Comments on manuscript HESS-2021-581

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

By Neukum et al.

This is the second version of a manuscript that I already reviewed. Evaluating groundwater recharge in such semi-arid regions of Africa is of great importance, and simple quantifications methods are crucially needed. Therefore, I believe that this paper deserves publication. Compared to the first version, the manuscript has been improved. Nevertheless, I would recommend to better highlight and discuss the major points of the study. I addition, it will probably need to be reviewed by a native English.

Despite the title, I am not convinced that this study provides robust results relative to evapotranspiration partitioning, since these specific results are not discussed, nor compared to other estimates. Instead, the major interest of the paper is more 1) the use of soil chloride content to constrain flux estimate in the ZNS, and 2) the magnitude of salt accumulation in the vadose zone, and its long-term implications.

Compare to Tewolde's previous work, authors claimed that they go further in producing time series of recharge for the period 2003-2016. They should explain how the field data presented in this work are used to validate the time variations of recharge fluxes.

In order to propose more generalized results of this study, author could summarize the main driving factors of recharge rates, and their spatial and temporal variations. This is actually too much diluted in the text.

Abstract has to be improved, to better describe the major results.
I am still not convinced that the FAO concept for ET partitioning is of major importance here. Better highlight the field data used, and the general methodology in the abstract. The last sentence of the abstract (line 27-2): there is no need of such a study to draw such a conclusion, since evapotranspiration rates rarely attain potential values under semi-arid climate...
Results should be presented in the abstract in terms of flux magnitudes, and driving factors (flooded areas, soil texture, etc…)

Line 355-358 : several interesting ideas are suggested here, but need to be better discussed.
355-356: « *Chloride concentration and water budget of the soils over the simulated time-period are rather unstable and differ for the six locations"*
I wonder if the so called "instability" of chloride concentration come from the simulations or from the data. On Figure 5, data doesn't evidence a time variation, compared to the probable uncertainty (soil sampling, water extraction, chemical analysis, etc... these uncertainties should be described). Clarify the significance of time variations, and how it is supported by the field data.

356-357: " At location ST2 with clay loam soil covered by Acacia and grass, accumulation of chloride takes place over several years, due to the high transpiration related to the effective field capacity (Figure 7)."
Figure 7 is confusing, because it displays "cumulative fluxes", while I would expect the net accumulation rate of chloride for the entire profile (Sum of chloride accumulation in the different levels). Clarify. Providing the magnitude of long-term salt accumulation would be of great interest.

In addition, the role of transpiration on the chloride fluxes and mass balances should be described. How are transpiration fluxes implemented in the model relative to chloride? Do the root pump dissolved chloride? Otherwise, explain and justify the mechanisms associated with such a "filtration". Is there a long-term turnover of chloride associated to the degradation of organic matter?

357-358: "However, in high precipitation years, most of the accumulated chloride is leached to groundwater and soil concentration diminishes."
Is there any data that support this affirmation?
The role of high rainfall on the leaching of soil chloride is also of major importance. This need to be detailed and argued in the discussion

It is argued (line 406) that chloride is stored in the vadose zone, and that it explained a "chemical memory effect". Do you refer to long-term chloride accumulation? Again, the magnitude of long-term chloride accumulation should be estimated for each of the study sites.

I still wonder about the depth of evapotranspiration. Authors consider the root depth, i.e. 0.05 to 1.5m (from table S1), which seems very shallow. What about the ST2 profile, with acacias trees ? It seems to me that that root uptake could attain higher depth. Therefore, the net recharge could be lesser

Figure 5 is not cited

In the revised version, geochemical data should be provided in a Table (precipitation and soil water chloride concentrations). A description of Chloride measurement is needed: which laboratory, which analytical technique, precision...

In Table 4 : add the average Chloride concentration, and the total absolute Chloride mass (i.e. concentration by water content, summed over the entire profile) for each profile