Food and Agriculture Organization of the United Nations

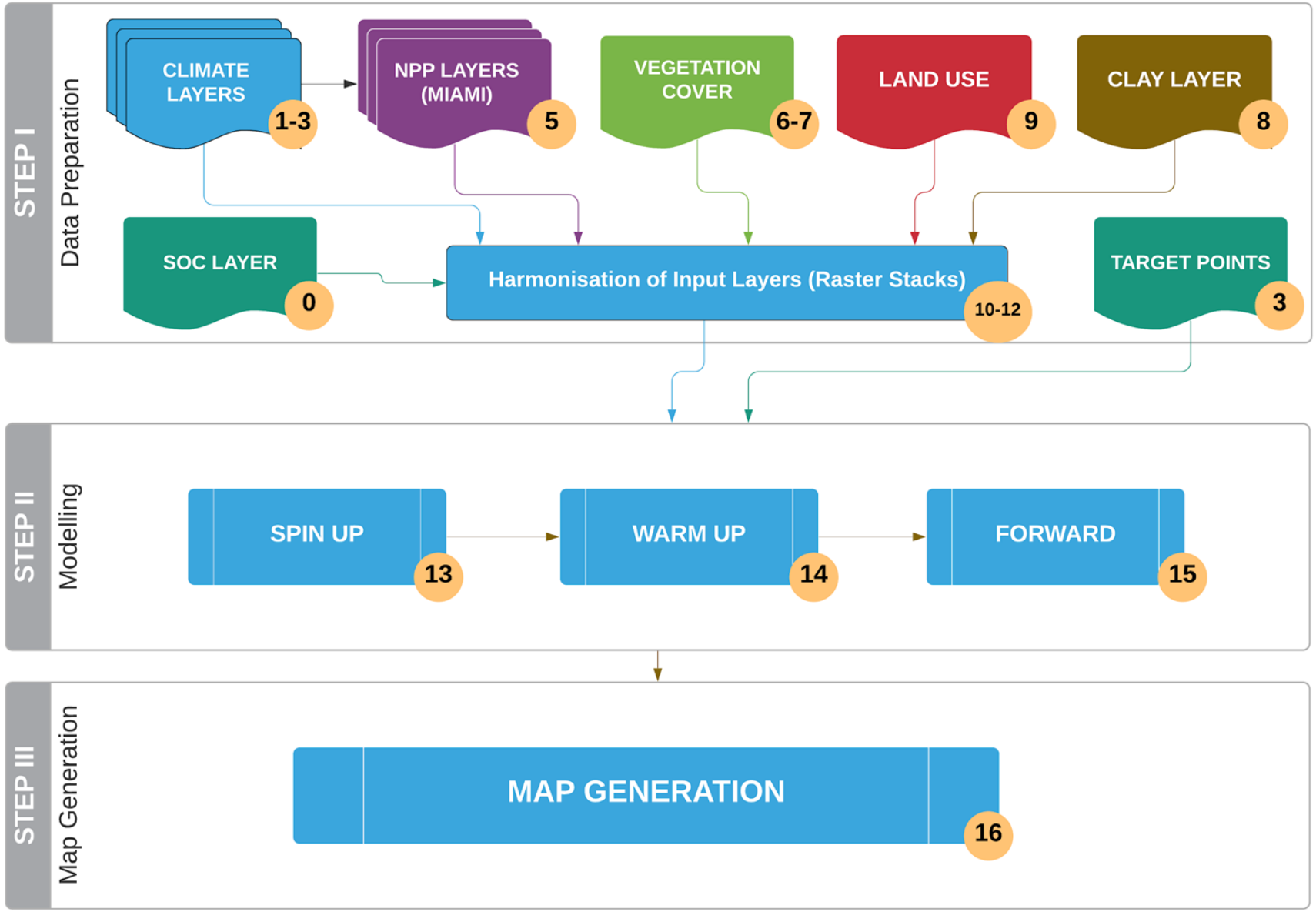
Global Soil Organic Carbon Sequestration Potential Map

