Food and Agriculture Organization of the United Nations

Global assessment of soil carbon in grasslands

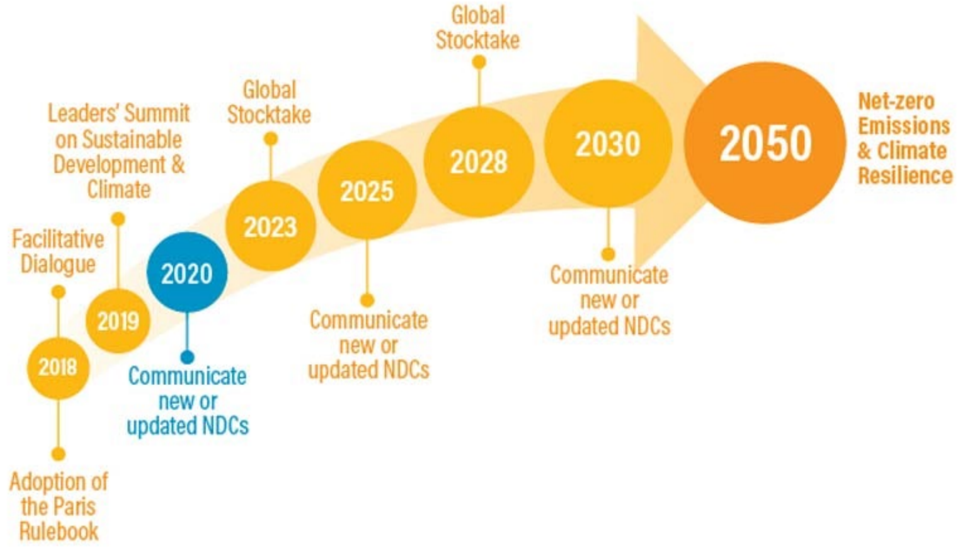
From current stock estimates to sequestration potential

Rome, 29 March 2023
Dr. Marta Dondini

Background

The adoption of the Paris Agreement in 2015 paved the way for countries to commit to the international response to climate change through the transition to a low-emission economy and the development of a climate-resilient future

Ambition Mechanism in the Paris Agreement



Source: wri.org/publication/NDC-enhancement-by-2020

WORLD RESOURCES INSTITUTE

Background

a) animal-source foods,
b) nutrition, health and well-being,
c) reduce GHG emissions,
d) food security.

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Key points of constraint that regulate the transfer of carbon inputs into stabilized SOM

(1) carbon inputs

(2) biomass export by grazing or cutting

(3) retention into different pools for SOM formation

(4) carbon loss from SOM decomposition

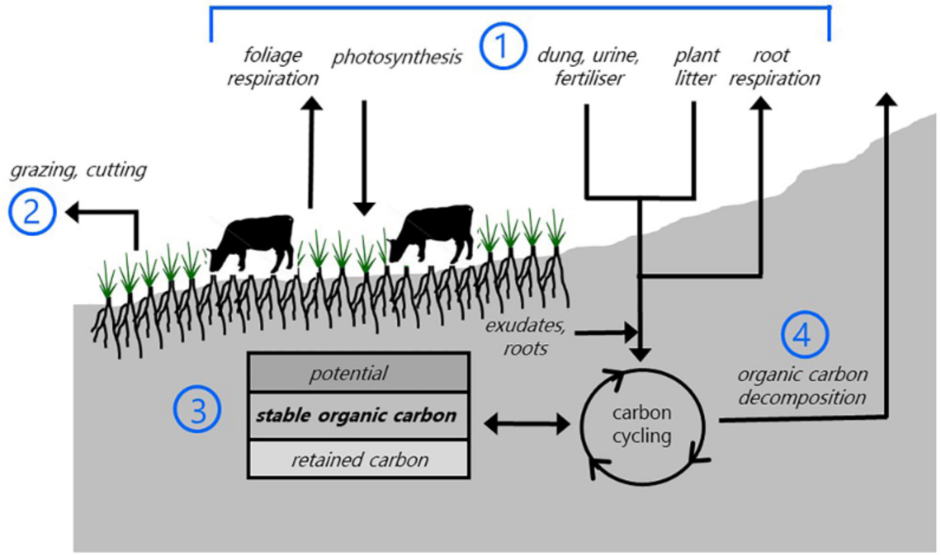


FIGURE 1 | Conceptual diagram of the components of carbon balance and the four key points of constraint that regulate the transfer of carbon inputs into stabilized soil carbon in a grazed system: (1) carbon inputs, (2) biomass export by grazing or cutting, (3) carbon retention as stabilized organic compounds to form soil organic matter, and (4) decomposition of soil organic matter to release carbon.

Whitehead D (2020) Front. Sustain. Food Syst. 4:585913.

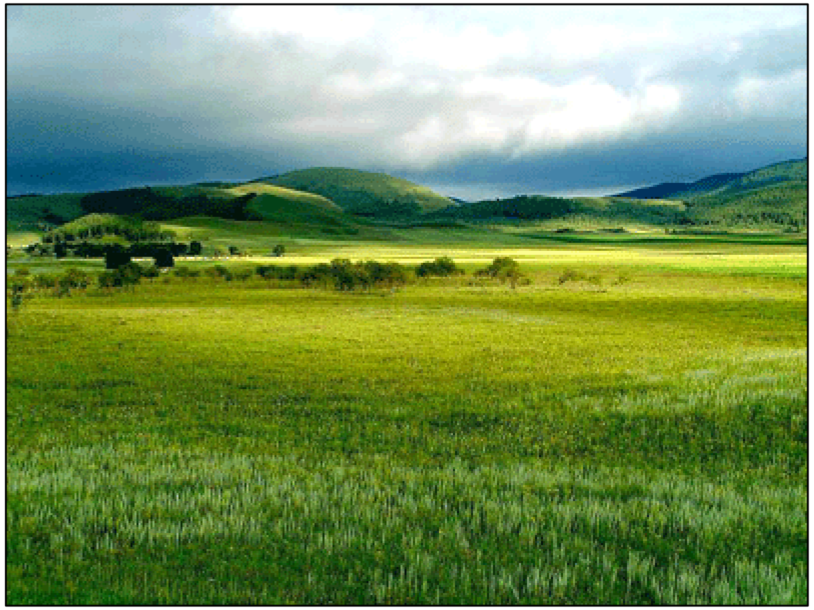
Practices to increase soil carbon storage

High potential

- Moderate/lower grazing
- Rotational grazing
- Reduced stocking rates or tactical rests

Medium potential

- Introducing legumes
- Increasing sward diversity
- Reduce cutting intensity
- Dung returns



