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A holistic approach for design of Cost-Optimal Water Networks

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ABSTRACT

This work presents a holistic approach for design of Cost-Optimal Water Networks (CWN) that considers the economics while exploring all water minimisation options in line with the water management hierarchy (WMH). Two stages are involved in analysing the model i.e., the freshwater saving mode (FWS-mode) and the economic mode (E-mode). The first stage applied the mixed integer linear program (MILP) formulation that yielded some initial values for the second stage. In the second stage, the model was formulated as a mixed integer nonlinear program (MINLP) that was used to optimise an existing water systems design. The novelty of the model lies in the simultaneous considerations of all levels of water management hierarchy (i.e. elimination, reduction, reuse, outsourcing and regeneration) and cost constraints in selecting the best water minimisation schemes that resulted in the maximum net annual savings at a desired payback period. The model is applicable for systems involving multiple contaminants, and is capable of predicting which water demand should be eliminated or reduced; how much external source is needed; which wastewater source should be reused/recycled, regenerated or discharged; and finally specify the minimum water network configuration for maximising the net annual savings at a desired payback period. The model has been successfully applied on case studies involving a building (Sultan Ismail Mosque, UTM) and an industrial process plant (a chlor-alkali plant).

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