

## ***Interactive comment on “Monitoring Groundwater Storage Depletion Using Gravity Recovery and Climate Experiment (GRACE) Data in the Semi-Arid Catchments” by Nizar Abou Zaki et al.***

**Nizar Abou Zaki et al.**

nizar.abouzaki@oulu.fi

Received and published: 15 February 2019

We want to thank the reviewer for his time and effort commenting our manuscript. We are aware that GRACE data have been used to examine groundwater depletion and that many studies have been published before. Still this study relies also on in-situ data regarding groundwater level (448 observation wells) and 22 observation station measuring the precipitation, evapotranspiration and flow on hourly bases. All the previous (GRACE) studies have in common the large scale study area. In our study, smaller scale helps noticing the direct effects of local hydrologic phenomena like droughts (Page 8: line 6-24) on the groundwater level and its occurrence in (GRACE) derived

[Printer-friendly version](#)

[Discussion paper](#)



data. The study discusses the efficiency of (GRACE) data as a tool that can be used for water management on local level (Page 17 Line 19 till Page 18 Line 2). Below are our point by point answers for the reviewer comments:

\* The section “Estimating Groundwater Storage Changes” is unclear as to whether  $\Delta S$  is calculated from observation wells or GRACE data. The opening paragraph mentions both methods, thus confusing the reader:

In the same section, please refer to (Page 6 – Line 1): data on monthly groundwater levels in the Bakhtegan catchment are available from 448 observation well. Also refer to (Line 13): Therefor ( $\Delta SI$ ) can be compared with water mass volume fluctuation derived from GRACE data. Both of these sentences show that ( $\Delta S$ ) refers to the in-situ data collected. Still this can be made clearer in the reviewed version

\* The main point of this paper was to assess the catchment using GRACE-derived water mass data (WMI) against in situ monthly measurements. To analyze this, the methods section describes isolating the groundwater component (GWMI) given in Equation 5. Yet minimal explanation of this is made in the results section and little is discussed other than the fact that GWMI and ( $\Delta SI$ ) results show a proportional fit. What is the average monthly variation of GWMI?

(Page 7 – Line 11 – Equation 5): equation 5, referred to a paper published by Rodell and Famiglietti (2002), indicated that in order to compare the GRACE derived data with the in-situ data, all the water bodies in the catchment must be eliminated. As this is a semi-arid catchment, besides groundwater bodies, surface water from Bakhtegan and Tashl Lakes, and soil moisture are considered the only water bodies. This is regarding the methodology. Regarding the results, the (GWMI) monthly variation are equivalent to (WMI) values, as the surface water and soil moisture variation are negligible compared to the groundwater volume variation. Groundwater is the major water body in the catchment. This can be clarified more in the revised version.

\* Calculated groundwater depletion estimated from ( $\Delta SI$ ) was determined to be 905

[Printer-friendly version](#)

[Discussion paper](#)



mm; GRACE data showed a 76 mm decline. However, results showed a groundwater level average depletion of 10 m in the catchment aquifers. Where does this value come from? This seems to disagree with the suggestion that the GRACE-derived data and groundwater level fluctuations showed good agreement, as presented in the conclusion section:

An average of 10 meter of depletion is the actual groundwater level decrease rate in the period of 10 years. The 905 mm is the water volume (depth) lost in the same period. This two results show two different things, and we guess the reviewer mixed between volume depth, and groundwater levels. For that if you review (Figure 4D) you will find a good fit between the two. Comparing the GRACE derived data results and the in-situ data, can be found in the discussion part, explaining these results. This can be because of small catchment size or because of the pressure stabilization mentioned in (Page 14 Line 18 – Page 15 Line 2).

\* It is confusing throughout the paper to what the KB indices represent. It is presented as representing GRACE data in some cases, and representing in situ measurements in others, despite being defined as  $KB = \Delta SI / WBI$  in Equation 7. Examples: - P7, L19: “GRACE data alone are not sufficient for analyzing catchment water mass fluctuations (Tourian et al., 2015), the data were compared against calculated net precipitation (WBI) and groundwater volume variation ( $\Delta SI$ )” - P8, L2: “KB shows the corresponding relationship between the GRACE data and groundwater volume variation.” - Figure 5: “water mass (KA) and groundwater level (KB) fluctuation with respect to monthly net precipitation change in the Bakhtegan catchment” - P14, L2: “KB shows the relationship between net monthly precipitation and groundwater level variation”:

This is true, and other reviewers also pointed out this point. (Page 8 – Line 3) must be corrected: (KB) shows the relationship between the groundwater volume changes and the precipitation. This will be corrected in the revised version.

\* Specific Comments:

[Printer-friendly version](#)

[Discussion paper](#)



Specific comments (5 to 21) will be reviewed and corrected where needed in the revised version, as they are related to text structure

\* Figure 6: What do the black lines surrounding the aquifers represent:

they represent the aquifers boundaries

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2018-471>, 2018.

Printer-friendly version

Discussion paper