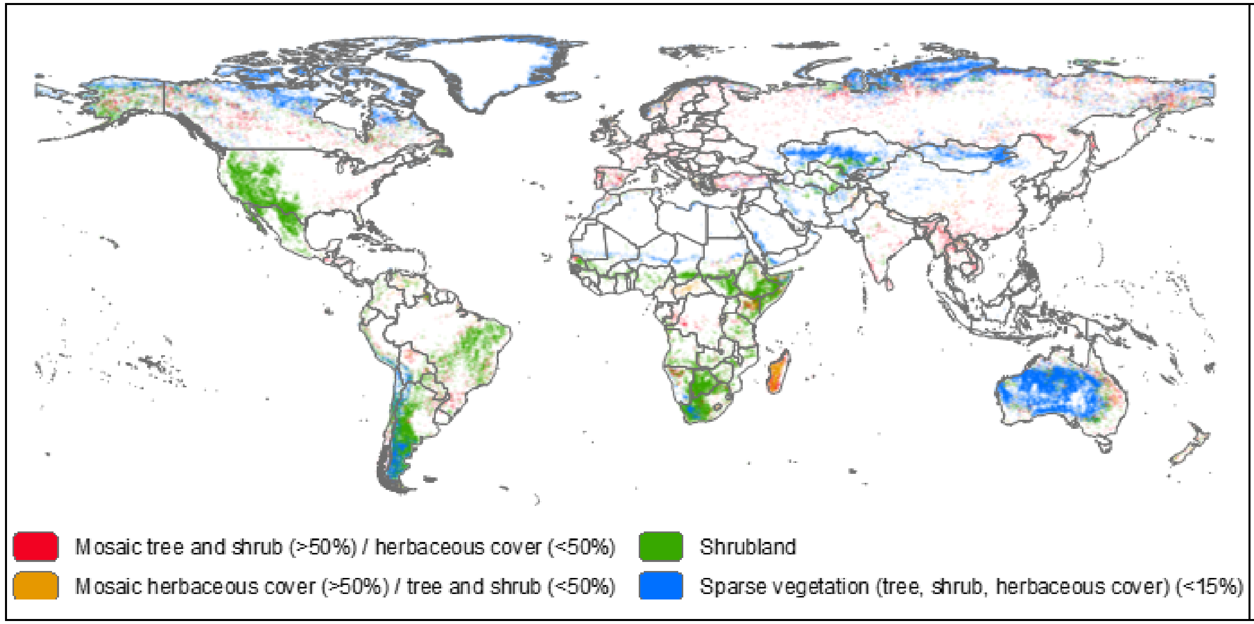
https://biomesinourworld.weebly.com/grassland.html

Objectives of the assessment

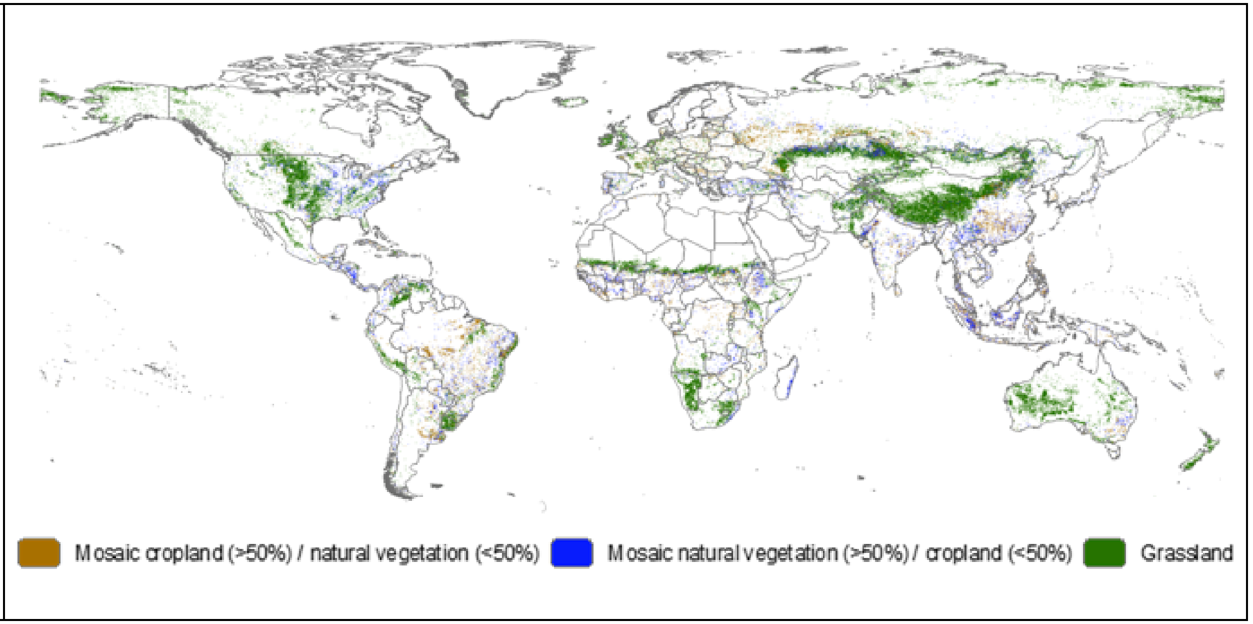
- To estimate the baseline SOC stocks of grasslands in the year 2010
- To assess the carbon input levels needed to maintain current SOC stocks, and
- To determine if such carbon input is available under current conditions
- To estimate the SOC sequestration potential of grasslands if management practices known to improve SOC sequestration are implemented worldwide.

