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Interactive comment on “Estimation of deep infiltration in unsaturated limestone environments using cave LiDAR and drip count data” by K. Mahmud et al.

Anonymous Referee #1

Received and published: 7 October 2015

The manuscript deals on an interesting topic like groundwater flow in the unsaturated zone of karst media considering as pilot site a cave located in SW Australia developed in aeolian calcarenites.

The title is descriptive enough, although the acronym LIDAR should be clarify from the first reference since on page 8807, line 5, is noted as the name of the chamber cave and its real meaning is not explained until 8899, l.17. Besides, the authors don't explain why they use this technique. This is just to check, because they have the technique, or is there any special reason?

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The work is well written and structured. However it is presented like a continuation of a previous paper (Mahmud et al, inpress) that sounds partially described again in present manuscript (particularly on section 3).

Besides the scope and the interest of the submitted manuscript is unclear. It sounds like the authors have installed a nice underground laboratory, the recorded a lot of data and then they try to give a meaning. This, from scientific stand point may sound potentially interesting, for a better understanding of processes in karst at small (near micro) scale, but this is not really useful in terms of infiltration assessment or unsaturated zone behaviour. In the manuscript it is indicated that this new technique can be applied to other cave sites but this sounds really difficult. Difficult to install a large number of drip water counters and difficult to apply LIDAR techniques every places everywhere.

At the end of page 8896, it is given information about how infiltration has been assessed but additional information should be done about its calculation. What method has been applied? Runoff is assumed zero but not information is given about the slope outside of the cave. What about the exokarstic features in the study area? Are there karst landforms (karren, doline) in the area?

Notation given to drip water points (page 8897, lines 10-15) sounds complicated and difficult to follow in the text. Probably the authors can use a more intuitive reference system considering numbers just for the point, capital letters (A-external chamber, B-inner chamber) and initial letters (l-logger and m-manual). Then, notation of stalactites is noted with Arabic numbers (page 8900, lines 23-24). Figure 3 is not clear enough (too small photos, references so difficult to see) to facilitate comprehension of the text. Sites 2E and 2B are cited in the text but they can't be seen on figure 3.

The period of record should be clarified. On page 8901 is noted from October 2012 to March 2015, but in line 19 is noted April 2012 to March 2015. However in figure 4 the records seem to start on August 2012. On page 8901 is noted that some counters didn't work correctly sometimes and the authors obtain series gaps using statistics

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tools but it should be more clearly explained. Records of figures 4a (particularly dark blue line) and 4b (most of the lines) show apparently too noise with high variation of short period phenomena which are not described in the text. How reliable are these records?. A correlation (even spectral) analysis of rainfall (effective rainfall) and drip water flow would be welcome to know how rapid is the hydrodynamic response of the unsaturated zone in the cave. In figure 4 should be represented the rainfall (or better effective rainfall) on the right axis, for example like a histogram with values increasing from top to bottom. Present figure 4b is unclear: too many lines (particularly figure 4b) and the colour lines of the legend can be not correctly identified in the figure. Are all the records necessary or it can be selected the most representative?

It would be better to separate present “Data analysis and interpretation” section into two different ones (on one hand Results and on the other Discussion). Interpretation of figures 5 and 6 is nor really argued in the text; it is just an assumption of figure and interpretation. Besides, what is really the contribution of LIDAR tool? How these data and images contribute to a better understanding and how useful could be there in other sites? A classification of flow categories is presented in connection with Mahmud et al. (in press) without really discussion. Two major types of flows and speleothems are presented jointly with an intermediate group, controlled mainly by matrix and fracture flows. However the role of dune bedding is not considered or discussed. The bedding may contribute to lateral flow into the record sites. Thus, correlation with overburden limestones thickness above the drip sites sounds not particularly reliable and the red cylinder represented in figure 10 may be difficult to assume. Points with high correlation may receive recharge from other areas located outside of their vertical or outside of red cylinder (Fig. 10 and page 8906) and conversely spatial dependence noted on page 8904 (line 20), because of lack of correlation, may be the results of a bad drainage from an external area located above the drip water point. In karst all these aspects may be possible (and another such as it is noted at the end of page 8904).

Concerning the cave discharge estimation (section 5.3), probably is better to consider

the integral of the hydrograph (the whole of the volume) instead of average value of drip discharge. How is really determined the area covered by each flow category from LIDAR images? Do you meant the “catchment area” of each point? The percentage of active stalactites (71.1 %) should change along the time, so this can affect to calculations. How the uncertainties noted on page 8906 can affect to the calculated infiltration data (120-170%)? How are possible these infiltration values? This contrast with the averages values given in the conclusions (60-70%). What may be the storage capacity of unsaturated zone in terms of previous recharge periods? How is possible this in an area where highly permeable sandy media exists (as noted in page 8896, lines 1 and 2)?

One additional key point of the manuscript is that it considers only drip data (jointly with LIDAR data) but this only inform about hydrodynamic of the system, not about the hydrochemistry or isotopic data. So, nothing relevant about the flow path or residence time in the unsaturated zone can be inferred from the data.

In present form, the manuscript is very descriptive (it shows the technique –method- and the results with a qualitative interpretation). Without to quantify hydrodynamic response and lacking the hydrochemical information, it is difficult to know the functioning of unsaturated zone. Therefore, the manuscript should be improved.

Minor comments: Site description section: it should be noted how is the topography on the study area, particularly the slope, since this affects to infiltration/runoff ratio and also if karst landscape exists in the area. It sounds not adequate to say that study area has Mediterranean climate because after figure 2 it can be seen that rainfall occurs predominantly during the dry months in Mediterranean area Page 8897, line 9: “Arabic number” instead of “numerical number” Figure 9. The red colour for circles are not suitable since the cave ceiling seems also red-brown. Change the colour. Page 8903, line 10: notation letter for standard deviation and mean are unnecessary Litre, in the international metric system should be noted as “l”

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