

Interactive comment on “Water in the Critical Zone: Soil, Water and Life from Profile to Planet” by M. J. Kirkby

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Review of ‘Water in the Critical Zone: Soil, Water and Life from Profile to Planet’ by Mike Kirkby

In this paper, Mike Kirkby provides a comprehensive overview of the role of water in soils. This review paper is a very valuable contribution as it will serve as a resource for researchers that are not so familiar with soil science to understand the complexity of the subject and to quickly find which literature is relevant to deepen their knowledge. The last section adds to this an important perspective on why understanding soil water is important from a more applied viewpoint. In my opinion this paper can be published but I do think its impact can be improved with some modifications. There are a lot of suggestions in the annotated pdf. The most important issues are to me:

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- The discussion on how water moves through a soil is interesting, but a key point is, in my view, neglected and that is that we often observe 'old' water to be pushed out during an event, rather than rainwater being spilled. It is, in my view, important that this concept is included and discussed in this review as otherwise a too simplistic view may result (and remain imprinted in the reader's brain ;-). The work by Kirchner, Tetzlaff and others provides a very useful starting point to discuss this here. - There is confusion on the role of bacteria and fungi. Fungi form mycorrhizae (and are symbiotic with plants): they provide the plant with enhanced access to water (and dissolved minerals such as P) in return for carbohydrates (sugars) produced by the plant through photosynthesis. Several kinds of bacteria, on the other hand, can live symbiotically with plants as nitrogen fixers (exchange of reactive nitrogen in return for carbohydrates). This needs to be clarified. - I am not convinced that Figure 5 and the discussion that goes with it are necessary: I do think the reasons for malnourishment are, most certainly, not only water shortage and I think the discussion would be made clearer (and more relevant) by removing this figure. - I think the discussion of crop production and water is fascinating but that a key element is missing. Nowhere there is a mention of crop yields: I assume the author assumes that we need ca. 0.5 ha of cropland per person but this crucially depends on yields ! In Europe, such a surface area is sufficient to feed at least 5 persons, while it may not be enough in the Sahel. The main reason for this are the much lower yields in the Sahel, which are due to a lack of ag technology (Mueller et al., 2012; Neumann et al., 2010) rather than water alone. The same is true for water: water use efficiencies vary greatly around the globe (Rockström et al., 2007). This really needs to be accounted for and brought into the discussion. This does not mean that water is not a critical issue: it definitely is, but the discussion is too simplistic if we assume that all cropland produces (or can produce) the same. As possible analysis could start from actual yields and cropland areas and water efficiencies per country (available at FAO) and then make the calculations.

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Mueller, N.D., Gerber, J.S., Johnston, M., Ray, D.K., Ramankutty, N., Foley, J.A., 2012. Closing yield gaps through nutrient and water management. *Nature* 490, 254-257.
Neumann, K., Verburg, P.H., Stehfest, E., Müller, C., 2010. The yield gap of global grain production: A spatial analysis. *Agricultural Systems* 103, 316-326.
Rockström, J., Lannerstad, M., Falkenmark, M., 2007. Assessing the water challenge of a new green revolution in developing countries. *Proceedings of the National Academy of Sciences* 104, 6253-6260.

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Please also note the supplement to this comment:

<http://www.soil-discuss.net/soil-2016-50/soil-2016-50-RC2-supplement.pdf>

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