Grassland definition & distribution

unimproved

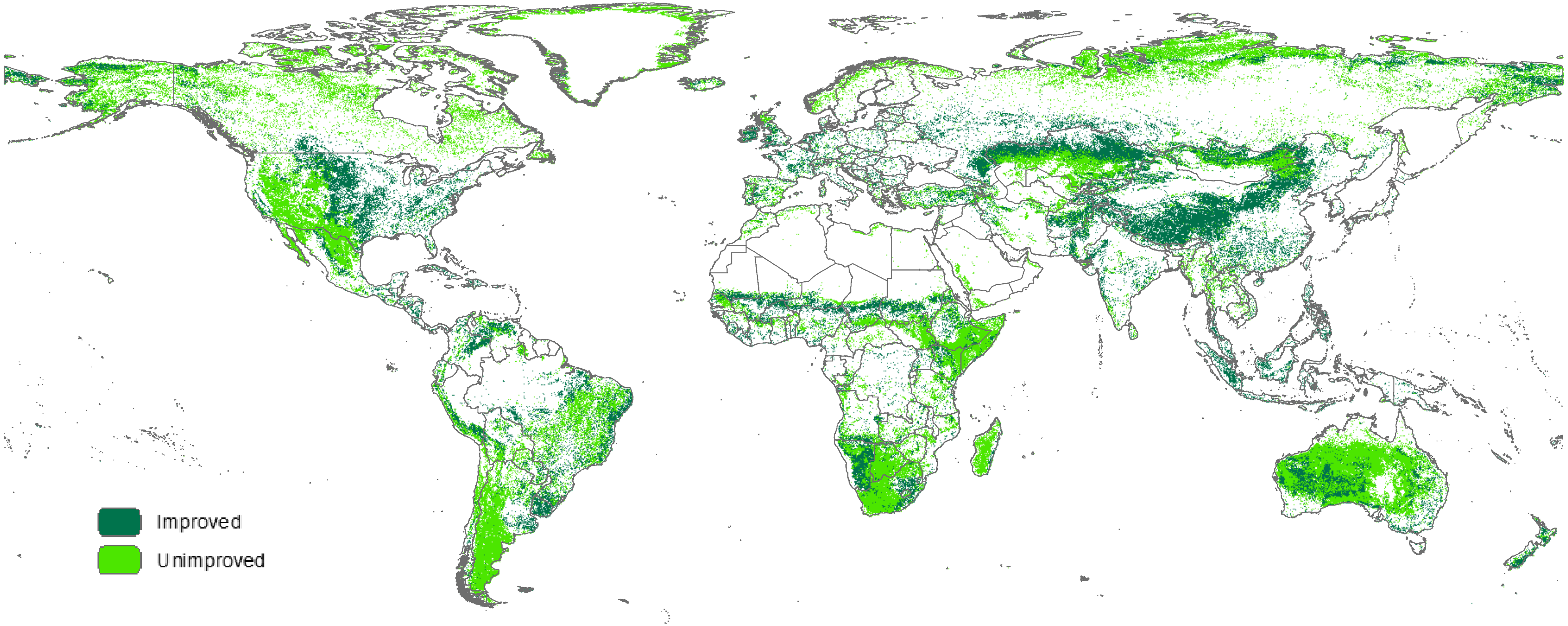


improved



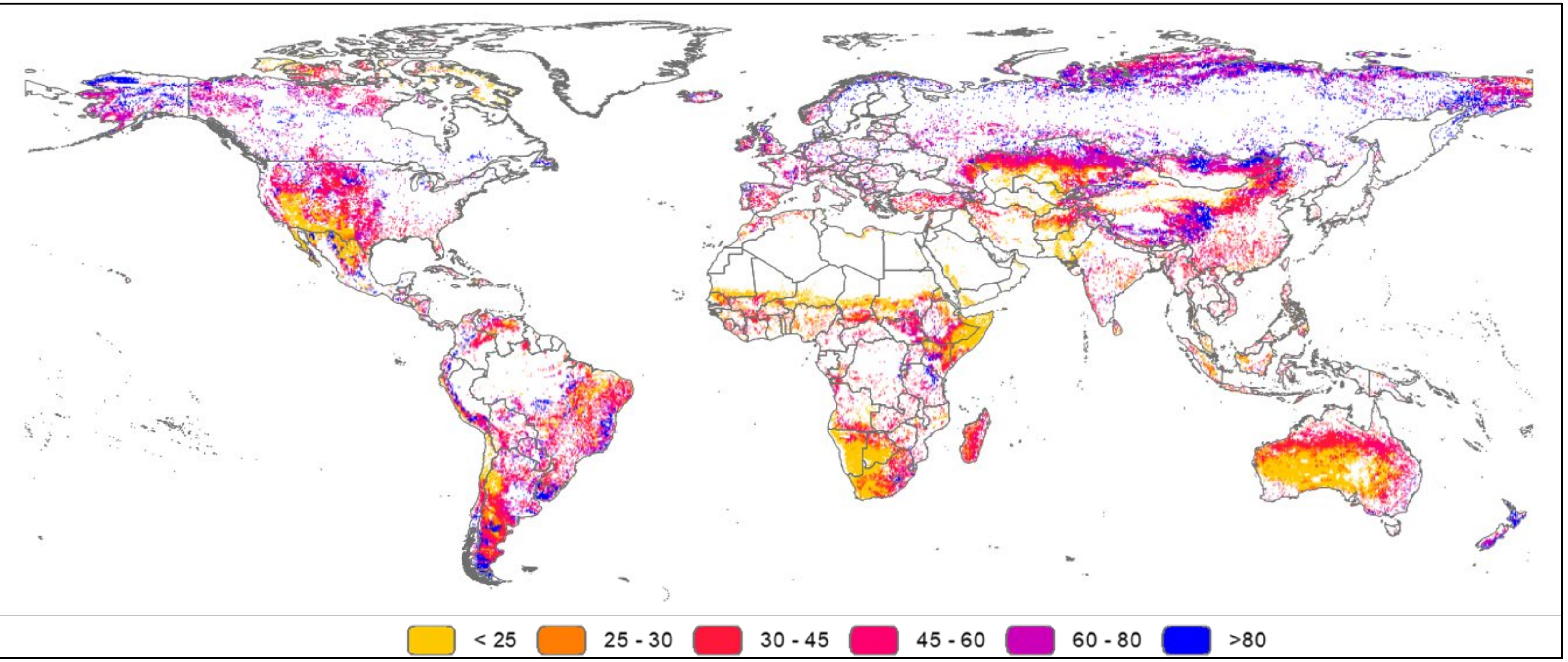
Source: ESA, 2017. Land Cover CCI Product User Guide Version 2. Tech. Rep. Cited 21 July, 2021. https://maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf

Grassland distribution



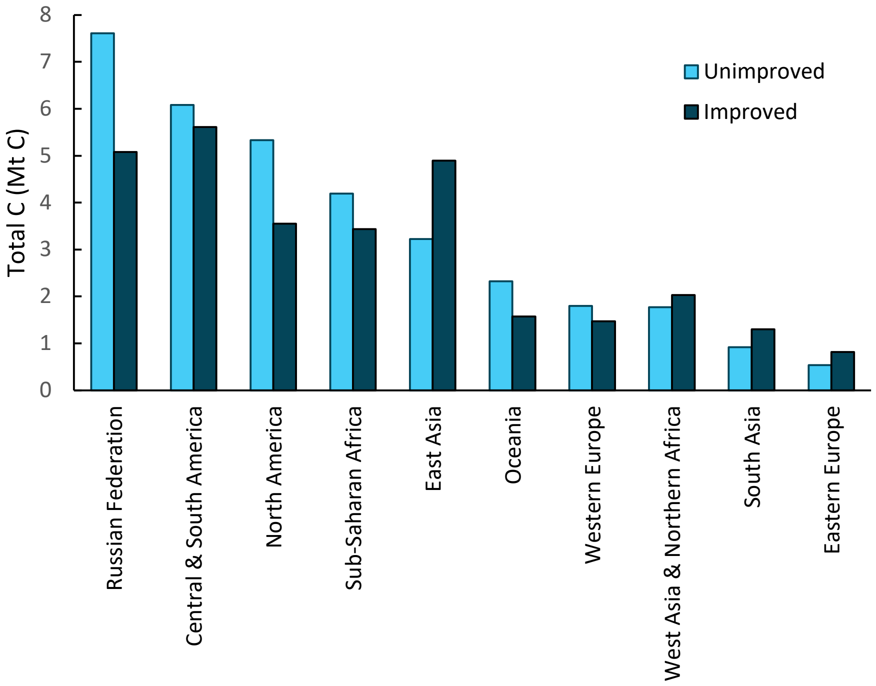
Source: United Nations Geospatial. 2020. Map of the World. United Nations. Cited 22 August 2022. www.un.org/geospatial/file/2285/download?token=puayKYRA modified with data from ESA, 2017.

