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Using a hydrological model for hypothesis testing of the processes determining the discharge of a spring from a small catchment underlain by fractured rock.

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The discharge of a spring at the outlet of a small (0.2 km2) catchment has been monitored for approximately 2 years. The spring is located at the base of a topographic and geological (anticline) ridge underlain by highly fractured quartzitic sandstones. The observed discharge data suggests that the outflow is a result of multiple sub-surface flow processes. An initial daily time-step hydrological model (based on the structure of an existing, widely used, monthly model) was established to simulate the discharge. The initial model structure assumed that the total spring discharge is a combination of relatively slowly responding groundwater coupled with more rapidly responding interflow from the fractures within the unsaturated zone above the aquifer. The model structure (and some of the forcing data) was progressively modified to achieve an improved simulation relative to the observed discharge data. Each modification is assessed in terms of not only the improvement in the simulations, but also in terms of the conceptual credibility of the model structural changes. One of the key changes that achieved improved simulations was related to assumptions about the seasonal distribution of potential evaporation on this north facing catchment (in the southern hemisphere). Another key change was the addition of a function that delayed the response of the unsaturated zone storage to rainfall inputs. The final model was able to simulate the observed response very well (Nash coefficient of better than 0.87) with the total spring discharge representing approximately 5% of total rainfall and the groundwater outflow contribution representing approximately 68% of the total spring discharge , with interflow contributing the remaining 32%. The results partly confirm previous hypotheses and modelling structures used for simulating catchment scale interactions between surface and sub-surface runoff in relatively steep fractured rock catchments within South Africa. However, this study also highlighted some questions about the real nature of small-scale processes that remain largely un-answered.