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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Spatial and temporal variability of groundwater recharge in a sandstone aquifer in a semi-arid region" *by* Ferdinando Manna et al.

Anonymous Referee #2

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General comments:

The manuscript describes a modeling study of the spatial and temporal variation of recharge in a 2.16 km2 upland catchment in a semi-arid region. Recharge in semi-arid regions constitutes a small fraction of precipitation and is subject to a large temporal and spatial variability. Studies of this hydrological component under semi-arid conditions are relatively few although the references provided by the authors are all more than 10 years old and should thus be updated when revising the manuscript. Nevertheless, I believe that the presented study expands research on recharge in semi-arid regions and that the manuscript deserves publication after revision.

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Discussion paper

My major concern of the presented work relates to the calibration of the MIKE SHE model, which is inadequately carried out and described. Calibration of a hydrological model should preferably be carried out using an autocalibration method (e.g. PEST) in order to (1) identify the sensitive parameters, (2) calibrate the parameters selected for calibration using an objective method, (3) identify non-uniqueness issues and correlation among the parameters, and (4) identify uncertainty intervals of the calibrated parameter values. The process can be carried out in a more or less sophisticated procedure but in any case it makes the process transparent. The authors do not describe which parameters have been subject to calibration and it is not discussed if the resulting parameters values are reasonable based on prior knowledge of the characteristics of the site. I will encourage the authors to carry out a sensitivity and calibration analysis using an autocalibration method.

My second major concern relates to the conceptualization of the system being studied. The subsurface consists of densely fractured bedrock with parallel beddings and vertical joints and faults leading to preferential flow as also emphasized by the authors at several places in the manuscript. For interpreting chloride and isotope concentration measurements preferential flow appears to be important. Furthermore, the authors have developed a conceptual model for recharge, where distribution between matrix and fractures is described (l. 469-479). The flow processes in and between the two domains are mainly based on speculation and not documented by modelling. The authors need to substantiate why two domains are not considered in their modeling approach.

Specific comments:

l. 66-75: Please update literature review with newer references. l. 103-104: As fracture flow is stated to be an important flow process the authors need to substantiate why this flow process is not considered in the modelling. l. 153-156: Is the lateral boundary condition a closed boundary? Is the lower boundary condition based on field measurements? To which extent will it impact the modeling results? Do I understand correctly

that groundwater does not contribute to stream flow and that all recharge will to deeper aquifer systems? Please elaborate on the model conceptualization. l. 178-179: What are the thicknesses of the two groundwater zone layers? l. 189: Table 2 is incomplete, unsaturated zone characteristics should also be listed. l. 205-211: Could you please be a bit more clear on how the land use are estimated. l. 280- : The calibration procedure needs to be elaborated and revised as described above. l. 301: Generally, I would consider a mean absolute error of 4.5 m to be rather high. Perhaps you mean root mean square error? l. 303-: To me it would make more sense to compare simulated and observed hydraulic heads directly? l. 316- 318: Perhaps the equivalent porous medium approach is suitable for simulation of water flow but for solute transport and the interpretation of chloride and isotopes I am not sure. l. 352: Fig. 8a and 8b. l. 373: Check consistency with lines 216-217.

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