Baseline soil organic carbon stocks (tonnes C/ha) 0-30 cm soil depth



Source: United Nations Geospatial. 2020. Map of the World. United Nations. Cited 22 August 2022. www.un.org/geospatial/file/2285/download?token=puayKYRA modified with data from Coleman.

Regional total (cumulative) soil organic carbon estimated for the year 2010



Source: UN. 2020. Map of the World, modified with data from Coleman, K. & Jenkinson, D.S. 1996. RothC-26.3 - A Model for the turnover of carbon in soil. In: Powlson, D.S., Smith, P., Smith, J.U., eds. Evaluation of Soil Organic Matter Models. NATO ASI Series, 38: 237-246. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-61094-3_17

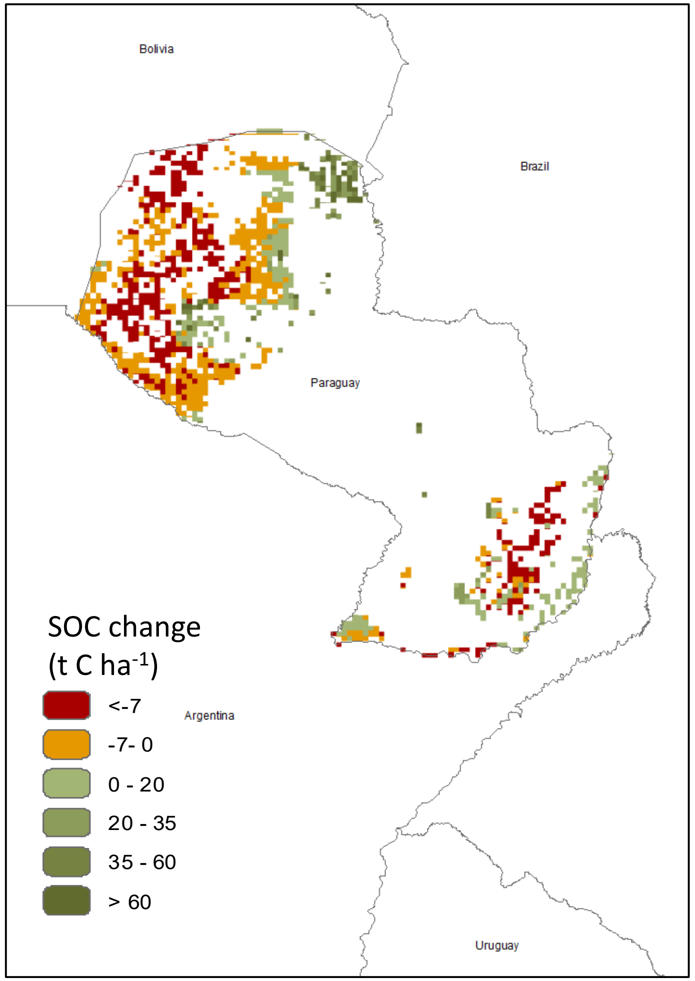
Case study – Paraguay

Intervention: pasture intensification

Changes compared to baseline:

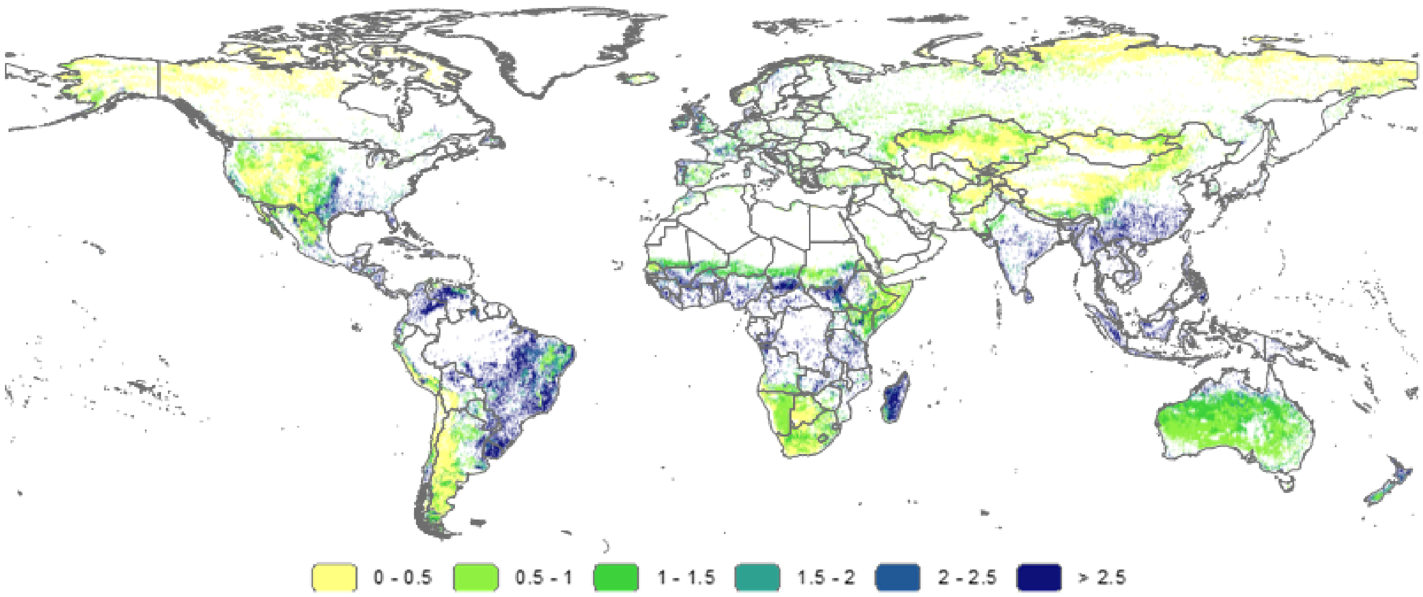
- Increase in biomass yield
- Change in feed intake
- Application of synthetic N fertilizer

change in C input to the soil



Source: United Nations Geospatial. 2020. Map of the World. United Nations. Cited 22 August 2022. www.un.org/ geospatial/file/2285/download?token=puayKYRA modified with data from Coleman and Jenkinson, 1996.

