

Interactive comment on “Estimation of future groundwater recharge using climatic analogues and Hydrus-1D” by B. Leterme et al.

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Q.A. How do you rate the quality of the science?

A.Competent, with no major flaws.

Q.B. How do you rate the originality of the work?

A.Some novel aspects.

Q.C. How do you rate the importance of this work to the discipline area?

A.Important research on topic of broad significance.

Q.D. Would you rate the work as 'cutting edge'?

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A.No.

Q.E. Are the experimental design and evaluation of the data satisfactory?

A.Yes.

Q.F. Are the conclusions justified?

A.N/A.

Q.G. Is previous related work adequately referenced?

A.Yes.

Q.H. Is the manuscript written in clear and concise English?

A.No.

Q.How would you rate the manuscript overall?

A.Good.

Q.What is your overall recommendation for the manuscript?

A.Accept after minor revision, not requiring further review.

General Comments

The paper describes the results of analysis related to a climate change impact on groundwater recharge in the Dessel region in Belgium. Recharge was modelled applying HYDRUS - 1D model. The future climate parameters were derived from the existing meteorological observation within the current climate zones, which are likely to replace the current climate type (temperate oceanic) in Belgium in the future. The author suggested that the benefit of such approach is the opportunity to use the ?real? data (opposite to simulated data based on downscaling of GCM results). This provides the likely changes in climate parameters, which are important for recharge estimation e.g. rainfall intensity and seasonality. The main comments1. Future climate projec-

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tions: a. The method for future climate projection would require clearer description. This is particularly related to the time line of the projections. Firstly, it may be useful to provide some reasoning why 10,000 timeline is selected. I presume this is due to the reference of nuclear waste disposal, and the needs to align projection with the life-time of possible contaminants, but I think it will help to provide some statement in this line.b. The author suggested that the GCMs results do not provide the required time scale of the projection (10,000 year); however the selection of the climate type which is likely to replace the current one in Belgium is still based on the GCM projections by 2100. With dynamic changes in climatic condition it is not clear what was the basis for an assumption that significant climatic changes are likely to occur during 100 years (climate type changes from temperate oceanic to subtropical), which may remain unchanged for the following 9,9000 year. c. The application of a tundra climate data for the analysis without consideration of the permafrost effect on the recharge does not seem to be justifiable, as it effect on water fluxes and their seasonality in soil profile is most profound. There is some reference to this in the text, but it is not clear how meaningful is the result of the analysis for FT climate type.d. The climate data from climate types used for the future projection are selected to reproduce average and extreme climate data. It would be also useful to provide a better characterisation of the meteorological/climatic condition in Dessel: how do they fall within the range of rainfall data within temperate oceanic climate zone? It would be also useful to identify how extreme climate data within temperate climate type may affect recharge estimation.e. It would be also useful to compare the outcome of this study with the similar studies by based on GCM results and there downscaling. It seems that the projected changes in recharge under alternative climate type have a large range (60 mm vrs 314 mm). Is it comparable with GCM-based analysis? The reference to 9% increase in rainfall in northern Europe, stated in the paper, is likely to have some band of projection if more than 1 GCM was used. 2. Recharge estimation: gross recharge vrs net rechargea. It may be useful to introduce a concept of net and gross recharge. As describe in the paper the shallow groundwater in the region lead to the evaporative

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losses from groundwater itself, and as such the annual ?net? recharge would be low or even negative. The gross recharge or the amount of water reaching groundwater table is likely to be high due to the thin unsaturated zone and highly permeable soils. It appears that the paper examine the latter. It would be useful to clarify how important is the effect of climate change on net diffuse recharge in these conditions. Reduction in gross recharge may lead to reduction in evaporative losses and as such may have minimum effect on net recharge. Is it possible to clarify what changes in gross recharge may lead to changes in net recharge?3. Clarity of presentation : the paper would benefit from scientific editing, with more specific comments are given below (the items are marked in the attached manustript Abstract(1) I would suggest using past tense (2) No clear : what current state is referring to here(3) It is confusing when the projections of 10,000 year based on 24 year observation record. It would be useful to clarifyIntroduction(4) GCM definition: we commonly use Global Climate Model, rather than ?General?. Probably it would be useful to check?(5) Under the item (b) it would be useful to give references to the previous studies where such method was applied for the future climate projections. Alternatively, if this is the first time this method used, the overall structure of introduction needs to be revised.(6) It is not clear what does this mean ?an entire climate state?? Why the meteorological stations are ?not optimal in terms of the environmental condition on its site?? What site does this refer to? Editing is required.(7) It is not clear why the use of 30-50 years observation is more reliable for such projections? The latter in the paper the selection of ?future? climate type is still based on the GCM projection within the next 100 years.(8) Editing is needed: why this scenario can not be excluded? Particularly when other conditions under this scenario (e.g. permafrost) are not included in consideration or discussed based on other published studies. Material and methods(9) Should mention here what is a seasonal rainfall distribution for DO climate type (as it is further compared with Cs and Cr)(10) As in the main comments: the climate type shift is projected by GCM by 2100, but the target is 10,000 in the future. How the use of 100 years projection is extrapolated to 10,000 years. What does ?AD? mean?Climatic analogue stations(11)

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This paragraph requires editing: the description of the station selection and its relevance to the climate type is not clear (12) Table 1 ? it would be useful to give some indication where Dessel meteorological data sits within the DO climate (close to average, max, min)? (13) The reference is not in correct place in the reference list (14) I am not familiar with soil classification in the region and for me it is not clear what the term 'poorly drained' related to, when sandy soil is considered? Does this suggest that the soil is waterlogged? In the modelling described further the lower drainage boundary kept on 3 m would not allow waterlogging. Would this influence the soil properties over the proposed assessment period? (15) It may be useful to show the seasonal water table fluctuation range Results (16) Table 3 shows the water budget related to recharge modelling results using climate data and under the grass cover (not the water budget of the climate station). Editing is required (17) Should the depth to groundwater for each scenario be added to the table? (18) The word 'record' should be omitted: low precipitation is the driving force, not its record (19) I am not sure if Figure 1 adds more information than Table 3. (20) Same comment as in (8) (21) If the paper is going to be present in its current layout, the position of tables and figure 1 should be better aligned with the referenced to them in the text: e.g. Figure 1 in text is mentioned after references to table 3. (22) The vegetation was modelled with the root zone or 30 cm, while the depth to groundwater within the model was much lower. Is it still 'shallow enough for use by vegetation'??

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/9/C80/2012/hessd-9-C80-2012-supplement.pdf>

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 1389, 2012.

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