GSOCseq

Summary and Conclusions –Isabel Luotto

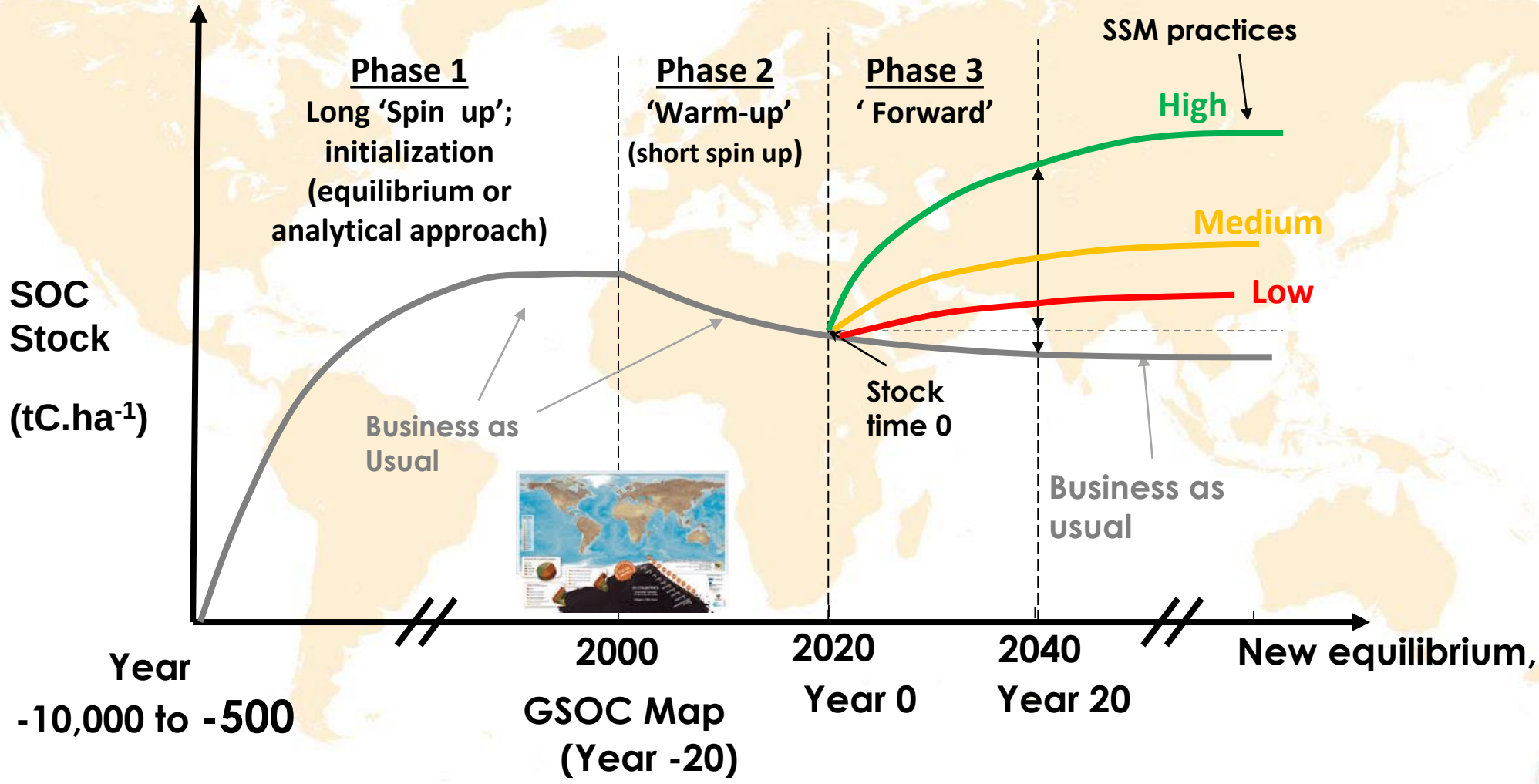
GLOBAL SOIL PARTNERSHIP

scripts



Global Soil Or

For each 1km x 1km pixel:



Approach based on Smith et al 2006; 2008; Gottschalk et al. 2012

Summary INPUTS

Input data requirements				
Data	**Variables**	**Time series**	**Units**	**Type**
Climatic data	Monthly air temperature	1980-2000; 2001-2020 (or until last year available)	°C	Raster
	Monthly evapotranspiration (Penman-Monteith)	1980-2000; 2001-2020 (or until last year available)	mm	Raster
	Monthly precipitation + irrigation	1980-2000; 2001-2020 (or until last year available)	mm	Raster
Soil data	Topsoil clay content (0-30 cm)	-	%	Raster
	Current Soil organic carbon stocks (0-30 cm)	Latest version of national FAO-GSOC map	tC ha^{-1}	Raster
Land use/cover	Predominant land use/cover, re-classified into: Minimum: 4 default classes required by model: agricultural crops, grassland/shrubland/savannas ; forests; others Optimum: 12 classes defined in the FAO Global Land Cover - SHARE (GLC-SHARE)	Minimum: representative 2000-2020 (or last year available) Optimum: annual land use 2000 to 2020	1-11	Raster
	Monthly vegetation cover. Obtained from national statistics/local expert knowledge; or derived from NDVI or spectral indexes (see section 3.3.4)	Minimum: average 2015- 2020 (or last year available period) Optimum: monthly soil cover 2000 to 2020	0-1	Raster

Summary

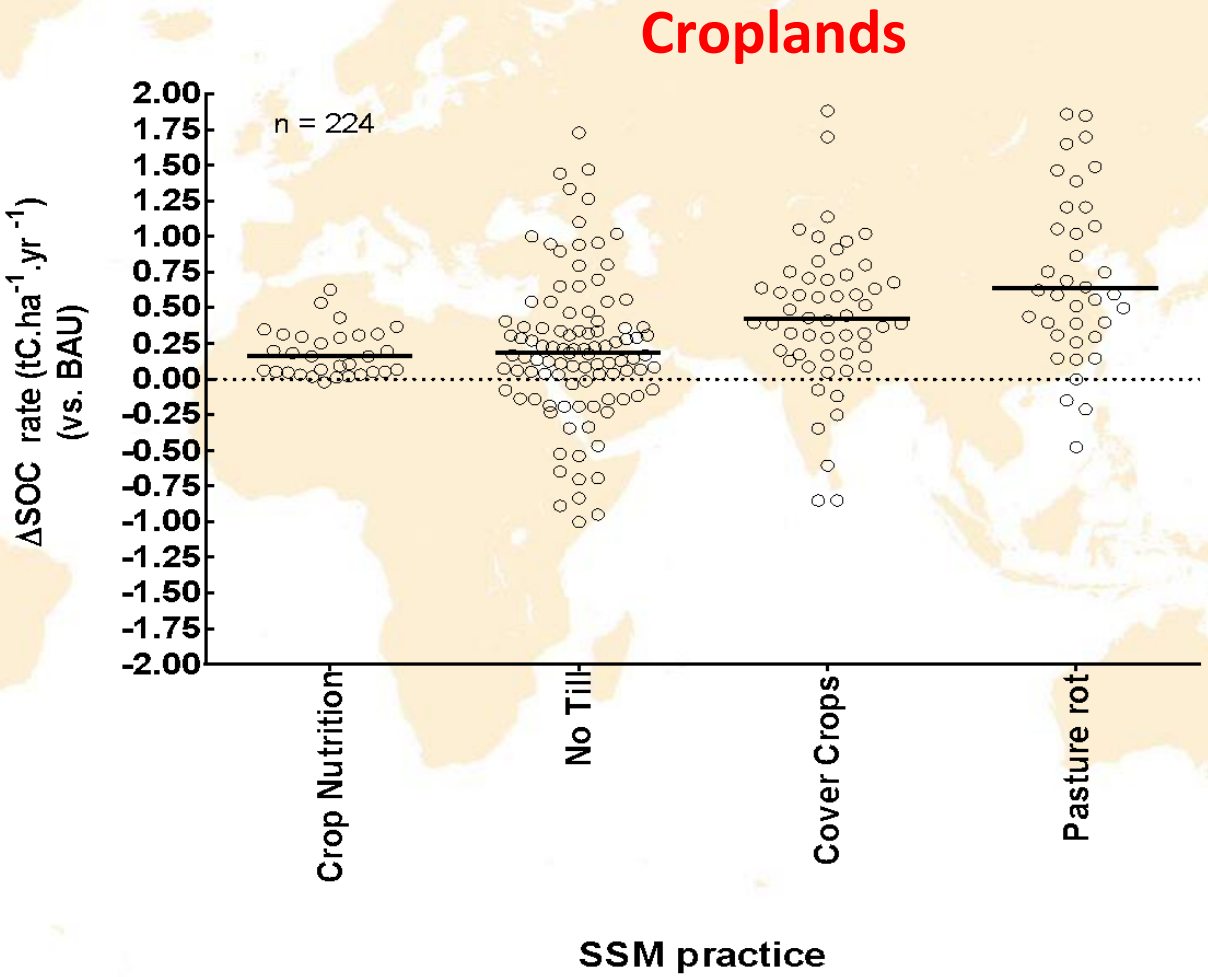
- Global layers (TerraClimate, ISRIC,ESA, etc.)

