To deal with the uncertainty of expert's opinion, the calculation is based on fuzzy triangular numbers, and finally, to make the results of the model actual, fuzzy numbers transform to crisp numbers by the centroid of area method. Qazvin irrigation network selected as the case study and The result of risk assessment revealed that at hazards level, the five riskiest hazard are: poor maintenance in the main canal with risk of 1.758, vandalism in Nyrpic module with risk of 1.6, reduced maintenance in intersection structures with risk of 1.618, untrained operators' error and inaccurate calibration in operation able gates with the risk of 1.54 and1.4. The result of risk aggregation according to hierarchical structure showed that in conveyance system among conveyance, regulation and delivery structures, the third one is the most critical structure with the risk of 1.966. Between two source of water supply, reservoir and well, the risk was obtained 1.274 and 0.99 respectively and indicated the criticality on the reservoir in compare with well. In the systems level conveyance system with the risk of 1.937 has the most risk. The result of model sensitivity analyses indicated that the change of overlap area in fuzzy membership, used in scoring stage, changed caused 1.2% and 2.12% change in decrease and increased mode respectively and the prioritization of the component and the riskiest hazards have no changes.According to the finding of this study, the most critical hazards belong to operation and maintenance activity category so drawing attention to operation methods and risk reduction of this threatening can robust the Reliability of system performance and prevent the consequent overall high-cost repairs.
Considering capability of the proposed model in determining risk parameter and also rectifying incompleteness of conventional assessment methods, application of the proposed model as a decision support model during management process and making decision recommended.