IAHS2017-22
IAHS Scientific Assembly 2017
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Water quality modelling of an impacted semi-arid catchment using flow data from the WEAP model

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The continuous decline in water quality in many regions is forcing a shift from quantity-based water resources management to a greater emphasis on water quality management. Water quality models can act as invaluable tools as they facilitate a conceptual understanding of processes affecting water quality and can be used to investigate the water quality consequences of management scenarios. In South Africa, the Water Quality Systems Assessment Model (WQSAM) was developed as a management-focussed water quality model that is relatively simple so as to be able to utilise the small amount of available observed data. Importantly, WQSAM explicitly links to systems (yield) models routinely used in water resources management in South Africa by using their flow output to drive water quality simulations. Although WQSAM has been shown to be able to represent the variability of water quality in South African rivers, its focus on management from a South African perspective limits the use of the model to within southern African regions for which specific systems model setups exist. Facilitating the use of WQSAM within catchments outside of southern Africa and within catchments for which these systems model setups do not exist would require WQSAM to be able to link to a simple to use and internationally applied systems model. One such systems model is the Water Evaluation and Planning (WEAP) model, which incorporates a rainfall-runoff component (natural hydrology), and reservoir storage, return flows and abstractions (systems modelling), but within which water quality modelling facilities are rudimentary. The aims of the current study were therefore to: 1) adapt the WQSAM model to be able to use as input the flow outputs of the WEAP model and; 2) provide an initial assessment of how successful this linkage was by application of the WEAP and WQSAM models to a small, semi-arid and impacted catchment in the Eastern Cape of South Africa for historical conditions. This initial assessment was performed by application of the two models to the Buffalo River Catchment in the Eastern Cape of South Africa. The simulations of the two models were compared to the available observed data, with the initial focus within WQSAM on a simulation of instream nutrient concentrations. The WEAP model was able to adequately simulate flow in the Buffalo River catchment, with consideration of human inputs and outputs. WQSAM was adapted to successfully take as input the flow output of the WEAP model, and the simulations of nutrients by WQSAM provided a good representation of the variability of observed nutrient concentrations in the catchment. This study showed that the WQSAM model is able to accept flow inputs from the WEAP model, and that this approach is able to provide satisfactory estimates of both flow and water quality for a small, semi-arid and impacted catchment. It is hoped that this research will encourage the application of WQSAM to an increased number of catchments within southern Africa and beyond.