- National layers when available!

Example

Meta-analysis
Local results of SOC changes

Adjust % increment in C inputs (Additional, Non standard products)



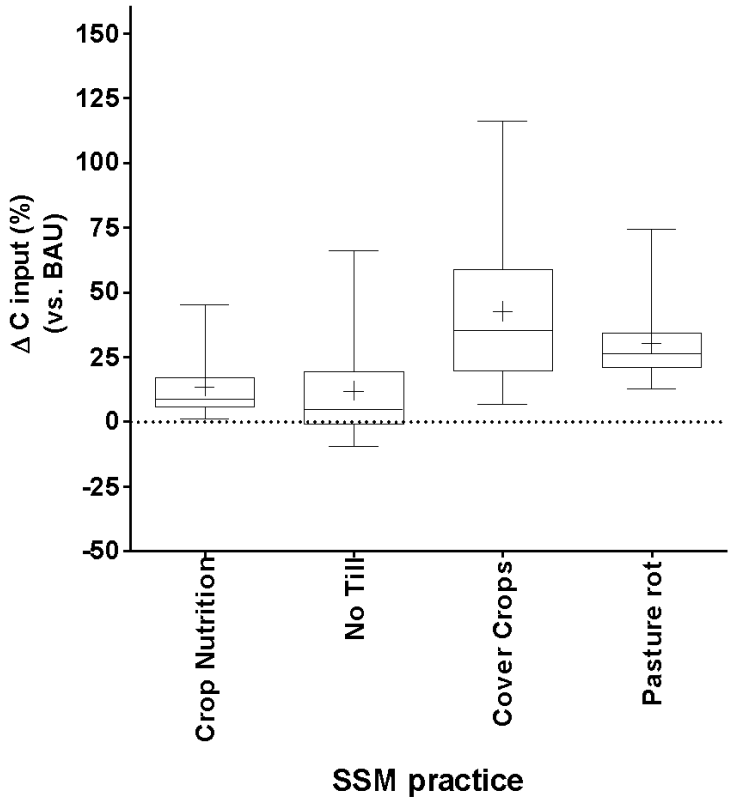
Adjust % increment in C inputs (Additional, Non standard products)

Meta-analysis

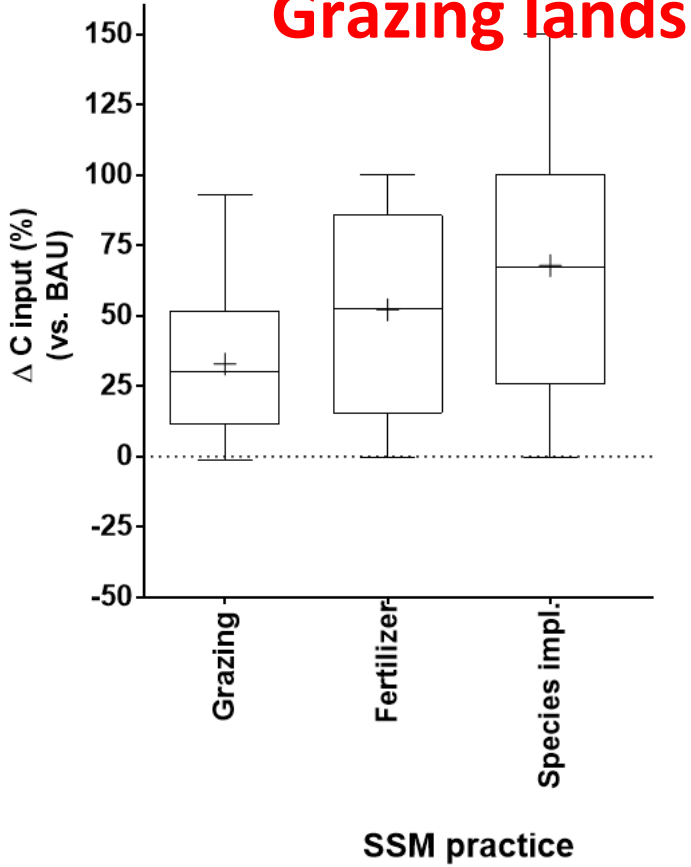
Local results of increase in C inputs:

- From published studies
- From Yield and production data (e.g. field trials)

