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Interactive comment on "Comparing three approaches of spatial disaggregation of legacy soil maps based on DSMART algorithm" *by* Yosra Ellili et al.

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Thank you for taking the time to review our manuscript. We will address the comments and revise the paper accordingly. Below reviewer's comments and our responses.

General comments

This paper focuses on testing if, and in which way, disaggregating legacy soil map is improved by adding supportive data in the procedure, i.e. soil legacy data and soil-landscape relationships deduced from local expert knowledge. The purpose of this study is important given the lack of accurate soil information in many regions of

the world. Those are particularly needed to better face the current process threatening/degrading soils. Moreover, some methods tested here could considerably help diminishing the time and cost for producing new accurate soil maps by reducing field work efforts. In my opinion, the manuscript is mostly well structured, logical, and the language correct. However, I have some concerns about the approach and the methodology.

Specific comments My concerns about this study join those highlighted earlier in the discussion by the referee Madlene Nussbaum. Indeed, the authors proposed to compare three methods of disaggregation, each based on the DSMART algorithm, and to test them on the Ille-et-Vilaine department. As far as I understand, the method 3 was proposed by Vincent et al. in 2018 who applied it to the entire Brittany (which includes the Ille-et-Vilaine department) using the same covariates (at the same resolution) and validation databases used here, but obviously at a bigger extent. Although Vincent et al. (2018) do not detail the results obtained by using the classical version of DSMART (i.e., the Method 1 here), they already visually compared the maps resulting from Methods 1 and 3 on a reduced area of Ille-et-Vilaine. The maps obtained here and in Vincent et al. (2018) showed that only âĹij 20 % of the validation data had been correctly predicted. The authors of the latter study already highlighted that adding the soil-landscape relationships (Method 3) did not substantially improve the results accuracy but tend to produce a more pedologically coherent map. Hence, the authors of Vincent et al. (2018) proposed different coherent ways to optimize the disaggregation procedure and improve its performance (through improving soil data, covariates, and predictive models). Here, the authors proposed to improve input data by combining DSMART algorithm to legacy soil data. Unfortunately, the legacy soil data are very largely outnumbered by the observations created artificially by the algorithm, limiting greatly their potential effect on the model performance. In this context, applying Method 2 is almost the same as applying Method 1. A weighing procedure should be implemented in the procedure for the Method 2. Considering the low performance of the different methods, I suggest the authors to dig in more in improving the procedure as suggested by Vincent et al. (2018) before applying a pairwise map comparative study. For example, the use of the legacy soil data could be optimized in Method 2 as proposed above and more complex and efficient ensemble tree methods could be tested (e.g., random Forest, cforest. . .) which have many advantages as, among others, integrated validation procedure and clear estimation of the respective variable importance in the model.

We thank Dr C. Chartin for the constructive feedback. As detailed below we have tried to address the reviewer's concerns about the methodology followed.

RESPONSE: The suggestion to give high weight to legacy soil profiles, which represent a small percentage of the virtual observations drown from the legacy soil map polygons (Method 2) is very relevant. However, the 755 extra soil profiles used to calibrate the model were already used to define the spatial boundaries of legacy polygons. Consequently, giving more weight to soil observations can bias predictions and overestimate the performance of this approach. May be the best way could be to use an independent soil dataset with extra soil profiles and giving more weight for the additional soil dataset. The objective of this study is not to select the best model that can be implemented in the DSMART algorithm to disaggregate legacy soil polygons as done by Moller et al., 2019 "Improved disaggregation of conventional soil maps". Our study aimed to assess the contribution of soil/landscape rules in the disaggregation procedure of existing legacy soil maps. Most of studies like Odgers et al, 2014, Holmes el 2015, emphasize the need of implementing expert-based rules in the original DSMART algorithm in order to improve the performance of prediction of soil types. However, as mentioned by Moller et al., 2019 no study has verified this hypothesis and assessed the real contribution of soil landscape rules in the disaggregation procedure nor how these rules can enhance the spatial characterization of soil distribution. To this end, we applied the same model as Vincent et al., 2018 at large spatial extend and we tried to characterize the differences between disaggregated soil maps generated by each DSMART based approach by using different validation approaches and pairwise

comparison method.

Technical corrections

l.143: Please, replace the underscore '_' by the dash '-' in "0_20 m" and "20_50 m".

Revised as suggested

l. 165-178: §2.2.2. 'Soil validation data' - As the existing detail maps define one of the three validation datasets, l. 173-174 should be aligned with l.167-172.

Revised as suggested

- The dataset extracted from 'Sols de Bretagne' is used for validation of M1 and M3 but also used as calibration datasets in M2: it has to be clear somewhere in the text.

RESPONSE: As suggested, we added the following sentence to clarify this point in line 297 "In this study, the validation dataset with 755 observations was used to assess the accuracy of digital maps derived from method 1 and method 3 and it was used as additional calibration dataset for method 2". This was also pointed out in the Figure 2, which presents the schematic of DSMART based approaches investigated in our study.