Carbon inputs (t C ha^{-1} yr^{-1}) needed to maintain current SOC level



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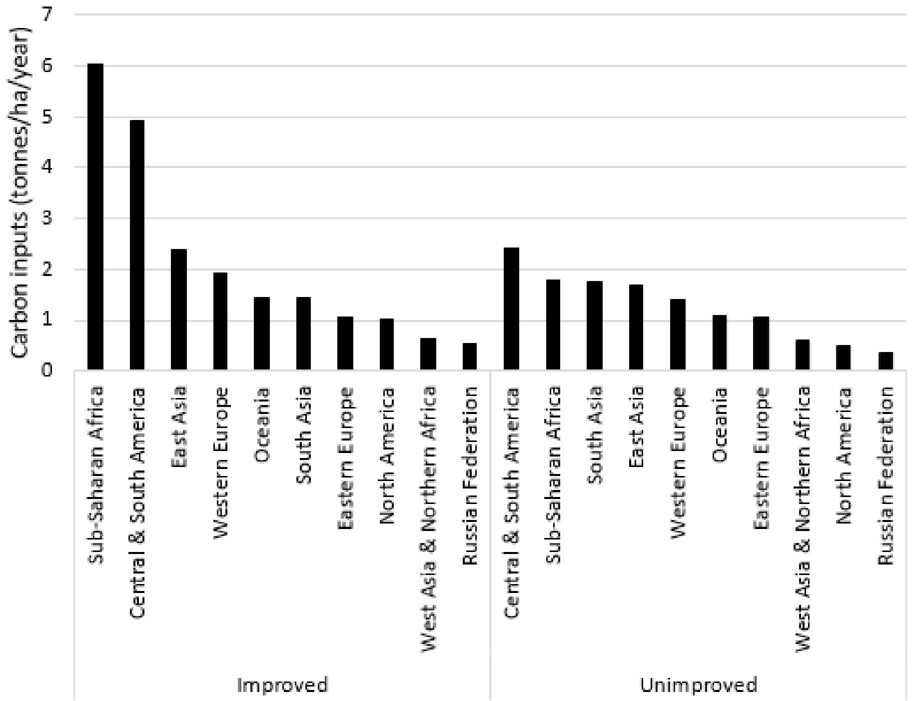

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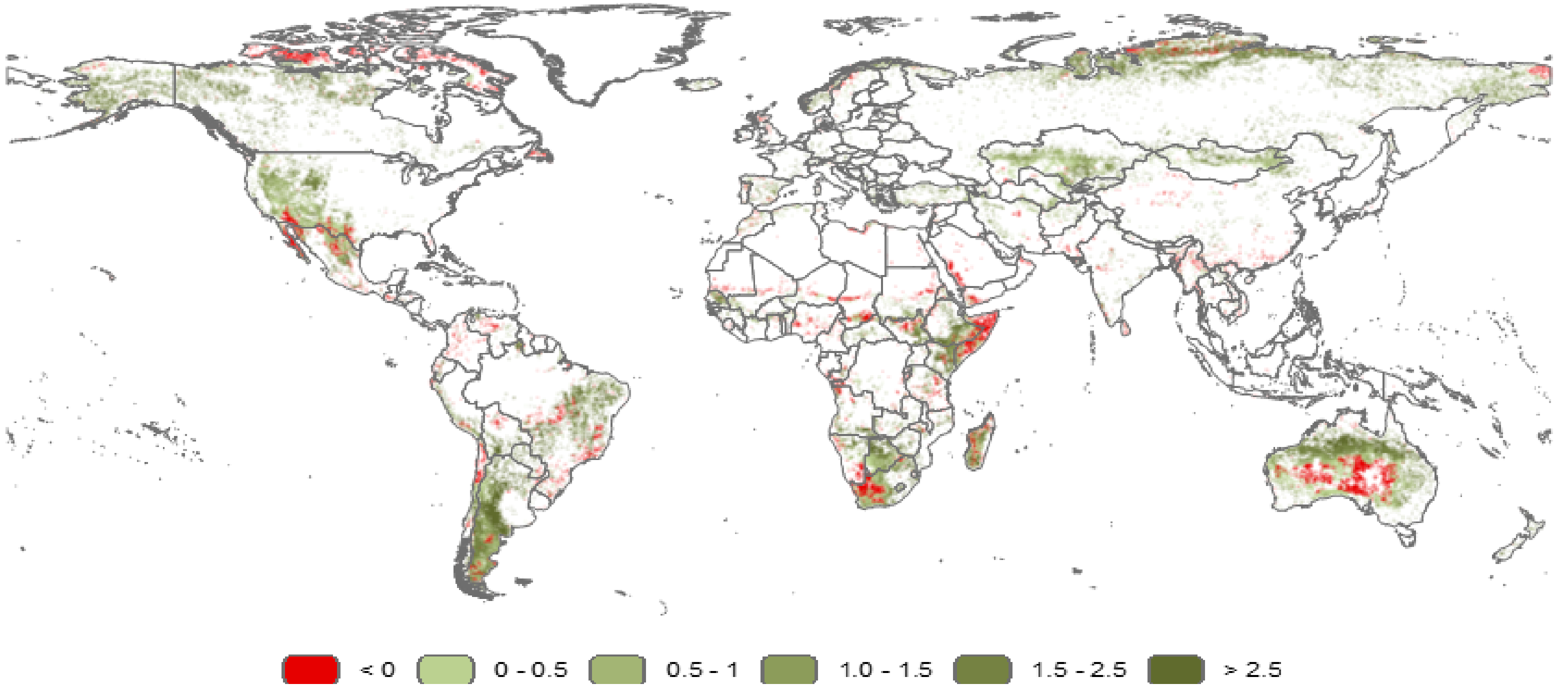
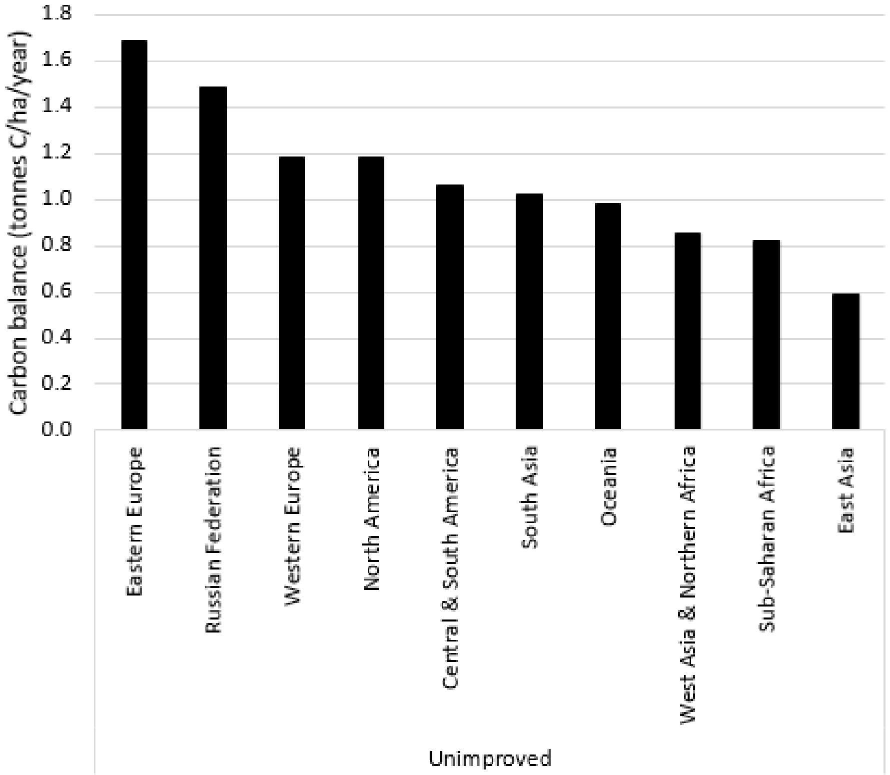
Carbon balance (t C ha^{-1} yr^{-1}) - unimproved



Note: negative values indicate that current stocks cannot be maintained. Carbon balances were calculated under current climatic conditions. Source: United Nations Geospatial. 2020. Map of the World. United Nations. Cited 22 August 2022. www.un.org/geospatial/file/2285/download?token=puayKYRA modified with data from Coleman and Jenkinson, 1996.



