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Fuzzy and conceptual-fuzzy modelling of complex river systems with scarce data: Case of Letaba River.

Katambara, Zacharia.

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ABSTRACT

The investment in water infrastructure on a number of river systems in South Africa and many other regions of the world so as to meet the ever growing demands for water over the last few decades, has not been matched by the implementation of adequate hydrometric data collection and water-use accountability practices. This has resulted in complex rivers systems with scarce data. A typical example in South Africa is the Letaba River system.

The main objective of this research was to investigate the applicability of fuzzy inference based and hybrid fuzzy inference-conceptual modelling approaches to highly developed and complex river systems with scarce data using Letaba River as a case study. For completeness, a standalone conceptual model was included and three models were therefore studied; a fuzzy inference, a hybrid fuzzy inference-conceptual, and a standalone conceptual model.

The evaluation of the modelling showed that:

- The models simulate better the flows at those locations of the river system that were impacted less by human activities.
- The fuzzy inference model was found to be a black box although it obtained the best statistical performance in modelling flow in those locations highly impacted by human activities.
- The conceptual model reproduced the main natural catchment and water resource development processes and systems reasonably well.
- The hybrid fuzzy-conceptual model performed comparably to the fuzzy model and also represented the catchment and water resource development processes in a manner comparable to that of the conceptual model. This suggests that the hybrid may be the better model to apply in situations where simulation accuracy and adequate representation of the catchment processes and water resource development system are required.

The study recommends that:

- Further studies on the use of the hybrid fuzzy inference-conceptual modelling approach need to be undertaken with the aim of improving both statistical simulation performance and system representation in the reality of scarce data.
- Deliberate initiatives need to be undertaken to improve collection and management of hydrometric and water use data in the Letaba River system and other data-scarce systems.