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Interactive comment on "Sustainable soil management requires a systemic approach" *by* Hans-Jörg Vogel et al.

Anonymous Referee #2

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Sustainable soil management requires a systemic approach

Vogel et al.

This is a well written paper, albeit somewhat repetitive at places, and it puts forward an interesting and novel approach to modelling soil systems. Even though it is somewhat abstract at this stage it makes valuable points that can add to the debate how soils should be modelled in a meaningful way. I am not convinced the title captures correctly the novelty introduced in the paper; the novelty is not that a systems approach is required (this has been made numerous time before), but the novelty centres on the approach they put forward so I would encourage the authors to search for another title that better captures the essence of the paper. The proposed modelling concept is very abstract as it is currently presented. I suspect the authors have already explored some

of the behaviour of such an approach and if so it might add value if they could make the approach more accessible by including an example. If that isn't possible at this stage, perhaps they could include a discussion on how this approach could be used in 'real' situations? I can see how the functional characteristics can be quantified, but I find a less obvious how the authors have decided what important functional characteristics are (and what are not); the fact that table 1 only list a few (apparently on purpose at this stage) makes me wonder how they envisage this to be progressed to modelling. Secondly, the behaviour of the system they project in Fig 3 is most likely to be determined by the interactions between the 'functional characteristics'; the authors have given this relative little consideration in their paper and I would welcome insights in how these could be measured (if possible et al), or what other means the authors consider to parameterise the system. This makes it difficult to assess if this is a viable option that is being put forward or if it is an alternative approach that retains difficulties they identified in other approaches. The above questions do not devaluate the approach they put forward in this paper; I believe that the challenging of current approaches is valuable and the gap in our knowledge appears correctly identified in this paper, whatever modelling approach we consider. Some additional comments are given below: P2 line 7: reminder $\Rightarrow$ remainder P2 line 10-18: I am not sure why the authors conclude that based on these papers the impression may e reached that our scientific knowledge on soil processes. . .. Is pretty much settled. . ..' I did not reach that conclusion from those papers, and it seems to me that this sentence was merely included to introduce to emphasise their view that this is a misimpression. Fig 1 is rather simplistic; this may be essential to introduce the remainder of the paper, but it lacks, for example, feedbacks with the climate, suggesting soil management being the only factor impacting upon soil. In going forward it is essential that our systems are sustainably management against the backdrop of a changing climate. I am not advocating expanding the figure, but a additional discussion of the boundaries of the system they consider might be welcome; it currently appears very centred on soil. It may also need to be recognised that there is a role for land management and not just soil management. Arguably the examples

they give in the figure aren't 'soil management' in the strictest sense, but agronomic measures. It would help in the caption of Fig 1 to make reference of details being described in Fig 2 and 3; some of the initial concerns (lack of feedbacks) I noted were resolved later in the article. P5 line 7: the 'interactions between physical, chemical and biological processes are mentioned repeatedly in the paper. P5 line 13: I agree with the limitations put forward against the bottom up approach, but would have welcomed a discussion against these points for the approach they put forward: is it really better? Is the spatial heterogeneity less of a problem? Is the lack of information on interactions not a problem? Is there no non-linearity in your system and/or interactions? It is unclear to me if the approach you put forward is 'different' or better in this respect. P6 line 30: you state that functional soil characteristics carry most valuable information; most valuable for what?, upon what is this statement based? How did you come to the set of functional characteristics in table 1? E.g. you list macro-pores which indeed can be a longer term process but at the same time changes almost instantaneously in response to wheel traffic/compaction. Fig 2: it may not be possible to link state variables to soil functions or ecosystem services in an empirical way, due to the dynamic nature of these, but progress has certainly been made in modelling these processes and relating these model outcomes to soil functions, ecosystem services and how these may respond to management. As such the focus on the state variables may not be as futile as is suggested by the authors as it fulfils a valuable role in model validations. I agree however with the authors that there is a gap in our knowledge on what they identified as functional characteristics. However, as indicated in their fig 2, the focus on functional characteristics leaves us with uncertainty about impact and indicators; they therefor appear to have replaced one set of uncertainties and unknowns hampering modelling with another. As indicated above some broader discussion on how this approach could be implemented might strengthen their call for an alternative approach.

P10 line 28: what is the new research you are referring too here? Surely soil-root interactions is not a 'new area of research'? You overlook the multitude of research in this field including the progress with modern technologies; it would be more helpful,

if you wish to keep this argument, to be more specific about what it is precisely that you require to progress your modelling. It seems to me that the interactions between the functional characteristics are a new area of research. This in my view is generic to systems approach that the interactions are critical to its behaviour, yet often unknown. I think if the authors could consider some of the above comments in their revision it would be stronger as a call for a different approach. I think it can make a valuable contribution to the academic community and stimulate debate on how best to model soil systems.

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