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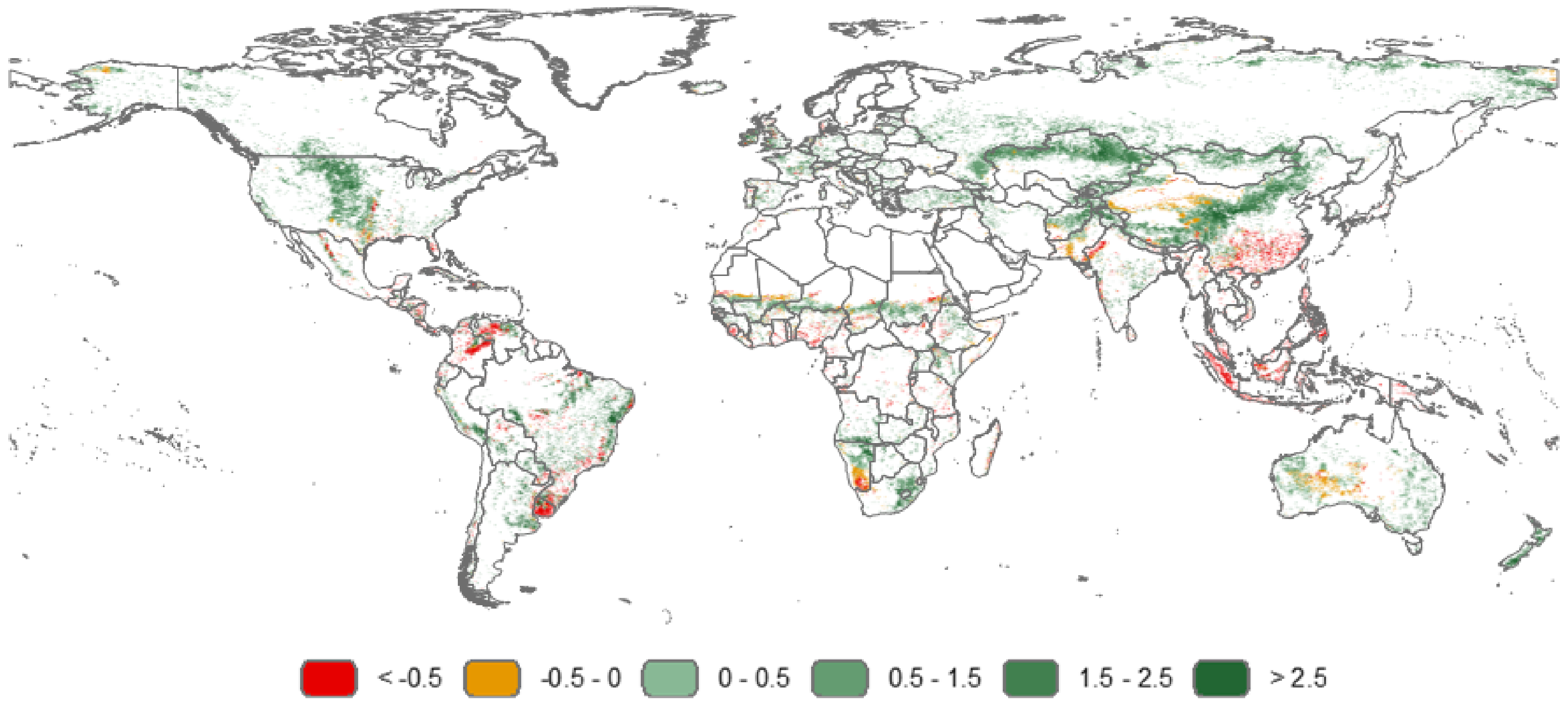
Carbon balance (t C ha^{-1} yr^{-1}) - inproved



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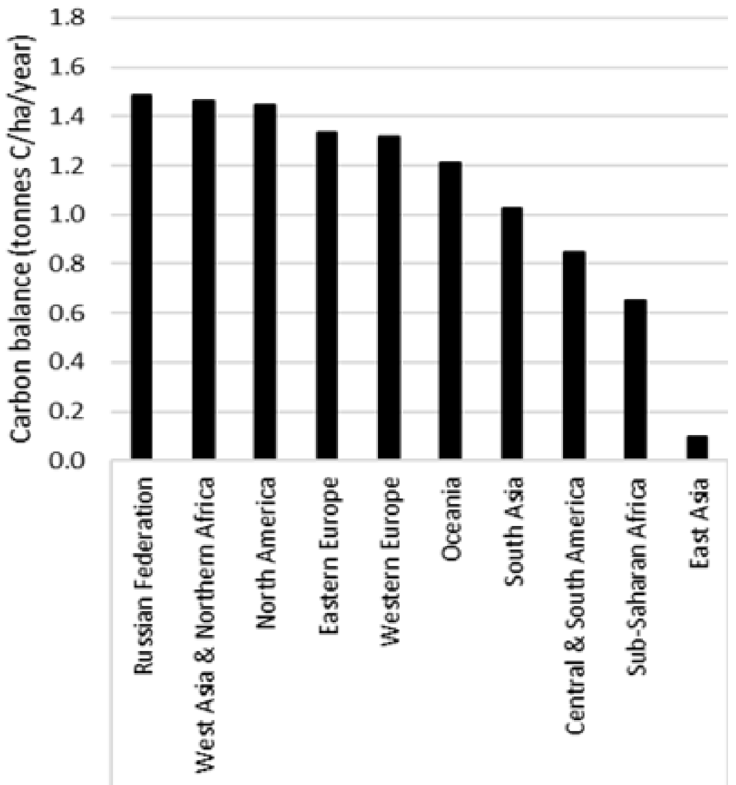

