Hydrol. Earth Syst. Sci. Discuss., 11, C2259–C2262, 2014
www.hydrol-earth-syst-sci-discuss.net/11/C2259/2014/

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Mapping irrigation potential from renewable groundwater in Africa – a quantitative hydrological approach" *by* Y. Altchenko and K. G. Villholth

Anonymous Referee #2

Received and published: 8 July 2014

In the paper, a simple method for estimating the amount of cropland that could be irrigated from groundwater resources (or more precisely groundwater recharge from soil) GWIP in Africa is presented and applied. Given the relatively low degree of current irrigation, the presented study is timely and relevant. It can be commended that the study takes into account alternative levels of groundwater resource requirements as well as rough estimates of water requirements for household, industrial and livestock water use. The applied method combines data on groundwater recharge, green water, cropping patterns, crop distribution and crop water demand from diverse sources.

However, the presentation of the study is poor and not transparent, and it makes the

study and its results difficult to understand. The method needs to be described more precisely (e.g. regarding the time steps, source of data), in particular regarding the many assumptions made (e.g. crop water demand seems to be independent of climate, mostly year-round cropping seems to be assumed, return flows not considered, green water estimated in PCR-GLOBWB as transpiration of which vegetation?). The paper therefore requires a careful rewriting such that the readers can efficiently understand the assumptions as well as their implications for the computational results.

In addition, it seems arbitrary to compute GWIP only in grid cells that had cropland around the year 2000. Then, for example, GWIP is computed for grid cells of 2500 km2 that are mainly covered by forest but do contain a few hectares or km2, but not for the adjacent grid cell where no cropland was known to exist in 2000.

Given that year-round cropping is assumed and crop water demand values in this study do not take into account different climatic conditions throughout Africa, is it really worth considering current cropping patterns for computing irrigation potentials? I suggest the authors compute, in addition to the presented work, GWIP for two simple cases:

1) Annual crop water demand = 1800 mm (like sugar cane, and not much higher than for most double-cropping in Table S2)

2) Annual crop water demand = 700 mm, to represent single cropping during the wet season

I think this sensitivity study would clarify the dependence of the computed GWIP on cropping patterns and also help to see to what extent the computed GWIP is not only dependent on assumption of environmental flow requirements but also cropping pattern (that may change in the future). In addition, such an approach would all allow computing GWIP also for half-degree grid cells without current cropland.

Central to the required clearer presentation is the specification of the temporal resolution of all elements of the computation. For example, where time series of monthly

HESSD

11, C2259–C2262, 2014

(or daily) transpiration used to estimate green water in Eq. 3, or mean monthly values 1960-2000), or was green water aggregated to annual values (in this case, it would have to be discussed why this is appropriate)? The computational results of Eq. 3 are expected to differ strongly with the temporal resolution.

In addition, it appears to be decisive for the computed GWIP that double-cropping with almost year-round crop growth is assumed. This leads to the high net irrigation water requirements shown in Fig. 4b, while growth of one crop during the wet period would be much lower, and a much higher GWIP would be computed. Please clearly state and explain the assumptions regarding cropping patterns (and related crop water demand).

Specific points: Abstract: P6066, I10. It is not correct that 41 years of data were used. 41 years of climate data were used to compute groundwater recharge and green water, while crop water demand is computed without taking into account neither temporal nor spatial variation of climate, and human water demand, irrigation efficiency and cropping patterns from one time period only were taken.

Is “cultivated land” and “harvested cropland” and “cropland” (in abstract) the same? Please use the same term if the same thing is meant.

In Introduction, present correctly / more precisely previous work as compared to the presented work (e.g. FOY 2005, Pavelic et al 2013). In particular, explain better the spatial resolution / scale. For example, the work of You et al. (2011) is not represented correctly. It is a continental-scale study, like the study presented in this manuscript, and, also like the presented study, considers water resources at the 0.5° grid scale. In Discussion, compare results of previous studies with results of this study (in terms of GWIP, but also relating it to total IP).

In Conclusions and Abstract, do not only mention aggregated Africa-wide values of GWIP but rather distinguish regions with no/small/large (total and additional GWIP) (as visible in Fig. 7b)

HESSD
11, C2259–C2262, 2014

Figure 4: Clarify in caption what is meant with irrigated area. All the cropland shown in Fig. 1 or only the irrigated part?

Table A1: Include country values of GWI based on Siebert et al. (2010), as shown in Fig. 7a, to show were additional irrigation would be possible. In addition include GWIP as a fraction of actual cropland.

Supplementary material: Additional text is required that explains the method for computing monthly crop water demands, discusses Tables S1 and S2 and provides sources of data. E.g. are the seasonal water demands in Table S2 computed by the authors, or from some FAO Table (then provide precise reference?

Table S2: The heading "Water need per growing period (mm)" needs to be deleted.

In Table S2, wheat, millet and maize have seasonal crop water demands between 650 and 695 mm. However, in zone 4 of Table S1, for example, the seasonal crop water demand of wheat/millet/maize is 870 mm. Would it not be more reasonable to use 695 mm, instead of using maximum crop water demand values at the monthly scale.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 6065, 2014.