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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Estimating annual effective infiltration coefficient and groundwater recharge for karst aquifers of the southern Apennines" *by* V. Allocca et al.

Anonymous Referee #1

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Review on Paper HESSD 10,10127-10159,2013

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Submitted to Hydrology and Erath System Sciences Discussions

General comment

This study deals with estimation of karstic groundwater recharge, especially with the separation of annual runoff from effective precipitation. Transforming water balance in a ratio of system input and output, the fraction of effective precipitation that reaches the karst springs AEIC is derived. Considering the extent of areas with 100% infiltration

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(low slopes, summit flats), the annual runoff ratio is determined from AEIC. A linear regression considering different surface descriptors of four well observed sample karst sites is used to determine AEIC for 40 other karst systems.

There have been only few studies that try to determine karst recharge on a larger scale than one single study site. The method and the results presented in this study are a significant step forward in the large scale estimation of karst water resources. For that reason I generally recommend this manuscript for publication in Hydrology and Earth System Sciences with minor revisions. For instance, some improvement is needed in the elaboration of some parts of the methodology and the choice and justification of using only four karst systems to establish the linear relation between AEIC, limestone areas, and summit flats and endoreic areas. In addition, some information is not directly contributing and might be deleted.

Specific comments

1. P10129L13-18: Please add some words that link karst groundwater resources and karst recharge, e.g. a definition of recharge (Lerner et al., 1990; Scanlon et al., 2006).

2. P10129L23-27: Please also mention modeling techniques for modeling karst recharge (e.g. Hartmann et al., 2012).

3. P10130L1-5: Please give some reference to studies that applied the AEIC already and add some words about its value for researches and decision makers.

4. P10131L20-24: Please don't refer to the general conceptual model of karst systems, but rather to studies that were done in this regions indicating that there are large groundwater bodies feeing the springs.

5. P10131L27-P10132L4: Please add some comment why the recharge areas of these aquifers can be assumed constant and not variable as in many other karst systems (e.g. Ravbar et al.).

6. P10131L5-P10133L2: Instead of explaining the characteristic hydrologic behavior of

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the karst systems in the Apennines in such detail, a small sketch about their functioning, i.e. a conceptual model would support the descriptions in this section significantly.

7. P101334L9-21: Please mention altitude range of the considered aquifers.

8. P10135L11-14: Please provide value of the altitude gradient of the temperature and the coefficient of determination/p-value for the linear relationship.

9. P10135L18-19: What is the temporal resolution of spring discharge measurements?

10. P10136L13-14: There are a lot of examples in karst hydrology, where a decreasing trend of groundwater resources was observed (e.g. Iurkiewicz, 2009; Wu et al., 2009). Please explain why inter-annual variations of groundwater reserves can be neglected here.

11. P10137L13: So ARC only refers to the areas that are not summit flats or slopes <5°? Why not using AEIC instead of AEICs in the equations? Please add some more explanation.

12. P10134L8-P10137L17: Some parts of the methodology need more detailed information:

a. The derivation of rainfall time series (in particular: how were the homogeneous subgroups identified?)

b. The calculation of groundwater inflows and outflows (which gradients/hydraulic conductivities/etc. were used?

c. The justification/evaluation fir Turc's formula to derive actual evapotranspiration. Especially at summit flats and slopes <5° this equation determines the entire recharge. It is therefore crucial for the presented methodology and some measurements or references that support the use of exactly this equation would be very favorable.

13. P10137L19-P10139L10: Some parts of these results only present the available data. Please move the respective parts to the "Data and methods" section. In addi-

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tion soil type, woodland area and slope were finally found to be not important for the regression analysis in Eq (7) and there is no reason to present this data in such detail.

14. P10139L12-21: These are interesting results, but since they do not contribute directly I suggest shortening this paragraph and just mentioning that there is another source of uncertainty due to the unequal distribution of stations.

15. P10140L18: Please add some description about how the uncertainty in the regression models was propagated through the equations (was it Gaussian error propagation?) to the Data and Methodology section.

16. P10141L1-10: Please provide the results of the correlation analysis with all 5 variables in a table or figure, including the coefficients of determination and p-values (or other measures of significance). Furthermore it should be discussed why the low number of only four sample karst aquifers are enough to establish this regional relationship (in the Discussion and conclusion section).

17. P10142L4-10: These elaborations highlight the real values of AEIC, maybe something like this could also be mentioned in the introduction. Please also refer to other studies that tried to regionalize karst characteristics with topographic and climatic descriptors (e.g. Hartmann et al., 2013).

Technical comments

1. P10128L16: it is somehow clear what “summit flats” are, but it would be appropriate to provide a small elaboration, because the literature also uses “summit plateau” or other similar expressions.

2. P10130L8-16: Please shorten, it is sufficient to provide a range of values that have been found and citing the different studies all together in on set of brackets.

3. P10130L20: See technical comment 1.

4. P10135Eq2: Since AEPi is not used in the following Eqs, this equation may be

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omitted.

5. P10136L8-12: it is difficult to understand what is meant by “indirect” inflows and outflows (Ui and Uu). Later, the authors use “groundwater inflow” and “groundwater outflow for Ui and Uu, which is much better understandable. I suggest to use these expressions consistently also in this paragraph.

6. P10136L11: deletes “s” in “discharges”

7. P10136L19+Eq5: Qp not defined, I guess the authors refer to Qt?

8. P10137L3: Why id Fig 3 appearing before Fig 2 in the text?

9. P10138L1: The use of “(a)” in a study site name (Accellica (a)) is confusing, please modify the name accordingly.

10. P10138L6-7: Usually citations/comparisons to other studies appear in the discussion/conclusions, but not in the Results section (also P10139L4).

11. P10138L24: The font in Fig. 3 is much too small, please enlarge (this is also true for some of the other figures, e.g. Fig1).

12. P10140L12: The coordinates in Fig. 6 not necessary.

References

Hartmann A, Lange J, Weiler M, Arbel Y, Greenbaum N. 2012. A new approach to model the spatial and temporal variability of recharge to karst aquifers. Hydrol. Earth Syst. Sci., 16: 2219-2231. DOI: 10.5194/hess-16-2219-2012.

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