Author Reply to Referee 2:

Theory of the generalized chloride mass balance method for recharge estimation in groundwater basins characterised by point and diffuse recharge

By N. Somaratne and K. R. J. Smettem

Anonymous Referee #2

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Authors Somaratne and Smettem attempt to provide a generally valid chloride mass balance method to estimate groundwater recharge in karstic environments. The method proposed in this paper will lead to higher estimates of groundwater recharge (as is evidenced by the first few abstract lines), thereby to a larger amount of potentially extractable groundwater. While I do see value in providing a generally valid chloride mass balance method, I recommend rejection of the manuscript in its present form for two reasons (the second having more weight than the first):

Author Reply: We appreciate Referee 2's recognition for a need of generally valid chloride mass balance method. However, we disagree with the perception that this paper will lead to artificially higher estimates of groundwater recharge, thereby to a larger amount of potentially extractable groundwater. Please note that recharge estimations should be based on robust methodologies for accurate recharge estimations, irrespective of extractable groundwater volume. We disagree with ultimate recommendation of Referee 2, the rejection of the paper in its present form as this decision is not based on scientific merit of the paper.

We compare below, the approach and results of Wood et al (1997), and results of Generalized CMB method to show and display how higher recharge is estimated by accurate (and realistic) conceptualization of recharge processes in karstic aquifers. In the paper, page 310 Line 16 to Page 311, Line 4, it states:

"Wood et al. (1997) classify the mode of groundwater recharge into interstitial (matrix) and macropore (fractures, cracks, solution features, natural pipes, animal burrows, root tubes and other openings) flow. For application to playa basins with macropore flow, Wood et al. (1997) use an equation of the form:

$$Q_{tb} = Q_{mb} + Q_{ib} \quad (3)$$

where Q_{tb} is total recharge through the basin floor (L^3T^{-1}), Q_{mb} is recharge through macropore (L^3T^{-1}), and Q_{ib} is recharge through interstitial pores (L^3T^{-1})."

(a) Wood et al (1997) used a surface runoff model to estimate total recharge (Q_{tb}), and the Generalized CMB paper used surface runoff to estimate point recharge (flowing into sinkholes).

(b) Wood et al (1997) used unsaturated conventional CMB (with C_u taken from soil cores) to estimate recharge through interstitial pores (diffuse recharge) ($Q_{ib,}$), and this paper used

diffuse zone chloride C_{gd} (which is equal to C_u) to include a diffuse recharge component of the Generalized CMB equation.

(c) Wood et al (1997) estimated recharge through macropores (Q_{mb}) with the knowledge of Q_{tb} - Q_{ib}; and the Generalized CMB paper used Equation 13C (which is basically adding point recharge and diffuse recharge). We have also shown that Wood et al (1997) Equation 3 above is special case of the generalized CMB when $C_{gd} >> C_s$ (See page 319, Line 8-11).

(d) Wood et al. (1997) report macropore recharge flux ranges between 60 and 80 % of total recharge and concluded that if the recharge in playa floors is calculated with only the conventional chloride mass balance method or the tritium method, the recharge is severely underestimated because of the presence of macropores.

(e) In our three case studies, the point recharge flux is estimated to contribute 63%, 85% and 98% of the total recharge for Uley South, Mount Gambier and Poocher Swamp fresh water lens respectively. We concluded that recharge is under-estimated by the conventional CMB, if point recharge is a dominant mechanism in groundwater basins.

Therefore, Wood et al (1997) and this paper produced consistent results. The higher recharge estimate is a result of accurately conceptualizing the recharge process and the use of a bi-model approach to the CMB method. Furthermore, hydrogeologists using the generalized CMB now have the theoretical background to the equation and well defined boundary conditions. This will help to improve the recharge estimation method in karstic aquifers world-wide, with a contribution to advance the hydrological science.

Please read the document "Why the Conventional CMB Fails in Karst".

Referee 2 -C1: I fully agree with the authors' statement (response to Referee 1) that HESSD is a platform for scientific interaction and discussion and should exclusively be used as such. On the other hand, given the senior author's affiliation, there is the possibility for conflicts of interest to exist. Possible commercial interests and scientific spirit must absolutely be separate. In a possibly re-submitted revised form of the manuscript, the authors could clarify and state that commercial interests do not exist.

