Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-410-AC2, 2016

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Application of global models and satellite data for smaller-scale groundwater recharge studies" *by* Rogier Westerhoff et al.

Rogier Westerhoff et al.

rogier.westerhoff@deltares.nl

Received and published: 26 October 2016

The comments of the reviewers are greatly appreciated. We also sincerely appreciate the long time taken for this review, as is clear from both the general and specific comments of both reviewers. We decided to put a more detailed comments to these reviews, after which the editor will make the decision to either address these in a revised paper, or to reject the paper. We will address the most important comments in this Author's Comment. Remaining specific and detailed comment will be addresses in a revised paper (if given the opportunity by the editor), and are in our opinion mostly a matter of further clarification text, or a more concise text.

Generally, our intention of this paper was to bridge the gap between large-scale mod-

Printer-friendly version

Discussion paper

els and smaller-scale models. We did this by: applying a global-scale model (WaterGAP) to s smaller scale with better input data (national data, and satellite data), and to communicate the differences. From those differences, we can then say whether it is feasible or not to bridge this gap. In our case it is, since the model comes up with similar recharge estimates at measured and modelled locations. From the reviewer's comments, getting this message has only partly successful. The message in the introduction came across, but some poorly defined assumptions make our method less credible, according to the reviewers. This is something we have to work on. In our opinion, it is a matter of defending why we use certain assumptions, which were merely made because other data was not available at the national scale to make better ones (e.g., the soil permeability, and soil PAW). We also included extra uncertainty in those cases, which is something we will try and defend better in an improved version of the manuscript. We chose a simplified model to prove our case that simplified models can be used in smaller-scale research. Not to replace local models, but to possibly fill in gaps in data-sparse areas; to explain differences in local models; to constrain other national-scale models; or to interpolate between different model areas. Given the reviewers comments, it seems better to elaborate on uncertainty. Uncertainty was in our opinion addressed, but reviewer's comments, especially reviewer 1, brought us to the idea of detailing this uncertainty in the manuscript. We have already done these analyses, both for the model ('model equation' or 'top-down') uncertainties, as the comparisons with ground observations ('bottom-up'). However, we did not include them in the original paper to prevent the paper from becoming too long. However, after seeing the reviewer's comments, we agree there is novelty in the approach of digging deeper in the uncertainty analyses. By doing this, we would automatically focus more on the differences, errors and uncertainties from the global and the local method. Thus, the title would then also change to something along the lines of 'Uncertainty of application of a global-scale groundwater recharge model and satellite data at the smaller scale'.

Reviewer 1: We will rephrase our statement on the WaterGAP model. We are very much aware of the very good work of de Graaf et al (2014), but have not associated

this groundwater model to also be able to step up as a global recharge model. We will use the WaterGAP inspired model, and mention other initiatives such as de Graaf et al (2014).

Soil permeability: we have worked with the data that are available on the New Zealand-wide scale. A mention is made of the critical permeability of 0.15, which equates to 4 mm/hr or less. We assume that soil permeability above 4mm/hr accepts all recharge. That is a very reasonable assumption, given that 4 mm/hr is considered a heavy rainfall. This model works on a monthly basis, where 4mm/hr equates to 2.8 m of rainfall per month. Of course, the monthly approach causes the largest uncertainty, but that is mentioned in the discussion and shows in Figure REF, where high rainfall showed not be modelled correctly. We will now describe better that the guess in the soil permeability higher than 0.15 does not affect the uncertainty of the method at all.

K/R ratio: the reviewer is right: we shall define this now as "the ratio of K over potential rainfall recharge". The implication of this ratio is, similar to Döll and Fiedler, is that we do not allow recharge that has drained through the soil layer in areas where the underlying geology is very impermeable.

We prefer to leave age in, because of findings in a report of Tschritter et al. (2016), where clearly including the age delineated aquifers in New Zealand areas better. Although this assumption comes with much uncertainty, not having it comes with even more uncertainty. We will try to better word why we choose to leave it in.

Reviewer 2: We have not worded in much detail what the intended use of this model is. We have discussed some option of what it could be used for, and those are mainly: to solve for inconsistency between regional boundaries, to fill in gaps in data-sparse areas, and to constrain other nation-wide hydrological models. Up to this point, there is no intended use. We are not trying to replace the local model approach, we are merely comparing how a global model approach compares to when applied at the smaller scale. We therefore do not feel much for the suggested title, i.e. you suggested title

implies that we work towards a fully operational national rainfall recharge model for New Zealand. In our opinion, this model would be used for its suggested purposes (see above), and mainly be useful to interpolate between existing models, and to fill data gaps where required. Any development towards a more operational character of this model would require more research.

Reviewer 2 does not see any novelty in the approach. We disagree with that. A global-scale model has not been developed for the nation-wide scale, with improved national data, and an uncertainty estimate. Furthermore, the method is novel, since it applies the AET to PET ratio directly through the satellite data, instead of calculating this through the soil moisture deficit. We did not highlight this novelty, and this is something we should do in an improved version of the manuscript. For New Zealand, the method is novel as it does not have a national recharge model, and this paper might pave the way for such a national approach on rainfall recharge. Those were described in the original paper, but we will try to describe those novelties better in an improved version, if given the opportunity by the editor. One more thing we will try to better word, is that we are not aiming to make 'the best model', because we assume local models will always be better. And that is also why we allow certain 'assumption/simplifications' in our model, and why we do not calibrate. In our vision, that is considered a good approach, as long as we define an uncertainty band for those assumptions/simplifications. The aim is to have a simplified model, that can bridge the gap between local and inconsistent model to the national scale. This is also considered a novel approach and we will try to better raise attention for that specific novelty.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-410, 2016.

Printer-friendly version

Discussion paper