

## ***Interactive comment on “Improving confidence in deep drainage estimates, for arid and semi-arid areas using multiple linear regression with percent clay content and rainfall” by D. L. Wohling et al.***

**D. L. Wohling et al.**

daniel.wohling@sa.gov.au

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Reply to Review Comment for “Improving confidence in deep drainage estimates, for arid and semi-arid areas using multiple linear regression with percent clay content and rainfall” Wohling et al., Hydrol. Earth Syst. Sci. Discuss., 8, 4535–4557, 2011.

Interactive comment on “Improving confidence in deep drainage estimates, for arid and semi-arid areas using multiple linear regression with percent clay content and rainfall” by D. L. Wohling et al.

C. Petheram (Referee) cuan.petheram@csiro.au Received and published: 28 July  
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2011

This paper makes a useful contribution to the literature on the development of generic recharge relationships and is of particular relevance to the Australian situation. I believe with more consideration the structure of the paper could be improved which would considerably strengthen the appeal of the paper. I recommend the manuscript for publication with minor corrections. Comments specific to each section and detailed comments are provided below.

Comments specific to each section. Introduction First paragraph should be revamped. As it stands it is not particularly inviting and the sentences don't link well together. Sentences starting on lines 19, 20 and 22 (pg 4536) are an example. The leading sentence needs to be attention grabbing, at the moment it isn't.

Reply: Yes, the first paragraph has been revised.

I'm not keen on the use of the word 'drainage' in the context of potential recharge. There are already enough terms in use for potential recharge without adding another. Besides which 'drainage' has a lot of other connotations in hydrology. If the authors want to use drainage, then please stick with the more conventional 'deep drainage', the use of just drainage is too ambiguous.

Reply: Yes, drainage has been replaced with deep drainage.

Methods Tense changes between present and past, please be consistent. E.g. Ln16 "...we filtered the database..." and then Ln20 "... that the MLR is performed.". Ln 21. "The data was re-queried...":

Reply: Yes, changed to consistent tense.

I question whether Ln 15-30 (page 4540) and 1-25 (page 4541) are necessary. It is a very dry read (even as a reviewer I just skimmed through this, without really taking any of it in) and the information could be easily summarised in table form. I also question whether this text belongs in the Methods section – a summary table yes, but study by

study descriptions I think not.

Reply: No, the authors added a summary table in lieu of text however still think that the text is necessary for people who are not familiar with these studies.

I would suggest setting the statistical methods section up in terms of Hypothesis to test (e.g. as per Petheram et al. 2002 – as that is on hand, but there are many other examples in the literature). Clearly stating each hypothesis concisely sets out the logic of the paper and facilitates a succinct results section.

Reply: No, the authors believe that a hypothesis test is stated and best placed in the aims of the introduction (last paragraph of the introduction).

Results. Currently the results seem to be a bit of a ramble. I couldn't see a structure and my attention drifted. If the statistical methods section set out the testable hypothesis clearly, then the results can be concisely reported in tabular form. This helps to make a clear distinction between results and discussion (which may be a little more speculative in nature).

Reply: Yes, the results section has been set out according to the 3 aims listed in the introduction.

Discussion makes some important points, particularly the applicability of developing and applying empirical relationships such as these with a GIS framework. Some discussion on the applicability of the relationships in countries other than Australia may be useful to an international audience (given the differences b/w Australian soils and vegetation and those of the northern hemisphere for example).

Reply: No, to the author's knowledge, this method has not been used outside of Australia and therefore we cannot discuss international studies.

Detailed comments Abstract Page 4536 Ln 6 – poorly justified??

Reply: No, to the author's knowledge, relationships previously reported between deep

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drainage vs. clay content were sighted by eye and included no statistical rigour. Therefore we believe the statement 'poorly justified' is not too harsh. Also, 2 of the 3 relationships cited were developed by the authors of this paper so we know how they were done.

Ln 10 – insert 'average' ...clay content of the top 2m. My first reaction on reading this was do you mean average or maximum clay content. From my reading I later found out it was average, but this should be said in the abstract as this is an important point/finding.

Reply: Yes, changed.

Ln 12- two comments. i). Are you sure about this? What about Watson et al. 1976 for example, they provided 95% confidence intervals on recharge estimates made in different rainfall zones of Nevada.

Reply: The authors agree that this is not the first time 95% confidence intervals have been placed on recharge estimates; however we believe that this is the first time 95% confidence intervals have been given to field based clay and rainfall measurements as predictors of deep drainage.

ii). This doesn't fully account for the uncertainty in using these data to estimate deep drainage. It doesn't account for measurement error, errors due to assumptions (a potentially systematic source of error) or systematic bias in where measurements are taken for example. There is also the question of scale. Recharge is scale dependent. Uncertainty estimates are provided but what scale are these estimates applicable (i.e. point, paddock, hillslope, subcatchment, region)? This is not addressed in the paper? If the data were predominantly point scale measurements (i.e. based on chloride displacement) then it would be wrong to assert that these uncertainty bounds were applicable when estimating recharge at the catchment scale (well I certainly wouldn't be using them).

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Reply: Yes, the authors agree and have added that these estimates, and therefore uncertainty, relate to point scale.

Introduction Page 4536 Ln 15 – The leading sentence needs to be attention grabbing, at the moment it isn't.

Reply: Yes, the first paragraph of the introduction has been revised.

Ln 26&27 – 'transient environment' – jargon and ambiguous to the layman (non-recharge specialist).

Reply: No, the authors believe that the audience reading this work would be scientific and have an understanding of recharge terminology.

Pg 4537 Line 1 – it's not just limited to the CFD method. What's written is not particularly accurate. Basically it is a balance between the resource use/value and the cost. If the land was high value (e.g. as a nuclear waste repository or irrigated land) then expensive measurements become viable.