Croplands



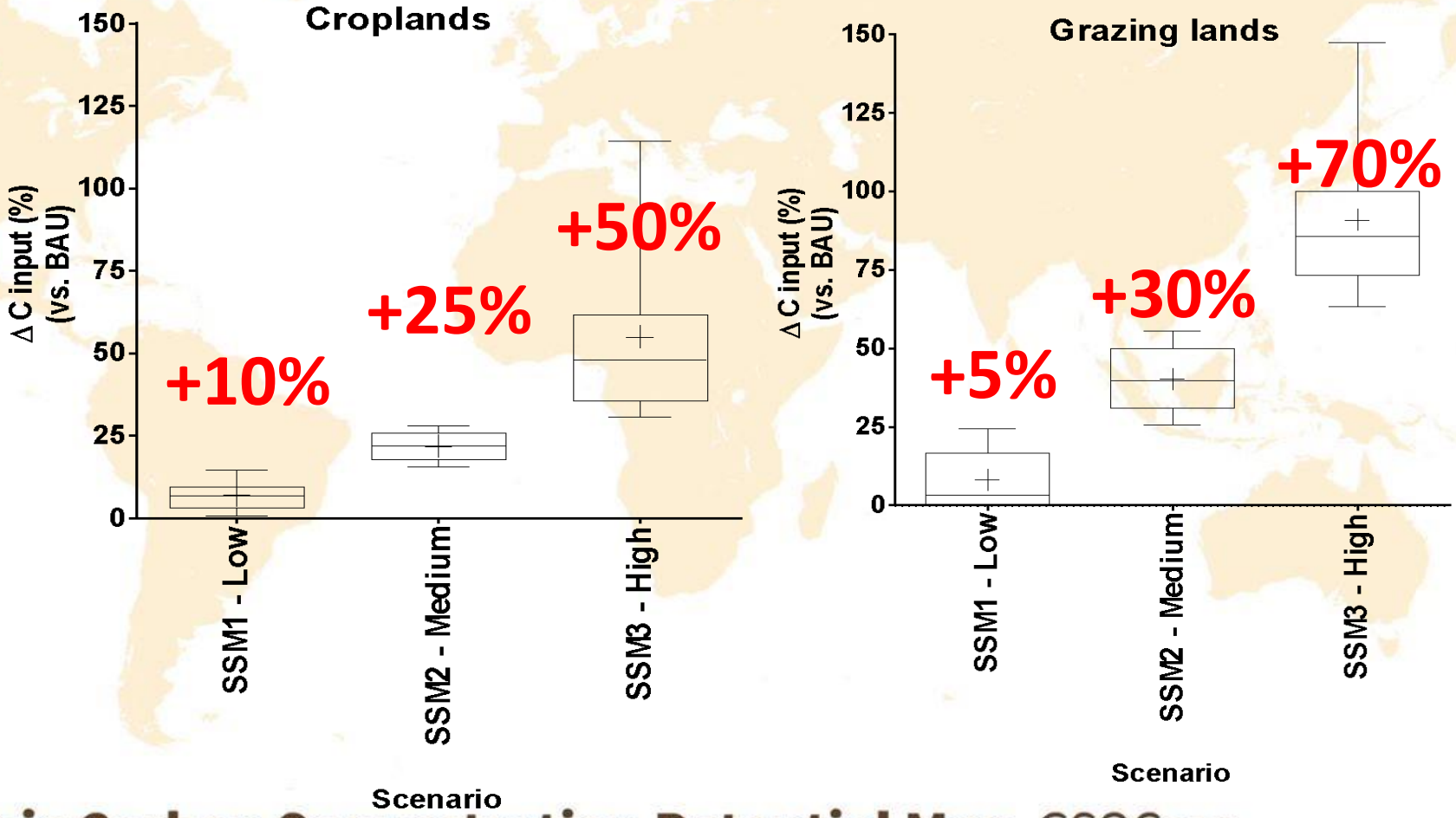
Grazing lands



Example

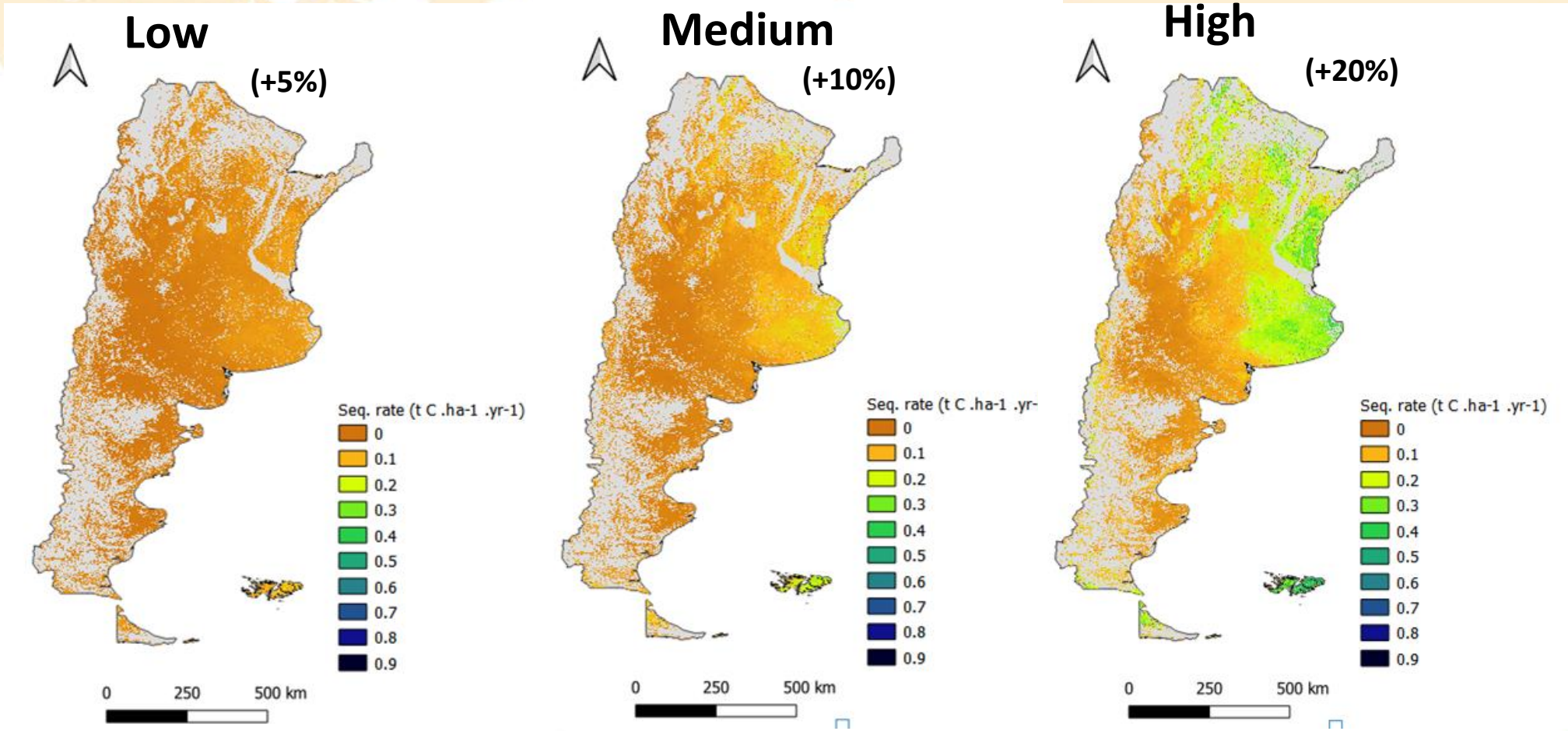
Meta-analysis
Local results of SOC changes

