Dear Reviewer 1,
We appreciate the time and effort you dedicated to thoroughly reviewing our manuscript and offering suggestions for improvement. Below, we outline how we plan to address the raised issues. We reference your comments followed by our corresponding responses. The changes that would be applied to the manuscript text are highlighted in blue and are visible in the uploaded PDF version of this text.

COMMENT 1
L40. Why information on hydraulic properties is often lacking. Particularly, now that the EU Commission proposes the Soil Monitoring Law and such attributes can be important for soil health. By the way, you did not mention anything in your manuscript about soil health. How those attributes are linked to Soil health and how to be used to estimate soil health?

ANSWER 1
1.1 We will revise that sentence in the following way:
"The basic soil properties, i.e., soil organic carbon content, particle size distribution, in most cases are locally available at high resolution (< 100 m), but information on bulk density, albedo, soil erodibility factor, soil hydraulic properties, and soil nutrient content is often lacking."
The reason for the above is that some of these properties are difficult to measure and/or too dynamic (like soil nutrients) and/or not relevant enough in some common applications (e.g. soil albedo is not important in daily agricultural management).

1.2 Soil hydraulic properties are important determinants of soil health as they influence water availability, soil structure, nutrient transport, gas exchange, and surface runoff. For soil health, the threshold values of its indicators might be interdependent. This needs an in depth description which is beyond the scope of this MS. Therefore we might not go into details, but mention soil health in the abstract and under conclusions to show that analysed soil properties are important to assess soil health.
We will highlight soil health in the first sentence of the abstract:
"To effectively guide agricultural management planning strategies and policy, it is important to simulate water quantity and quality patterns and quantify the impact of land use and climate change on soil functions, soil health, hydrological, and other underlying processes."
In the last paragraph of the Conclusions we will add the following text:
"The workflows and findings presented in the study offer practical guidance for model setup and data preprocessing in various modelling endeavours across Europe, such as hydrological simulations, assessment of soil health, land evaluation, crop modelling, and analysis of soil erosion risk among others."

COMMENT 2
Table 1 is not easily readable as proposed. I would propose to have a landscape format and add also a column as Reference. Practically, transfer the reference from first column to the new one. Some corrections are also necessary:
2.1 It is European Union (EU). Of course if you state Member states is similar but more precise to refer to the EU.
2.2 In Soil hydraulic or Physical data , you can add (as there are new datasets that have not been taken into account in your analysis ; such as the Bulk density in the EU and the Global K-factor:

1. https://esdac.jrc.ec.europa.eu/content/topsoil-physical-properties-europe-based-lucas-topsoil-data *** Clay, silt and sand content; coarse fragments; bulk density; USDA soil textural class; available water capacity. Resolution 500m. as in Ballabio et al., 2016
2. https://esdac.jrc.ec.europa.eu/content/chemical-properties-european-scale-based-lucas-topsoil-data *** pH, pH (CaCl), Cation Exchange Capacity (CEC), Calcium carbonates (CaCO3), C:N ratio, Nitrogen (N), Phosphorus (P) and Potassium (K) as in Ballabio et al., 2019
3. https://esdac.jrc.ec.europa.eu/content/soil-bulk-density-europe ****** Soil Bulk density in Europe as in Panagos et al., 2024
4. https://esdac.jrc.ec.europa.eu/content/global-soil-erodibility ***** The Global K-factor of Gupta et al. 2024

Those are different that LUCAS. You mentioned LUCAS but those datasets are derived through LUCAS with Machine learning.

ANSWER 2

Thank you for the suggestions, we will format it to landscape and move references into a separate column.
2.1 We will correct it.
2.2 Thank you for the suggestions we will add these four datasets to Table 1.

COMMENT 3

L116-117: in this place and other places of the manuscript. You mentioned this sentence but you have to admit that also application of PTF has a huge uncertainty and it not proper for all different pedo-climatic regions of Europe. EU is so diverse that the just one PTR is not the valid approach for the whole EU. Your statements such as this one as so strong and negative towards other estimations or assessments. In general, I would suggest a more multi-model approach where assessments based on machine learning or interpolations can be compared or assessed together with assessments of PTF.

ANSWER 3

Here we intended to draw attention on not combining local basic soil data with continental or global soil hydraulic maps, but use local basic soil data and derive the missing properties from that to keep consistency in the data (locally available and the derived one).
We will modify lines 116-118:
"Where local soil maps with soil layering, organic carbon content, clay, silt, and sand content are available, it is suggested that missing soil properties, such as bulk density, soil hydraulic properties, and albedo are estimated from the locally available basic soil properties to ensure consistency."