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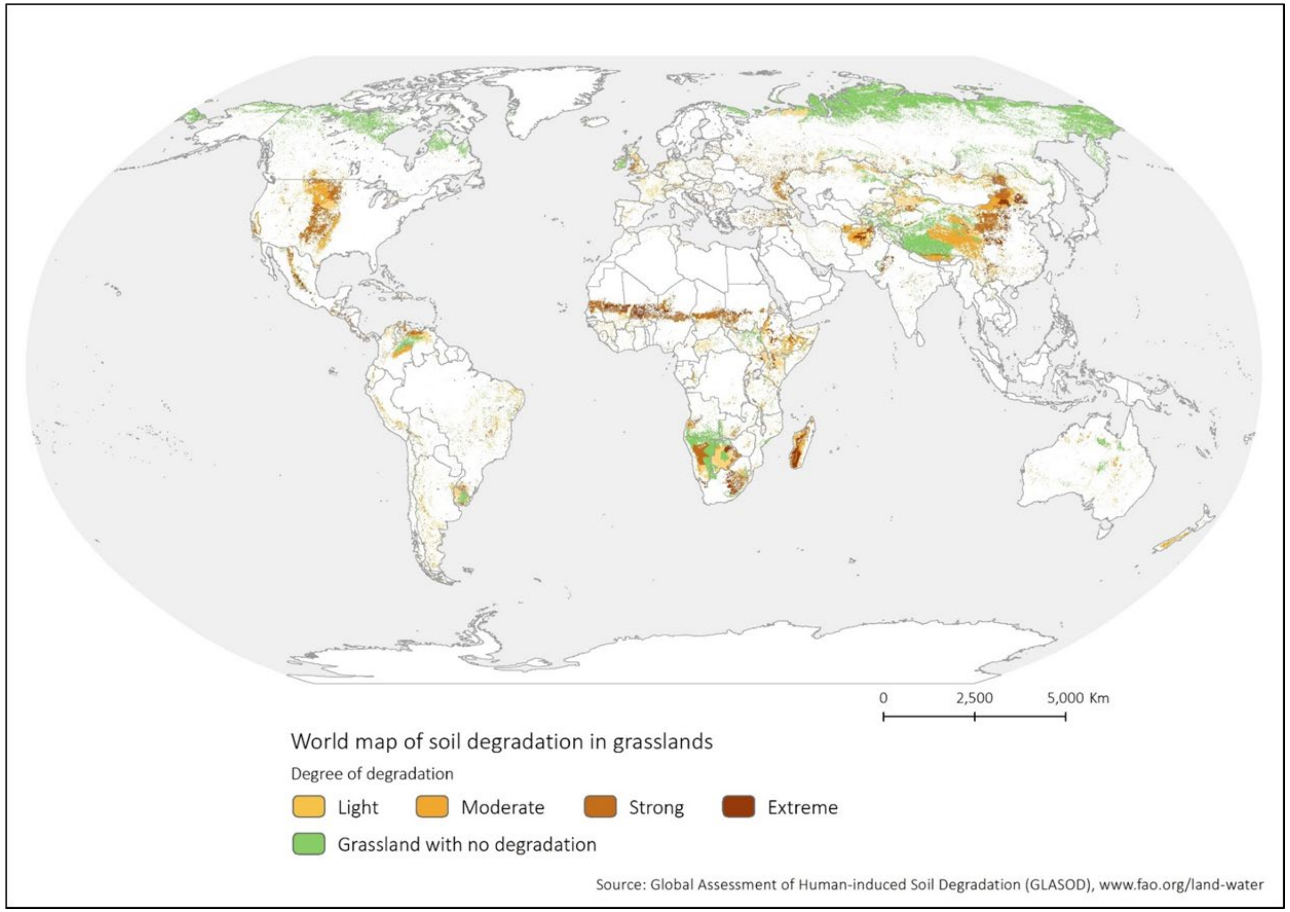
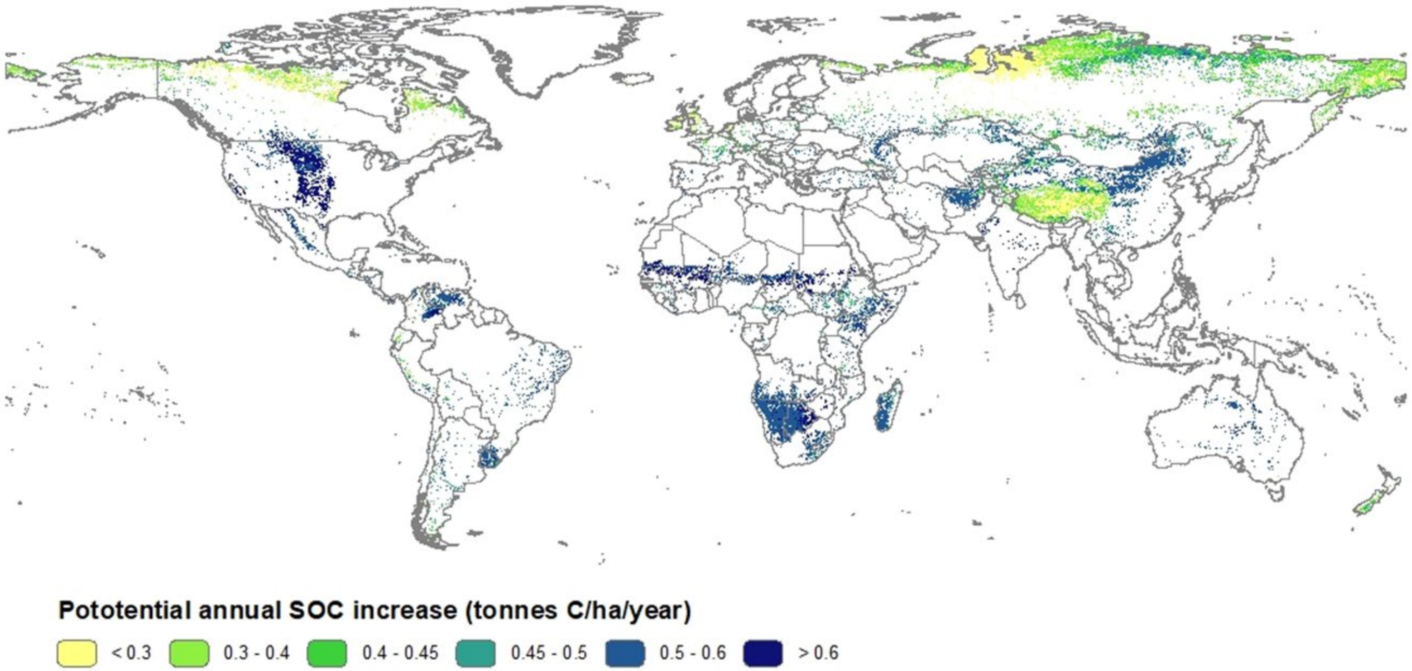
Potential attainable increase of soil organic carbon