Lead Author Reply: The focus of referees comments should remain the scientific merit of the content of the paper. After replying to Referee 1's first round of comments, we decided to answer only the scientific contents of the paper, not any perceptions or allegations. However, in response to allegations appearing in the Referees comments for the second time, the lead author provides following fact about his affiliation.

South Australian Water Corporation is South Australian Government owned agency established to provide water and waste water services to the South Australian community. As it is South Australian Government owned, it belongs to the People of South Australia. For details, please visit:

http://www.sawater.com.au/sawater/

Water resource management in South Australia is managed by the South Australian Department of Environment, Water and Natural Resources, under the Natural Resources Management Act 2004.

The specific legal instruments that control water allocation from the case studies in the paper can be viewed at web site of the above mentioned Department.

As given in the second sentence in the Introduction (page 308, Lines 19-21), in Europe alone, 30% of land surface is made up of karst exposures. As Wood et al (1997) did in playa basins, the authors contend that the generalized CMB will be a useful tool to the world hydrological community working on recharge estimation in karsitic aquifers. The paper should be viewed in this broad minded context beyond the boundaries of a single small aquifer.

Again the authors appeal with respect to the scientific community to focus on a debate of the merit of theory presented in the paper.

Referee 2-C2: . The authors base this work on three internal reports that did most probably not undergo a high-standard review by international peers, and particularly on one manuscript (Somaratne et al. 2013) that is currently (as of Feb-07 2014) subject to discussion at HESSD. All six reviewers of Somaratne et al. 2013 have unanimously recommended rejection of Somaratne et al. 2013 for scientific reasons. It is, in my opinion, unwise to keep putting manuscripts on HESSD while their base is not yet consolidated. My feeling is that I would first close one construction site before opening another. Scientific journals do usually not accept manuscripts containing references to unaccepted submitted other manuscripts.

Even if the authors may not agree with reason 1 (and even if conflicts of interest do not even exist for that matter), reason 2 is sufficient not to accept the manuscript. I warmly encourage the authors to work on Somaratne et al. 2013, and to not submit work based on unconsolidated science.

Author Reply: We agree that internal reports do not undergo an international peer review process but they contain valuable data collected from each study. Please note that apart from Somaratne et al (2013) and this manuscript (Generalized CMB), to the best of our knowledge, the only other published article is Wood et al (1997) application of the bi-model to quantify recharge in playa basins.

With regards to recent HESSD submission of Somaratne et al (2013) we would like to state that most of the comments were directed to the Structure of the paper rather than Contents. No Referee has disputed the salient points of the paper (a) Boundary condition of conventional CMB is not applicable when point recharge is present (b) Preferential groundwater flows exits through interconnected networks (c) Representative groundwater chloride samples cannot be obtained due to incomplete mixing (d) The bi-model approach may be the appropriate CMB method when point recharge is a contributing factor. In fact, some of the reviewers reinforced the above points with their own experience, and stated that the conventional CMB always underestimates groundwater recharge when point recharge is present. Three referees acknowledged bi-model approach to CMB is the way to go when point recharge is a contributing factor. The editor and Referees provided valuable guidance to improve the manuscript through revisions.

Following the guidance of the editor and some of Referees, the paper was completely re-organised, particularly the Methodology (expanded), Results and Discussion (expanded and more clarifications were provided). We believe this is not uncommon in journal review and publication, where editor(s), reviewer(s) and author(s) work together to produce a useful scientific paper for hydrological community.

Perhaps Referee 2 may not aware that this manuscript (Generalized CMB Methods...) also underwent minor revision even before publishing in HESSD. The editor suggested to provide certain clarifications and requested to make this a stand-alone article without a need for reference to Somaratne et al (2013). By this way, the manuscript was improved from its original version.

References

Wood, W.W., Rainwater, K.R., and Thompson, D.B.: Quantifying macropore recharge: Examples from a semi-arid area. Ground Water, 35, 1097-1106, 1997.