We agree that PTFs have uncertainty, especially when those are applied on soils which have specific soil characteristics, e.g.: specific clay mineralogy, high exchangeable sodium content, high organic carbon content, which overrides the influence of basic soil properties on soil hydraulic characteristics. We will add the following text to highlight it:
"The predictions are subject to uncertainty, which depends on the similarity between the training data used for the selected prediction method and the target area in terms of soil physical and chemical characteristics (Román Dobarco et al., 2019; Tranter et al., 2009)."
We will modify line 129 :
"For the selection of the prediction approaches, three requirements had to be fulfilled: i) the prediction algorithm had to be trained on temperate soils and should not be specific to a particular soil reference group, …"

Our aim is to provide workflows which could be easily applied anywhere in Europe. Using ensemble approach or geostatistical methods is out of the scope of this study, but we will add under conclusions (before the last sentence) the following text:
"The presented workflows could be further improved by using a multi-model approach and applying geostatistical methods."

COMMENT 4
The evaluation of your results takes place using the EU-HYDI . This database as you state is not publicly available. This is really odd and not transparent. Others do European assessments (Soil Grids, ESDAC) or Global assessments but the point data (LUCAS, global point data) are available. Therefore, the approaches are transparent and everybody can test them.

ANSWER 4
The reason for using EU-HYDI for this study is that it is the most representative soil hydraulic dataset for Europe that we could use for this study. The internal use and no external openness of the dataset has been requested by the data providers during the establishment of EU-HYDI, which was initiated and coordinated by EC Joint Research Centre (JRC) in 2013. Some contributors have given the JRC licence to distribute their raw data publicly on the European Soil Data Centre. Based on information from JRC it will soon be available from ZENODO. Information about data availability is provided here: https://github.com/melwey/euhydi_public . We will add this information under "Data availability" section as soon as the link will be available from JRC:
"6,583 samples of 1999 soil profiles, summing up to 35 % of the EU-HYDI dataset is available from ZENODO DOI LINK. The entire dataset cannot be made publicly available due to its legal restrictions."
And add information about the LUCAS dataset:
"LUCAS TOPSOIL data can be accessed through European Soil Data Centre (ESDAC) (European Commission Joint Research Centre, 2024; Panagos et al., 2012, 2022). Local measured topsoil phosphorus data is private, only results of analysis and derived information can be published."

COMMENT 5
In Bulk density, the BD of Hollis is not so simple. Hollis has proposed different PTF per different land uses. Therefore, please pay attention in this use. In addition, as mentioned before, you ignored the recent public assessment of EU Bulk density with 6,000 points available (to download).

ANSWER 5
Thank you for pointing out that Hollis derived more PTFs, we will use the PTFs derived for "cultivated topsoils", "all other mineral horizons" and "all organic horizons" based on the suggestion of Hollis et al. (2012). We will rerun the BD PTF analysis on the LUCAS point BD dataset, as well.

COMMENT 6
For K-factor, the most used function is the by Wischmeier and Smith (1978) and Renard et al. (1997) (as described in Panagos et al., in Eq. (1)).
You use a different equation and then you try to compare your results with the ones which have used the Renard equation. This is a little bit odd.

ANSWER 6

We would like to compare soil erodibility factor values which are derived in different ways, i.e. with the equation and retrieved from the European map to analyse the difference. We believe that this is informative for the readers who are not familiar with the computation of soil erodibility and very interesting to see the differences. The differences in the results can highlight the importance to use the appropriate equation for the computation or treat the erodibility factor as a parameter that has to be further tuned in the model calibration.

Our aim was to use only those equations which can be readily applied for the soil properties most frequently available and not use the ones that require non-easily available soil properties, such as soil structure or permeability. The Renard et al. 1997 equation fits into this logic, therefore we will add K factor computed with it (K_computed_Lenard) and compare its result with the methods already included.

COMMENT 7

In 2.4, for P it is not only the fertilization which plays a role. The available P in soils is a combination of P inputs (Fertilizers, manure, atmospheric deposition, chemical weathering) and outputs (plant uptake, plant residues , erosion). Therefore P level is not influenced only by fertilization. Please be careful and change as appropriate!

ANSWER 7

Thank you for the suggestion. We will modify it with the following text:

"The available P level in agricultural soils is influenced by the P inputs – fertilizers, manure, atmospheric deposition, chemical weathering – and outputs – plant uptake and erosion. The agricultural management practices (Tóth et al., 2014) are determined by factors such as the country's economy, climate, tillage practices, and crop production characteristics."

COMMENT 8

In soil chemical parameters, authors do not explain why not N and K?

ANSWER 8

Organic nitrogen could be computed from soil organic carbon, but its inorganic part is variable in space and time, therefore it is complex to predict it. We have a paragraph on N at the end of section 2.4. There we explain why we do not consider inorganic N. Potassium is not typically included or computed in environmental models, therefore we did not add information on K.

We will modify line 325 of the manuscript:

"Organic nitrogen can be estimated from soil organic carbon content (Amorim et al., 2022; Liu et al., 2016; Pu et al., 2012; Zhai et al., 2019) if measured data are not available. The concentration of inorganic nitrogen in soil is …"

COMMENT 9

In section 3.1, the performance of BD PTF is not valid as I explained my problematic for the Hollis eq (which is not used properly).