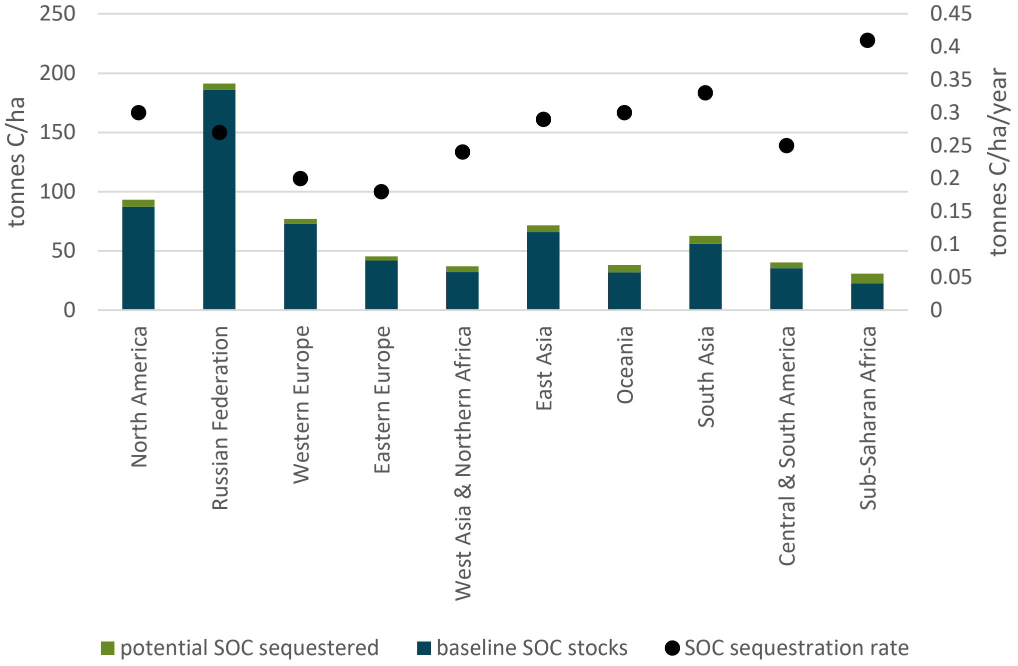
- Soils Grid 250 m - ISRIC World Soil Information
  - SOC
  - Bulk density
  - Sand content
- The %-increase in SOC after 20 years of **0.27**



Potential attainable increase of soil organic carbon…if best management practices are applied worldwide



Note: maps were produced based upon a geospatial analysis of datasets from the SoilsGrids250 database. Source: United Nations Geospatial. 2020. Map of the World. United Nations. Cited 22 August 2022. www.un.org/geospatial/file/2285/download?token=puayKYRA modified with data from Sommer and Bossio, 2014 and Hengl et al., 2014.



Note: Results are given by regional averages per hectare (bars) and their annual increment (dots)). Source: UN. 2020. Map of the World, modified with data from Sommer, R. & Bossio, D. 2014. Dynamics and climate change mitigation potential of soil organic carbon sequestration. Journal of Environmental Management, 144: 83–87. https://doi.org/10.1016/j.jenvman.2014.05.017; Hengl, T., de Jesus, J.M., MacMillan, R.A., Batjes, N.H., Heuvelink, G.B.M., Ribeiro, E., Samuel-Rosa, A., Kempen, B., Leenaars, J.G.B., Walsh, M.G. & Ruiperez Gonzalez, M. 2014. SoilGrids1km — Global Soil Information Based on Automated Mapping. PLOS ONE, 9(8): e105992. https://doi.org/10.1371/journal.pone.0105992

Summary

- The present study provides a spatially explicit report on the state of grassland soils,
- On average, in the year 2010 the SOC stock under unimproved grasslands was 53 tonnes C/ha and 50 tonnes C/ha in improved grasslands,
- Almost double the amount of C input is needed to maintain current levels of SOC in improved grassland, compared to unimproved,
- The majority of grassland soils seem to receive enough organic material to maintain current carbon stock levels,

Summary

- Negative carbon balance was found in East Asia, Central and South America, and Africa south of the Equator,
- 0.3 t C/ha/yr could be sequestered if best management practices are applied,
- Sub-Saharan Africa and South Asia show the highest potential for carbon storage on a per hectare basis, followed by Oceania, North America and East Asia,
- The Russian Federation showed the highest potential for total carbon storage, globally.

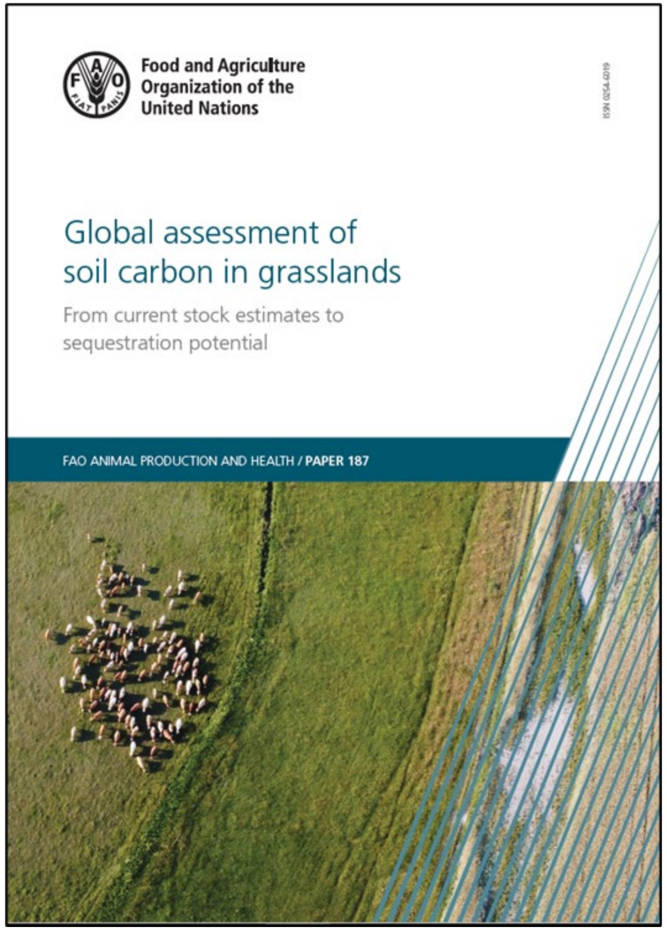
Uncertainties

- Grassland definition and distribution affect all underlying input data and therefore exacerbate the uncertainty of the model results,
- Variability in carbon inputs (plant residue and animal excreta),
- Initial soil carbon and bulk density,
- Model parameters,
- Soil saturation,
- For a full system budget, it is imperative to include estimates of GHGs emissions.

Findings

1. The results of this report could support the inclusion of SOC targets in NDCs,
2. To prioritize carbon returns in deteriorated soils that have a negative carbon balance,
3. To protect SOC in areas – particularly under unimproved grasslands – with high carbon stocks,
4. Grasslands could contribute to the recarbonization of degraded land,
5. 17 percent of the *4p1000* sequestration target could be reached in the top 30 cm of grasslands.

Thank you



https://doi.org/10.4060/cc3981en