Adjust % increment in C inputs (Additional, Non standard products)



Global Soil Organic Carbon Sequestration Potential Map GSOCseq

Standard Products



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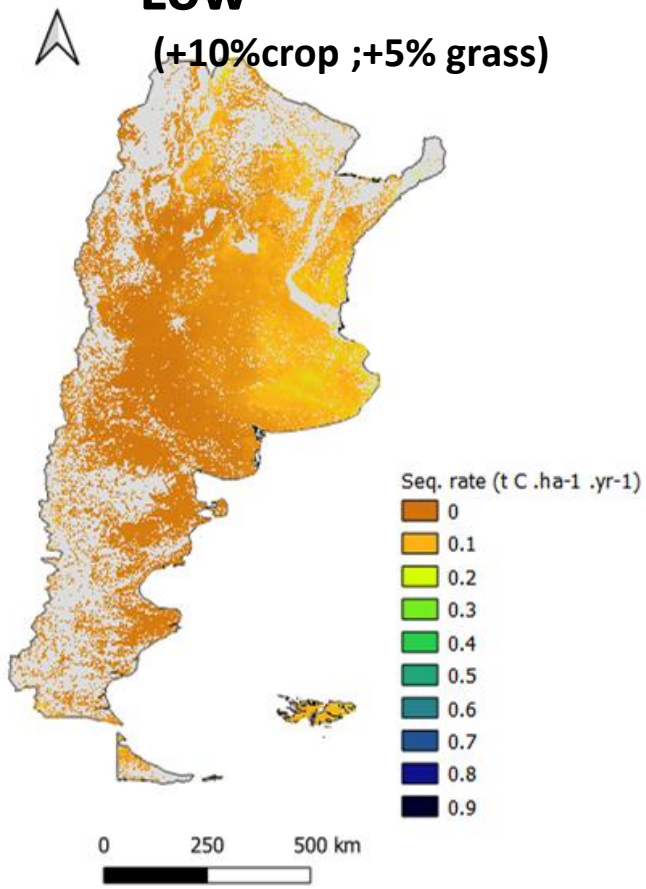
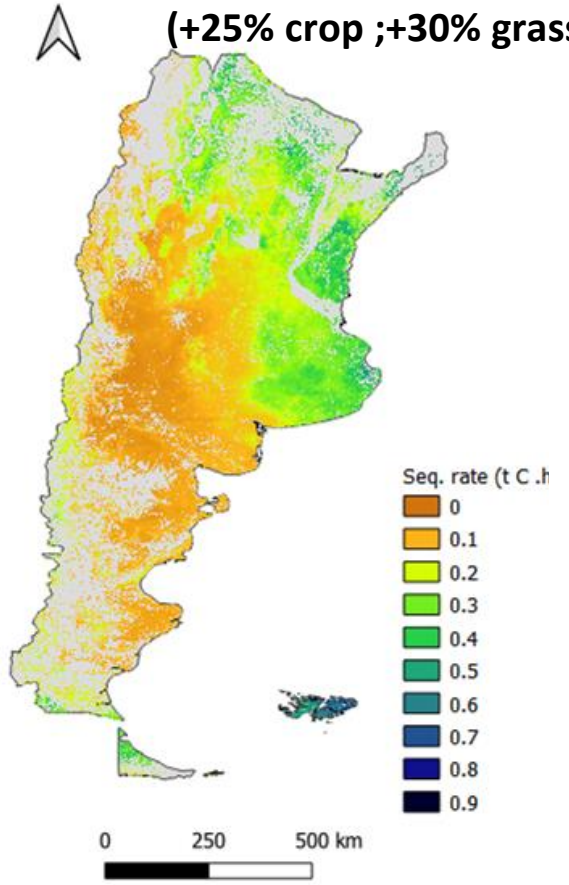
Non-Standard Products
Using modified coefficients

