Review Report

Title: Modelling groundwater recharge, actual evaporation and transpiration in semi-arid sites of the Lake Chad Basin: The role of soil and vegetation on groundwater recharge

Author(s): Christoph Neukum et al.

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General Comments

In this research, the estimation of Evapotranspiration (ET) and groundwater recharge in Chad Lake Basin (CLB) has been done using unsaturated zone studies and modelling approach. In this regards, the authors collected soil samples from six boreholes and measured grain sizes (soil texture), water content and chloride concentrations. In addition they used climatic data (precipitation amount and Cl content) and vegetation cover characteristics to calculate the ET by a dual-crop coefficient method (Kc=Kcb+Ke). Hydrus-1D software was used to model unsaturated flow and transport and then to simulate the groundwater recharge and separated evaporation and transpiration values.

In my opinion, the structure of the manuscript is fairly appropriate as it generally represents a good example of unsaturated zone modelling. Although the results are highly site-specific, the collected data and modelling approach could be interesting for the readers of the HESS Journal.

Specific comments

More explanations are needed about the criteria for selecting the sites (soil profiles) in LCB as they are so close and limited. Regarding the extensive area of the LCB, are the selected sites representative of the region? Is it possible for upscaling the results from these limited sites to the whole LCB? What is the recommended strategy for upscaling results in LCB as a whole?

Selection of sites was limited mainly by accessibility and project's goals. At the time of sampling, the project concentrated in study cases in Waza Logone and Salamat.
The types of soils we have worked with (sand, loam, clay and their combinations) are the most common in the LCB. However, due to the extension of the LCB, we surely do not cover all existent soils.
We do not intend to extrapolate our values to the whole basin. We are very much aware that this would be an impossible work. What we want to show is that, using a generalised model, it is possible to determine recharge rates in areas with low accessibility and lack of data.

Why the bulk densities were not measured in the field? (Line 169)

Because of the difficulties handling the samples and sending them to Germany for measurement. We are aware of the limited accuracy of available methods, which increases with sampling depth (Al-Shammary et al. 2018[1]).

[1] https://doi.org/10.1016/S1002-0160(18)60034-7

Regarding the uncertainties inherited with the modeling approaches especially in unsaturated zone with more limited and unknown data, how do you confirm the modeling results on simulated ET and groundwater recharge values?

Results of evapotranspiration were not confirmed. However, the estimated values of the soil model as well as the calculated results are within plausible ranges. Our recharge values are in accordance with other studies, e.g. Bouchez et al., 2019[2].

We confirm our estimated recharge values with those published for the same area (Lines 451-454). We are not able to confirm them by other methods (groundwater level variation, lysimeter), because they do not exist in our study area

In the case of groundwater recharge you need to verify the modelling results by presenting the groundwater hydrographs and show any consistency between the recharge time series and water table fluctuations and then confirm the reliability of the method and results.

We agree with you, but these data are not available in the LCB, at least not in our study regions. This is the challenge of working in data scarce areas and one important motivation of this study.

Please explain in the text, why you used the both flow and transport modelling for estimation of ET and groundwater? Regarding the higher uncertainties in transport models, the basis for implementing transport model needs to be clarified as it was possible to estimate both ET and groundwater recharge by a flow model, only.

Our model was calibrated using measured values of chloride and water contend with depth. Thus, transport model was necessary. This is already explained in chapter 3.

Technical corrections

Line 1: In the title “actual evaporation and transpiration” is better to be replaced as “actual evapo-transpiration”.

We prefer to leave as it is since we calculate both physical quantities separately

Line 74: check the English “Pedotransfer functions (PTF) bridge available and needed data and are frequently used to”.

Corrected as: Pedotransfer functions (PTF) bridge available and needed data. They are frequently used to…

Line 108-109: The sentence is redundant, better to be deleted.

Done

Line 121: ST1 has not shown on Fig.1.

[2] Bouchez, C., Deschamps P., Goncalves J., Hamelin, B., Nour, A.M., Vallet-Coulomb C., and Sylvestre, F: Water transit time and active recharge in the Sahel inferred by bomb-produced 36Cl. Nature, scientific reports, 9: 7465, (2019).

Sorry! St1, St2, and ST3 were shown as S1, S2, and S3 in the map. The map has been corrected

Line 331: The figure caption (Fig. S1.) needs more clarification. You need to explain the abbreviations.

Done