

Comment on hess-2022-291

Michael Stewart (Referee)

Referee comment on "Estimating karst groundwater recharge from soil moisture observations – A new method tested at the Swabian Alb, Southwest Germany" by Romane Berthelin et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-291-RC1>, 2022

General Comments

This paper uses soil moisture measurements to estimate recharge to a karst groundwater system via a soil drainage model. The karst outflow is from a single spring, whose discharge is used for comparison with the estimated recharge. The model performed reasonably well for single rainfall events and simulated 88% of the long-term average annual recharge volume for a Swabian Alb catchment.

The research question is well within the scope of HESS and presents novel concepts leading to a new method of estimating recharge in a karst groundwater system. The conclusions reached are substantial, relating to the validation of the method. The methods and assumptions are valid and clearly described. The experimental results are extensive and amply sufficient to support the interpretations and conclusions. Description of the method is clear and would allow the recharge estimation method to be applied to other catchments with the required data. The authors give adequate credit to related work and clearly describe their own contribution. The title is good, and the abstract is concise and appears complete.

Presentation is well structured and clear, and the language is satisfactory – some technical corrections are made below. Math formulae appear to be correct. There do not appear to be any unnecessary parts of the paper. The number and quality of references is satisfactory.

Reply: We thank the reviewer for his positive and valuable comments that will contribute to improving the manuscript. We will apply all recommendations as suggested by the technical comments. Please find below the answers to the specific comments.

Specific Comments

The method is original and ingenious, and works relatively well for the catchment tested, which has eight years of hourly data on rainfall, soil moisture and spring discharge available for testing. There may be problems with application to different catchments because of lack of data. In addition, catchments with substantially different types of recharge such as recharge from sinkholes or from streams flowing into sinks in their beds may present problems with implementation of the method. Larger catchments with very varied catchment areas may also present problems.

Reply: Indeed, the lack of data might be a problem. For this method, it is needed to have precipitation, soil moisture and discharge data available. From our experience, soil moisture probes are robust, reducing the risk of data lack if the maintenance can be done frequently.

The presence of recharge from sinkholes would create more recharge events linked to precipitation but not to a soil moisture event. This could be highlighted during the first steps of the method. However, the recharge volume estimation from soil moisture would be indeed reduced in that case.

We will specify it in the manuscript accordingly.

There are considerable assumptions/requirements with the method. 1. The catchment area must be delineated accurately, this may be difficult in some areas. 2. Contributions from different vegetation covers and soils (as in this study) need to be assessed by multiple soil moisture measurement sites. 3. For comparison with the recharge estimated from the soil measurements, the spring discharge should be able to accurately represent groundwater recharge. This may be difficult in systems with several outlets.

Reply: The catchment area and discharge data that represents accurately recharge need to be defined to estimate the volume of recharge. Nevertheless, if this is not possible, the method still can be used to predict the recharge occurrence and relative dynamics, with other recharge measurements such as drip rates from a cave, discharge from epikarst outlet etc..

We will add these points to the manuscript in the discussion.