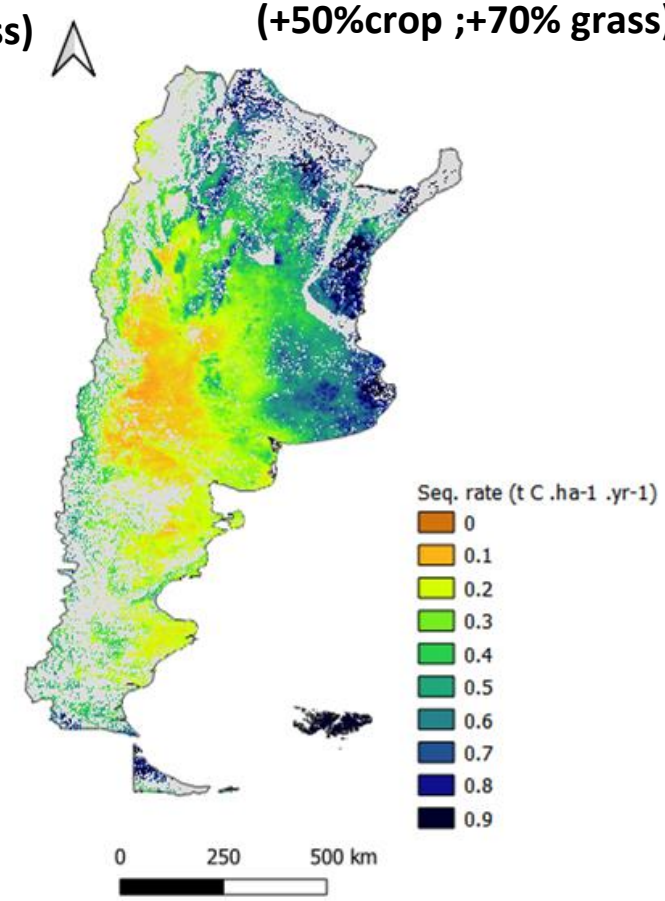
Low
(+10%crop ;+5% grass)



Medium
(+25% crop ;+30% grass)



High
(+50%crop ;+70% grass)



Global Soil Organic Carbon Sequestration Potential Map GSOCseq

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… Some aspects to consider

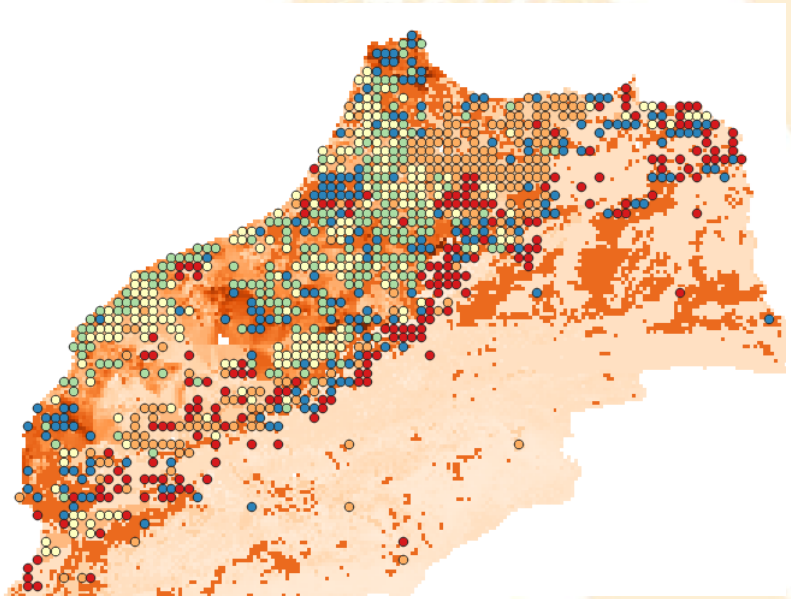
- **Units**: Clay content (g/kg vs. %); GSOC Map (g C/m2 vs TC/ha); units and sca

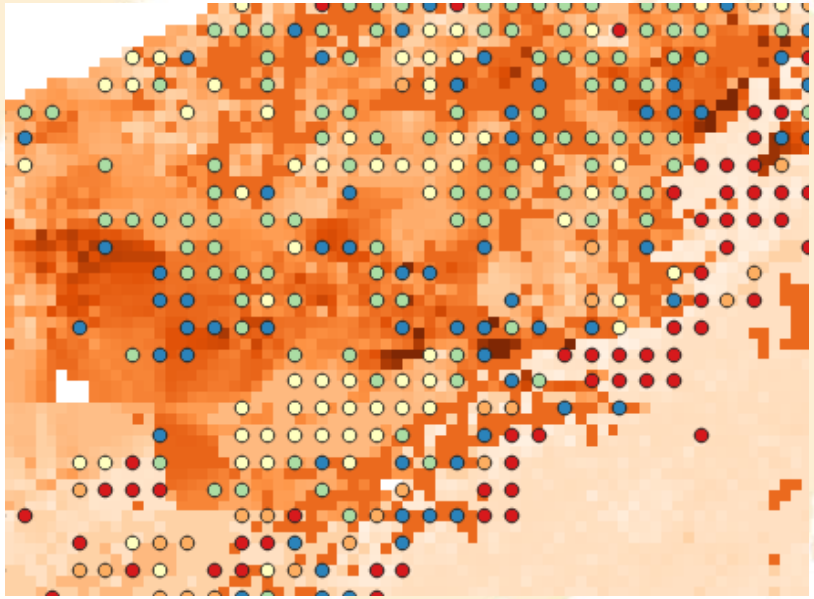
- **Outliers**...can be reprocessed ("euler" vs "lsoda")... Generally <2% points...Run those points with SoilR

… Some aspects to consider

- **Time (Spin up)!** = monthly runs, 500 years ...Can take more than 15 days, specially in countries with large agricultural areas:
  - First run a subset of points
  - Start with standard product (target points in agricultural + grazing lands)
  - Run by **provinces/chunks**

