Hydrol. Earth Syst. Sci. Discuss., 10, C5355–C5358, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C5355/2013/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Hydrological functions of sinkholes and characteristics of point recharge in groundwater basins" *by* N. Somaratne et al.

A. Werner

adrian.werner@flinders.edu.au

Received and published: 3 October 2013

The manuscript by Somaratne et al. reviews data from three field cases and then attempts to offer an interpretation regarding the role of sinkholes versus diffuse recharge in aquifers overlain by sinkholes or point recharge features. The manuscript lacks the usual elements of scientific presentation and logical argument, and seems to be compiling conclusions that are not sufficiently supported by evidence or citation. Much of the manuscript is dedicated to the complexities of flows in karst aquifers, but the focus of the paper is on recharge pathways (unsaturated zone processes), and this presents as a mismatch between the research objective and the assertions that are offered based on literature review. The major emphasis on the complex nature of karst

aquifers is also found to contradict the later notions of the manuscript, which purports that seemingly stable freshwater bubbles reside in the vicinity of point infiltration in karst aquifers, when such a notion seems highly unlikely under conditions of strong heterogeneity, and high temporal variability, where preferential flow paths are surely more likely to dissipate small freshwater bubbles to downgradient areas once recharge stops. In the case of the extremely transmissive and heavily pumped Uley South aquifer, small groundwater mounds that might occur under any major recharge point sources, during the wet season, would surely spread and disperse with the ambient groundwater during the extended dry season (which coincide with periods of highest pumping). In any case, the notion of stable freshwater bubbles in Uley South is not defended with field data obtained by the authors. Rather, it is more likely that the transient nature of that particular system would lead to break-down of any freshwater bubbles and mixing due to the extensive pumping network and the high seasonality of rainfall.

The manuscript also requires additional evidence to defend the notions offered relating to recharge processes in the systems under investigation. Statements about recharge processes in each basin are offered prior to the presentation of data, and hence it reads that these are predefined notions and not intetpretations arising from field data and previous investigation.

There are also clear signs that previous literature has not been properly explored, and in some cases, the findings of previous literature are incorrectly cited. For example, Ordens et al. does not suggest that sinkholes are a minor component of recharge to the system, but rather, they suggest that sinkholes re-distribute surface water more so into the unsaturated zone rather than transporting surface water directly to the watertable. Time lags in water table responses to recharge plus other evidence point to this conclusion.

The primary point the manuscript makes is that gaps in Cl vs O18 data do not suggest that unsaturated zone (matrix) flow has a significant role in recharge mechanisms, but that rather, sinkholes produce localised pockets of freshwater that are routinely

not sampled, hence leading to the Cl-O18 data-gap. This conclusion is indefensible for numerous reasons: (1) the Uley South case (which is used as the primary example) clearly has a very high density of sinkholes, and hence the likelihood of sinkhole recharge "bubbles" being isolated and unmeasured by the extensive monitoring network seems extremely unlikely, (2) the steady-state assumptions of the manuscript are grossly violated in all of the systems being assessed, (3) the idea that a gap in Cl vs O18 data is indicative that sinkholes do not contribute significantly to recharge has not been posed by anyone except the authors themselves, and hence they are trying to disprove a notion that they themselves invent. Previous studies are careful not to make rapid conclusions from individual environmental indicators, but rather, plausible interpretations are offered and are based on a range of data types. Multiple-technique methodologies, and skepticism in interpreting small and/or single-technique data sets (due to non-uniqueness and uncertainty in most recharge estimation methods) are encouraged in landmark papers by Scanlon and others. The same wisdom should be encouraged by the authors, rather than the black-and-white message that is offered regarding the influence of sinkholes on Cl-O18 data sets.

There is no doubt that karst aquifers recharged through preferential pathways are extremely complex settings in which to study hydrogeology and ascertain optimal water resources management approaches. The current study suggests adopting a bi-modal approach to the use of the Cl-mass balance method, but there is no evidence given by the authors to support such an approach. What's more, the practical difficulties in applying such a strategy may be insurmountable - i.e. one would need to try to determine the extent over which stable freshwater bubbles, if they indeed exist, might occur, so that the breakdown into diffuse and sinkhole recharge could be produced. It is therefore no surprise that the authors make no attempt to apply the method that they recommend. In reading the Reviewer's comments, I wholeheartedly agree with the assertions made there, and also find that there are no significant advances on the current body of knowledge contained within the manuscript.

On a positive note, endeavouring to assess recharge processes in complex systems is a worthwhile undertaking given the lack of understanding of the surface-subsurface flow within such settings, and the authors ought to be commended for their ambitions to characterise the various components on recharge in these sorts of systems. Future efforts would be strengthened by focused field investigation programs and the application of various environmental (and forced) tracer techniques, combined with localised conceptualisation and modelling to untangle the complicated interactions between sinkholes, permeable sediments, highly seasonal rainfall-runoff processes, and the flow and transport within underlying karst aquifers.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 11423, 2013.