- Could you please precise what are the main characteristics considered by an expert to define a STU and how you converted legacy data points and vector maps to raster (l. 176-178)?

RESPONSE: The STU nomenclature respects the French soil classification system (Baize and Girard, 2008). It reflects different information at the same time like the weathering degree of soil parent material, the redoximorphic conditions, the soil type (referring to the identification of diagnostic horizons depicting pedogenetic processes), and the soil depth. This was clarified in the manuscript (Line 163-167).

We used Arc Toolbox from ArcGIS software to create a raster layer from punctual soil observations using the tool points to raster conversion. In our case, we never have 2 profiles in the same pixel of 50m.

We also used Arc Toolbox from ArcGIS software to create raster maps from accurate maps using the tool polygon to raster conversion and we selected the assignment type "Most Frequent", and a cell size of 50 m.

l. 277-291: The validation procedure should be more explicit and maybe improved by computing one or two more parameters in order to better apprehend the performance of the models.

RESPONSE: Most of studies that applied DSMART algorithm like Odgers et al., 2014, Holmes el 2015, Chaney et al., 2016, Jamshidi et al., 2019; Moller et al., 2019, Zeraatpisheh et al., 2019 have computed the same validation measures “the overall accuracy”. Moreover, only few studies like Chaney et al., 2016, Vincent et al., 2018 have considered pixel neighbored, as we done in our study, to compute validation measures with some flexibility.

In a recent publication entitled “Validation of digital soil maps derived from spatial disaggregation of legacy soil maps” (Ellili-Bargaoui et al, 2019, https://doi.org/10.1016/j.geoderma.2019.113907), we developed a validation strategy to validate STU maps, single classification criterion maps (parent material, soil depth, soil drainage class, soil type) and continuous soil property maps using an independent dataset, selected by stratified random sampling design.

l. 179-200: §2.3 ‘Soil covariates’ Please, could you quickly justify the choice of the covariates used in this procedure, and maybe make a parallel with the characteristics considered for defining STU?

RESPONSE: The selection of covariates was based on a prior knowledge of the study area and its soil forming factors particularly the parent material and some topographic characteristics like the elevation. This choice was also based on previous studies carried out over the same study area like Lacoste et al. 2011, Lacoste et al. 2014, Lemercier et al. 2012. Moreover, some soil covariates particularly soil parent material and soil drainage characteristics are also used to define STU.

- The TPI and waterlogging parameters are categorized here. I understand that it facilitates the computation of the soil landscape relationships, but have you try to input the continuous versions of these parameters in the models?

RESPONSE: Like Vincent et al, 2018, we have used a TPI based landscape classification, which classifies the landscape into 5 classes: ridges, upper slopes, steep slopes, gentle slopes, lower slopes and valleys. In our study, we do not use the continuous version of the TPI to calibrate the model, but we expect found similar results.
- The landscape unit parameter is an aggregation of vegetation, land use and relief attributes. Why did you prefer to use one aggregated layer instead of more accurate maps about land use, vegetation and relief attributes? Is there a significant correlation between all of these parameters? Is it in order to take into account the landscape morphology at different scales, i.e. main features with the Landscape units and then local features within thanks to more accurate relief attributes layers?

RESPONSE: The landscape classification resulting from a supervised classification of MODIS (MODerate resolution Imaging Spectroradiometer) imagery (Le Du-Blayo et al., 2008). This landscape classification particularly focuses on agricultural land use and spatial organization, considering not only land cover and relief, but also elements of the landscape as the network of hedges. It allowed considering the landscape morphology and capturing the main landscape and local feature of our study area. Until now, there is no more accurate exhaustive information on landscape units taking into account spatial organization of the agricultural land.

l. 256: Could you precise which proportions of the 18,320 samples used in the Method 3 are derived from expert knowledge and from the random selection implemented in the DSMART algorithm?

RESPONSE: The number of samples from the expert rules can be easily deducted. In the line 266 of the manuscript, we specified that for each realization 18, 320 samples were generated, where 14,370 virtual points are randomly selected (line 220). Therefore 18,320 – 14,370 = 3950 points were derived from expert knowledge. As requested, this was clarified and pointed out in the manuscript (Line 266-268).

Figure 1: Please, reduce the size of the dots or change to triangles. Precise the scale of the detail maps.

Revised as suggested.

Figure 3: Please, could you precise the names of the STU in the legend or in the caption.

Revised as suggested.

Figure 6: Please, add the x-axis labels.

The x-axis labels correspond to STU ordered by increasing cumulative area as mentioned on the Figure.

Figure 7: Please, harmonize the covariate names with main text.

Revised as suggested.

Many thanks for your suggestions that allowed us to improve our paper.

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