In addition, why you do not test the PTFs against the LUCAS 6000 measured data which are publicly available?

ANSWER 9

Thank you to point it out. We have received the data from EC JRC and will perform the analysis.

COMMENT 10

The problematics on 3.3 have also described above as your results tend to compare non comparable stuff (different equations used!!!).

ANSWER 10

Our aim is to compare different methods for deriving soil erodibility data. We believe it would be informative for readers to see the variation in derived soil erodibility values when using either an available soil erodibility map or an equation. This information will show that these predicted values could be used as preliminary approximations and need for K calibration.

We will add the following modification of line 425-427:

"While both can be used for environmental modelling, i) European soil erodibility map could be linked with LUCAS topsoil dataset and maps, ii) employing Eq. (17) might offer greater consistency with the other local basic and physical soil data, aligning more seamlessly with the modelling process."

COMMENT 11

In 618-619: you refer to something that it is too obvious. IF there are local data, of course they are better. The case is how to cover the data gaps in case local data are not available? That is why I have proposed a multi-model or multi-data source assessment?

ANSWER 11

We will delete the sentence with that obvious statement (starting with "In summary, …"). As mentioned under our ANSWER 3, the aim of this study is to present easy to apply methods. Combining P map derived based on European data with locally measured data fits the idea of multi-data source solution, therefore we will add it to line 622:

"Where available, it is recommended to use measured data to overwrite the geometric mean values, creating a multi-data source solution that reflects the spatial pattern of nutrient content within arable land areas."

COMMENT 12

Similar in your conclusions L653. It is too obvious!

ANSWER 12

We agree, therefore we will delete that sentence and modify lines 654-655 in the following way:

"Local data tend to retain finer soil details, hence it is recommended that users prioritise the utilisation of local (national) soil databases when it is deemed representative and reliable."

COMMENT 13

L675-685: you cannot propose this as the only way forward without making available your reference dataset (EU-HYDI)!!!

ANSWER 13

We intended to write that the methodology can be applied on other databases as well. We will modify the sentence in the following way:

“The study’s methodology can be applied for soil databases not only in Europe but also in other regions or global datasets, …”

COMMENT 14

L16: which are the underlying processes?

ANSWER 14

We will add some examples for the underlying processes:

“ … it is important to simulate water quantity and quality patterns and to quantify the impact of land use and climate change on soil functions, soil health, hydrological, and other underlying processes.”

COMMENT 15

L28-29: why there an significant increase of available datasets?

ANSWER 15

We will modify that sentence in the following way:

“The availability of raw and derived soil datasets, specifically soil hydraulic data, has increased significantly in Europe over the last 10 years as a result of the Soil Strategy and Soil Monitoring Law proposed by the EU Commission.”

COMMENT 16

L159: Not only different methods but also through different ISO protocols, depths, etc and in different laboratories which sometimes is impossible to compare.!!

ANSWER 16

We agree.

We will add ISO protocols in L159-160:

“Different countries and institutions measure sand, silt, and clay content using different ISO protocols and methods by recognizing different cutoff limits and classification standards.”

COMMENT 17

L325: It is nitrogen

ANSWER 17

Here we would like to refer to inorganic nitrogen forms, which are more soluble in water, therefore are more susceptible to leaching and loss through processes like denitrification, volatilization, and leaching. We will modify lines 325 and 326:

“The concentration of inorganic nitrogen in soil is highly variable in space and time and the dynamic of its amount is significantly influenced by leaching, denitrification, volatilization, and nitrogen fertilization (Zhu et al., 2021).

REFERENCES ADDED IN THE DOCUMENT:

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Liu, M., Ussiri, D.A.N., Lal, R., 2016. Soil Organic Carbon and Nitrogen Fractions under Different Land Uses and Tillage Practices. Commun. Soil Sci. Plant Anal. 47, 1528–1541. https://doi.org/10.1080/00103624.2016.1194993

Pu, X., Cheng, H., Shan, Y., Chen, S., Ding, Z., Hao, F., 2012. Factor controlling soil organic carbon and total nitrogen dynamics under long-term conventional cultivation in seasonally frozen soils. Acta Agric. Scand. Sect. B Soil Plant Sci. 62, 749–764. https://doi.org/10.1080/09064710.2012.700318

Román Dobarco, M., Cousin, I., Le Bas, C. and Martin, M. P.: Pedotransfer functions for predicting available water capacity in French soils, their applicability domain and associated uncertainty, Geoderma, 336(April 2018), 81–95, doi:10.1016/J.GEODERMA.2018.08.022, 2019.

Tranter, G., McBratney, a. B. and Minasny, B.: Using distance metrics to determine the appropriate domain of pedotransfer function predictions, Geoderma, 149(3–4), 421–425, doi:10.1016/j.geoderma.2009.01.006, 2009.

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