

## ***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 #2**

Received and published: 16 September 2013

This is an interesting paper that addresses an important topic – the quantification of groundwater recharge in karst aquifers. The figures are nicely done and are helpful for understanding the methods and results. As outlined in my review comments, I think that the paper introduces some confusion by not clearly emphasizing that groundwater recharge and infiltration are two different processes. Also, there are a few concerns related to the water budget equation and assumptions used to simplify it.

Major comments:

(A.1) The paper should make a more clear distinction between infiltration and ground-

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water recharge. Infiltration is water movement into the subsurface. Recharge occurs when the water arrives at the water table (Stephens 1996; Healy 2010).

It seems that the water budget method is in fact determining the fraction of effective precipitation (total precip - evapotranspiration) that becomes recharge. Is this correct? It appears this way because there is no analysis of vadose zone fluxes where infiltration would be the key inflow.

I am not familiar with the annual effective infiltration coefficient (AEIC). It may be that the authors are aiming for consistency with other literature . . . however I noticed that only a few AEIC references are provided, and only one of these is from a readily available recent publication (Bonacci 2001). I think that the authors should consider revising the definition of this ratio using the term “recharge.” This would correct the confusion and make the current paper more consistent with recent literature.

(A.2) The water budget equation (Eqn. 3) does not correspond to a clear conceptual model. What is the averaging volume – is it the entire subsurface (unsaturated and saturated zones), or just the saturated zone, or does it also include the land surface? The fact that runoff and infiltration are on the same side of the equation, along with groundwater outflows, contributes to the lack of clarity. This is particularly important because Eqn. 3 is the basis for the methods utilized in this study.

(A.3) The budget equations on page 10136 include terms for groundwater inflow and outflow (from/to neighboring geologic units that share a boundary with the karst aquifer being analyzed). It is stated that these flows were “estimated by the application of Darcy’s law,” yet there is no further description or mention of these water budget components. More details should be provided. How significant are these groundwater flows? How were heads in each aquifer estimated, and what assumptions about hydraulic conductivity?

This point seems particularly important for the analysis of outflow volume. The recharge fraction could be under-estimated if it is assumed that all natural discharge is

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through one or two major springs when in fact diffuse groundwater outflow ( $U_u$ ) could be significant.

(A.4) In addition to precipitation and ET, the water budget method used in this study relies on measured groundwater outflows to estimate the recharge fraction. In my opinion, the paper would be strengthened if some of these data (e.g., springflow hydrographs) were shown.

(A.5) The regression equation (Eqn. 7) and the statement that “the preceding equation confirms the insight that the flat and endorheic area is a factor affecting the mean AEIC more strongly than lithology” appears to be the most important general result of this study. However there were only 4 sites used to develop the regression, and the Accellica aquifer is the only example with low limestone coverage; it is also the only aquifer that has a low percentage of flat area. Does this bias the regression in some way?

Minor comments:

(B.1) I feel that the paper should have a different title - for reasons stated earlier about the distinction between infiltration and recharge. Also I have the impression that AEIC is not well established in the literature, although I am not an expert on this topic.

(B.2) I couldn't follow what happens to the runoff ( $R$ ) between Eqns. (4) and (5). Can this be described more clearly in the discussion that goes along with the equations?

(B.3) In Eqns. (3) and (4), the notation  $Q_t$  is used for “tapped discharge.” Is this groundwater pumping from wells? Later in Eqn. (5), the notation  $Q_p$  is used. These should be made consistent, and the quantity should be defined more clearly.

(B.4) Line 10 on page 10139 – sentence is unclear. Stops abruptly after . . . “and hence by a total effective infiltration.” Should this be “higher” effective infiltration?

(B.5) Figure 1 is a little confusing because there are numbers used to describe geology in the legend, and there are other numbers with similar font used to provide the aquifer

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ID. How about using capital letters (A,B,C,D, ...) for the geologic descriptions? Then the caption could state that “the posted numbers refer to each aquifer ID – see Table 2 for a listing of aquifers.” This would further improve readability of the paper by providing a way of locating the 4 aquifers that are discussed in detail (Matese, Termino, Accellica, and Cervialto).

REFERENCES Stephens, D.B. (1996), *Vadose Zone Hydrology*. CRC Press. Healy, R.W. (2010), *Estimating Groundwater Recharge*. Cambridge Univ Press.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 10127, 2013.

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