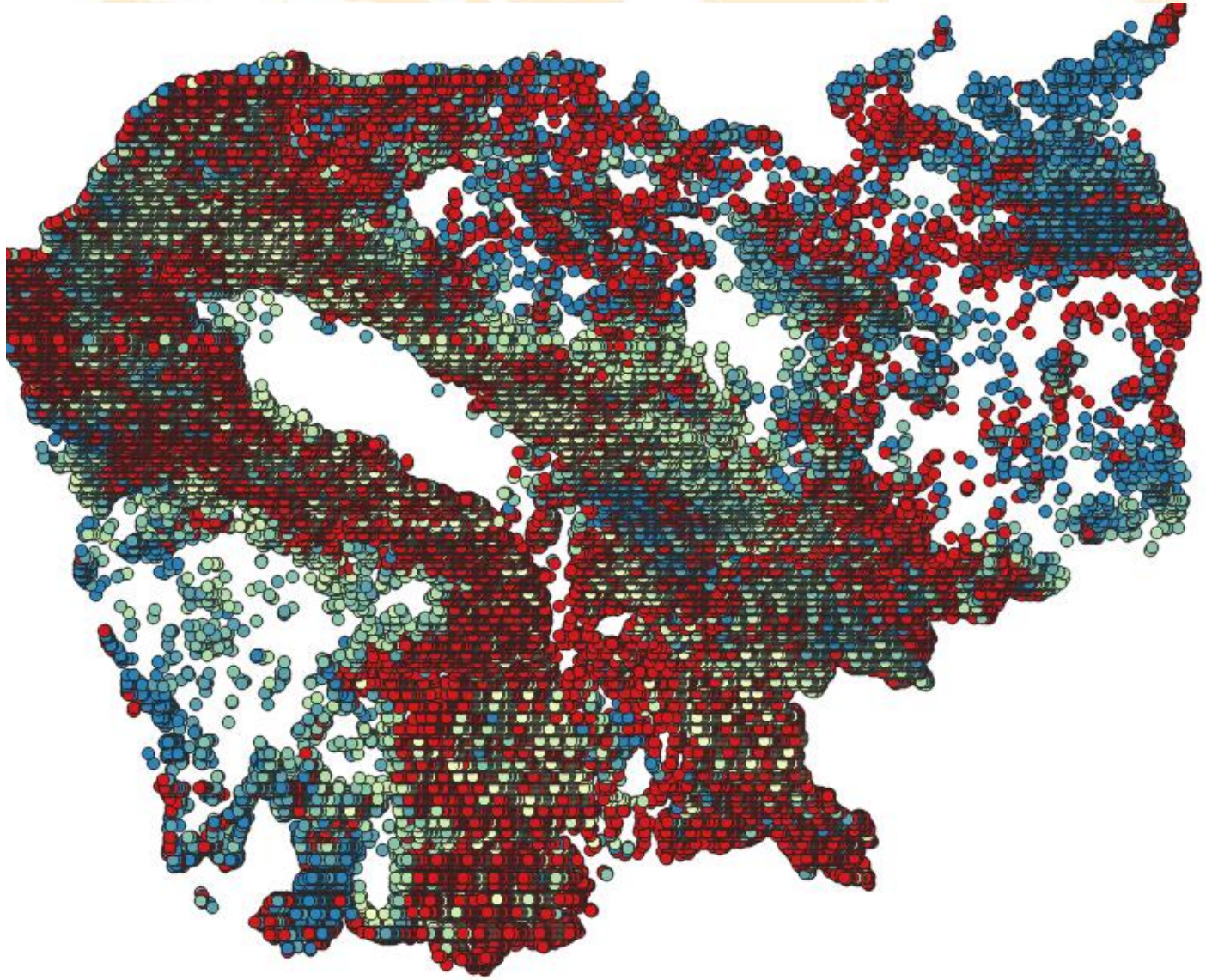
… Some aspects to consider





- Generate target points and run the model for all points
- Subset just to test if the model is working ok

… Some aspects to consider



- Check Forward Vector for NA or 0 values
- Start checking the stocks at T0
- Filter Select points with no data and re-run model

(lsoda vs euler in the scripts 13, 14, 15)

- Check input layers have data for that areas!

Standard Products: Final and intermediate Products

- **|_ Maps**
  - **|_ National Absolute SOC Sequestration rate Map for the BAU scenario** *(ISO3CountryCode_* **GSOCseq_ASR_BAU**_*Map030.tiff)*
  - **|_ National Absolute SOC Sequestration rate Map for the SSM1 scenario (Low)** *(ISO3CountryCode_* **GSOCseq_ASR_SSM1**_*Map030.tiff)*
  - **|_ National Absolute SOC Sequestration rate Map for the SSM2 scenario (Medium)***(ISO3CountryCode_* **GSOCseq_ASR_SSM2**_*Map030.tiff)*
  - **|_ National Absolute SOC Sequestration rate Map for the SSM3 scenario (High)***(ISO3CountryCode_* **GSOCseq_ASR_SSM3**_*Map030.tiff)*

  - **|_ National Relative SOC Sequestration rate Map for the SSM1 scenario (Low)** *(ISO3CountryCode_* **GSOCseq_RSR_SSM1**_*Map030.tiff)*
  - **|_ National Relative SOC Sequestration rate Map for the SSM2 scenario (Medium)***(ISO3CountryCode_* **GSOCseq_RSR_SSM2**_*Map030.tiff)*
  - **|_ National Relative SOC Sequestration rate Map for the SSM3 scenario (High)***(ISO3CountryCode_* **GSOCseq_RSR_SSM3**_*Map030.tiff)*

  - **|_ Initial SOC Stocks at T0** *(ISO3CountryCode_* **GSOCseq_T0**_*Map030.tiff)*

|_ Uncertainty Maps

  - **|_ Uncertainties: National Absolute SOC Sequestration rates for the BAU scenario** *(ISO3CountryCode_* **GSOCseq_ASR_BAU**_*UncertaintyMap030.tiff)*
  - **|_ Uncertainties: National Absolute SOC Sequestration rates for the SSM1 scenario (Low)** *(ISO3CountryCode_* **GSOCseq_ASR_SSM1**_ *UncertaintyMap030.tiff)*
  - **|_ Uncertainties: National Absolute SOC Sequestration rates for the SSM2 scenario (Medium)***(ISO3CountryCode_* **GSOCseq_ASR_SSM2**_ *UncertaintyMap030.tiff)*
  - **|_ Uncertainties: National Absolute SOC Sequestration rates for the SSM3 scenario (High)***(ISO3CountryCode_* **GSOCseq_ASR_SSM3**_ *UncertaintyMap030.tiff)*