Reply: Yes, the authors agree and have changed the sentence.

Line 5 – are you sure Kennett-Smith et al. (1994) was the first to introduce a surrogate measurement for drainage? What about Turc (1954), Mandel & Shiftan (1981), Sinha & Sharma (1988), etc or Sophocleous (1992) as you mention later.

Reply: Yes, the authors were referring to the first effort to introduce a surrogate clay measurement for predicting deep drainage and have changed the sentence.

Ln 19 – 'aforementioned work'?? which?

Reply: Yes, inserted the actual references instead of 'aforementioned work'.

Ln 18 – logic is difficult to follow here. Many, many studies have shown rainfall explains a large degree of variation in observed recharge variation (e.g. Petheram et al. 2002 found it explained 60% of the variation under annuals). However, the use of Fig 2

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(a relationship between clay content and recharge) seems to be a rather convoluted way of making this point? Perhaps the authors are trying to demonstrate that if you incorporate clay content then the relationship with recharge still holds?? Seems rather convoluted to me. I would suggest revisiting the logic and structure of the first few paragraphs in the introduction.

Reply: Yes, re-structured the introduction.

Pg 4538 Ln 2. Insert. ....over 172 studies across...'dryland areas of'...Australia.

Reply: Yes, inserted change to text.

Ln 10 It may be worth saying that this is because most studies in the literature do not report clay content and when it is reported it is not reported in a consistent manner (sometimes it was reported as the average of top 1m, top 2m or maximum value instead of average value). This is an important point as it would be good if future studies provided this information (in a consistent manner) to help the future development of generic relationships. I think one of the contributions this paper could make is putting forward a strong case for future studies to report potential surrogate parameters in a consistent manner e.g. average clay content in top 2m

Reply: Yes, inserted comment.

Ln25 – Three sentences in a row start with Keese et al. 2005. I suggest you mix it up a bit.

Reply: Yes, changed.

Ln27-30 using present tense?

Reply: Yes, changed.

Pg 4539 Ln 11 – "best metric of clay content"... - for an aim of the paper it's a bit ambiguous as to what this means.

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Reply: Yes, improved the sentence to be less ambiguous.

Methods Pg 4541 Ln 25 – change ‘methodology’ to methods. You are not studying different statistical methods. i.e. methodology is the study of methods.

Reply: Yes, changed

Pg 4542 Ln 7 – remove ‘a’

Reply: Yes, changed.

Results P 4544 Ln 18-19 – reword sentence.

Reply: Yes, sentence reworded.

Pg 4545 Ln 4 reword. . .”Using this larger data. . .” ???

Reply: Yes, sentence reworded.

Ln 6- point (b) it’s the best of what? How can you say this when there are many other proxy measures you haven’t tested. Besides which I don’t see that average clay content explains more of the variation in the data than rainfall?

Reply: Yes, reworded sentence to clarify point.

Ln 5-10 Sentence too long making it hard to follow.

Reply: Yes, the authors have changed the sentence structure to a series of dot points.

Ln 10 – across Australia? The paper is titled improving estimates across arid and semi-arid regions of Australia. Given their geographic bias’ do you expect these relationships to hold across Australia (e.g. what about tropical northern Australia)?

Reply: Even though the authors believe that there is a difference between tropical northern Australia and southern Australia, we cannot prove otherwise as pointed out in Crosbie et al. 2010. Therefore the authors do not think the statement should be altered significantly other than to add in ‘arid to semi-arid’ Australia.

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Pg 4546 Ln 1 – I don’t think the authors have demonstrated that their 95% confidence intervals are an improvement on Crosbie’s. To me this would imply the authors have tested their and Crosbie’s 95% CI against an independent dataset and found their 95% CI to be more robust.

Reply: Yes, the authors agree, we cannot state that these 95% prediction intervals are an improvement on Crosbie et al. 2010. Therefore the sentence has been reworded.

Ln 3 – the use by Crosbie et al. of Australia wide coverage of soil (and veg) data is an important point.

Ln7 – “. . .without any such consideration to the level of uncertainly involved”. I think that statement is too harsh. Many studies in the literature devote a considerable proportion of their discussion to issues of uncertainty in the development and application of generic recharge relationships. Yes most don’t quantify confidence intervals but in many cases this was a deliberate decision.

Reply: The authors were only referring to previous deep drainage vs. clay content relationships developed over the past two decades in south east Australia and not recharge studies in general. The authors have added quantification of level of uncertainty to minimise the harshness of the statement.

Ln 14-17 – what is the basis of this sentence? I don’t necessarily disagree but it has come from nowhere. Can you provide a reference?

Reply: Yes, reference now included.

Ln 17-18 “. . .Greater dependence on local recharge”. – greater than what? I don’t actually understand this sentence. Please reword?

Reply: Yes, the sentence has been changed to clarify.

Ln20 – I don’t agree. Where water fluxes are low and residence times are long (i.e. deep unsaturated zones) the temporal variation in recharge reduces with depth and

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approaches a long term average constant value.

Reply: Yes, the authors agree. The term deep drainage was meant to be used instead of recharge.

Page 4547 Ln 1 I'm not entirely sure what the authors mean by this sentence. Yes I agree different management practises can potentially affect results but with upscaling relationships like this you can also get compensating errors.

Reply: Yes, the sentence has been re-written to clarify the point.

Ln 5-10 Glad to see this discussion in here. I think it is a very important point. The development of relationships from regional scale GIS data and then their application again through regional scale GIS data is attractive but fraught with danger. If the authors have data demonstrating this point/issue I would have thought that its inclusion would be a valuable contribution to the literature.

References cited above not already cited by authors.

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