SOIL Discuss., author comment AC2
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Reply on CC1

David G. Rossiter et al.

Author comment on "How well does digital soil mapping represent soil geography? An investigation from the USA" by David G. Rossiter et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-80-AC2, 2021

SOIL-2021-80 Reply to CC1: Alex McBratney, 29 Sep 2021

The Authors October 28, 2021

We thank this group from the University of Sydney for their perceptive comments. We reply with the same headings as their comments.

1 Digital Soil Mapping

Both these colleagues and one reviewer prefer the more common term “digital soil mapping” to “predictive soil mapping”, making the argument that (1) DSM is the more common term, especially in recent highly-cited literature; (2) all maps are in some sense predictive. We accept this comment and will modify the text accordingly. We do still refer to the review by Scull, although his term “predictive” no longer appears in the text or title.

The commenters fairly summarize the main characteristics of the three DSM products; we feel this is well-explained already in the text.

2 Soil Geography

“The paper talks about soil geography. What might we mean by that? Gen- erally, it can be taken to mean the spatial distribution of soil entities or the evolution of the spatial distribution of soil entities.” Our meaning is the first, however, our “entitities” have been represented by soil properties, as explained next.

In the revision we will make it clear that discretization of continuous maps to level sets was a first approach to comparing the patterns of continuous maps. Of the DSM approaches evaluated, none predict classes. POLARIS does, giving the predicted probability of many classes (soil series). Soil Properties and Class 100m Grids of the United States (SPCG) also predicts classes, but at the level of Soil Taxomomy Great Groups, which may be 100’s of series. SoilGrids v2 does

not (yet) predict classes, and when it does these will likely be Reference Groups, perhaps with single qualifiers, in the World Reference Base (WRB) system.

So, comparing these patterns is not yet possible. Indeed it is an important research area: “Description of the spatial distribution of soil classes remains an underdeveloped area of pedometrics.” Since our classes are histogram-equalized reclassifications (i.e., ordinal classes), not nominal classes as in a soil classifica- tion system, we do not want to bring up this topic in this paper.

The commenters ask for “spatial methods that recognise continuity”. As pointed out, we used the variogram, and the reduced sill due to regression is not relevant to our comparison – we are not claiming the sill represents the original variables, rather (as pointed out) the predicted variables.

3 Ground Truth

We did not intend to use SSURGO as actual ground truth, and indeed we point out the various reasons why it may not be accurate, even in the context of its design scale. We are sorry that the paper gave this impression. In the revision we will modify the text in various places to make this clear. Notice that the first Reviewer stated “I fully support the idea of using local soil maps elaborated by experienced soil surveyors as an alternative (complementary) ground-truth, despite the well-known weakness of soil maps” and this was indeed our intention.

We did not mean to imply that "the final goal of DSM is to recreate a polygon map". No, we are interested in digital soil maps (per grid cell). We will review the text and adjust so as to remove this impression,

"The authors do not mention the intrinsic uncertainty of mapping units which are not homogeneous as a single polygon might suggest." We pointed out that polygons of SSURGO are linked to multiple constituents and estimates of their proportion.

"The North American mental model tends to focus most on soil topographic relationships whereas the digital soil mapping approaches are more explicitly multi-factorial." This is not the case. The USA model (we can not speak for Canada or Mexico) is explicitly multi-factorial, the main factors being (in- deed) topography, but also vegetation/land use and geomorphic relations (e.g., post-glacial features, playas or alluvial fans), and soil surface features visible on airphotos, e.g., salinity. Field surveyors use all these clues to locate point observations and, especially, polygon boundaries.

We agree that "to do a convincing [pointwise] comparison, it is important to have an independently observed dataset with which to compare the various representations". This is of course not feasible with our resources. We do have the point observations from NASIS but this is a heavily-biased sample set as it was mostly from purposive sampling of representative pedons, and of

course was used in the model building for all three DSM products. If our aim were to compare maps by their success at reproducing points, we could have done statistical evaluation on this set. However, our objective, as stated in the Introduction, is to evaluate the spatial pattern and relation to soil geography. For this the "ground truth" can not be a set of points, it must be some pattern. Hence our use of SSURGO.

"Ideally such a comparison of the various maps with the independent ob- served dataset will be made in a statistically robust way, i.e. through the use of probability sampling and design-based inference." Indeed if the aim is to evaluate success of point-wise predictions. But this is not our aim, and we will try to make the distinction clearer in the text.

We do know and use solar and Taylor diagrams for model evaluation, but again, these pointwise techniques are not applicable for our purpose.

4 The Way Forward

We agree that in many areas of the world with poor resources for systematic soil survey DSM is likely to be by far the most used method of making up-to-date soil maps. But we do not agree with this comment as it applies to the USA (our study area) nor other countries with active soil survey programmes. The position of the NRCS on this can be summarized as follows:

"We agree that modern soil survey draws heavily from the fields of DSM, applied statistical modeling, and numerical ecology. The final results from these methods may not always be in the form of gridded maps. For example, super- vised classification has been successfully used to check internal consistency of map unit concepts and assist with the placement of delineations (polygons). We believe that soil survey should blend the most applicable tools from traditional field survey and applied statistical methods, supported by pedologic theory and regional land use considerations."

We will add this or similar language to the discussion in the revised paper.

Please also note the supplement to this comment:
https://soil.copernicus.org/preprints/soil-2021-80/soil-2021-80-AC2-supplement.pdf