  - **|_ Uncertainties: National Relative SOC Sequestration rates for the SSM1 scenario (Low)** *(ISO3CountryCode_* **GSOCseq_RSR_SSM1**_ *UncertaintyMap030.tiff)*
  - **|_ Uncertainties: National Relative SOC Sequestration rates for the SSM2 scenario (Medium)***(ISO3CountryCode_* **GSOCseq_RSR_SSM2**_ *UncertaintyMap030.tiff)*
  - **|_ Uncertainties: National Relative SOC Sequestration rates for the SSM3 scenario (High)***(ISO3CountryCode_* **GSOCseq_RSR_SSM3**_ *UncertaintyMap030.tiff)*

- **|_ Documents**
- **|_ Report** (ISO3CountryCode_Report.doc, docx)

7 Final Standard Products with their uncertainties

29 Total products (considering intermediate)

..After Generating the Map…

https://fao-gsp.github.io/GSOCseq/annex-ii-quality-assurance-and-quality-control.html

Step 1 Check that 29 products have been labeled appropriately and are in the correct format

Step 2 Check the projection and resolution of all products

Step 3 Check that the products were generated for agricultural and grazing areas only

Step 4 Check that all target areas have been included in the process

Step 5 Check for units, range, and outliers

..After Generating the Map…

https://fao-gsp.github.io/GSOCseq/annex-ii-quality-assurance-and-quality-control.html

Final SOC Stocks

- Most of the values should fall between 15-100 t/ha
- Minimum values should be greater than 0 (except for -999 Values, which indicate no data values)
- -999 values should be masked out
- There should not be negative values other than -999
- Maximum values should not exceed 800 t/ha.
- Mean values SOC SSM3 > SSM 2 > SSM 1 > BAU

..After Generating the Map…

https://fao-gsp.github.io/GSOCseq/annex-ii-quality-assurance-and-quality-control.html

Absolute sequestration rates (ASR)

- The expected range for all maps should fall between -4 to +4 t/ha
- ASR BAU: usually most values from -0.5 to + 0.5, with median values near 0 or lower
- ASR SSM1: usually most values -0.4 to + 0.6, with median near 0 or higher (similar to BAU)
- ASR SSM2: usually most values -0.3 to + 0.7
- ASR SSM3: usually most values -0.2 to + 0.8
- -999 and -49.95 Values (-999/20) indicate no data values. Values <= -49.95 should be masked out
- Negative values other than -999 and -49.95 (meaning SOC losses between 2020 and 2040) should not exceed -4
- Maximum values should usually not exceed +4.
- Mean values SSM3 > SSM 2 > SSM 1 > BAU

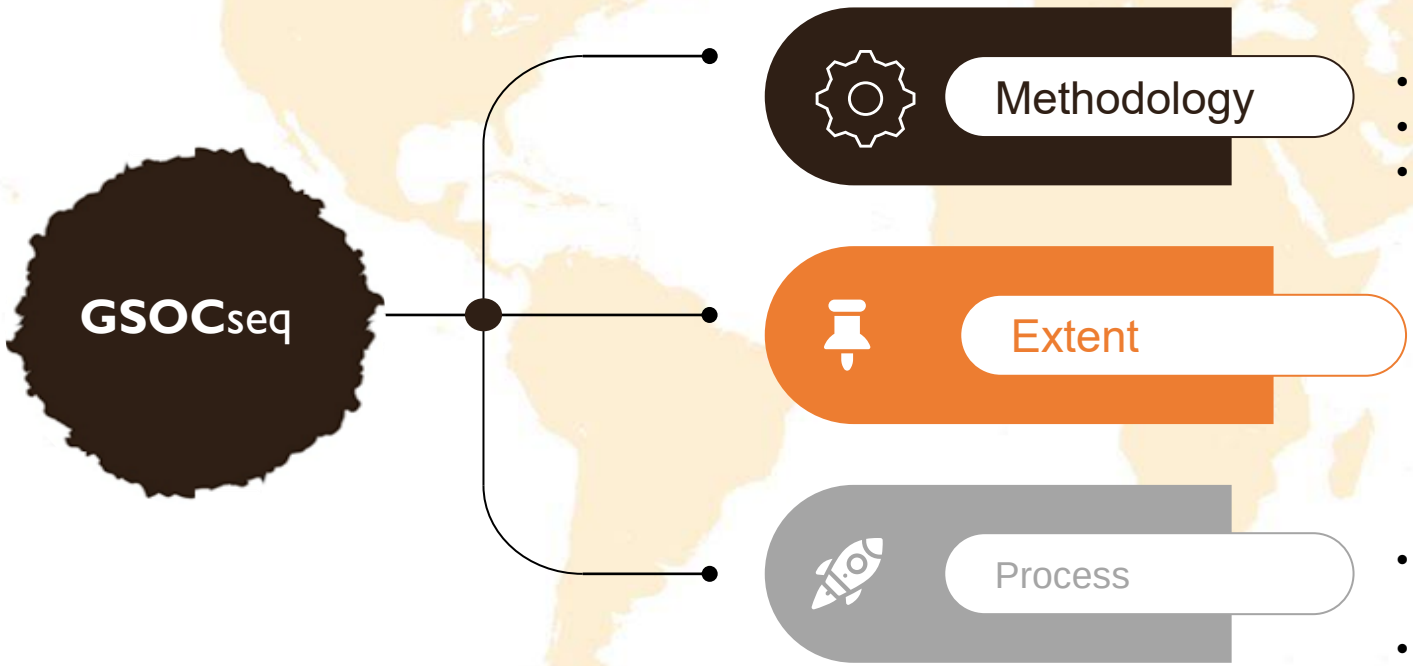
..After Generating the Map…

https://fao-gsp.github.io/GSOCseq/annex-ii-quality-assurance-and-quality-control.html

Relative sequestration rates (RSR)

- The expected range should fall between 0 to +4 t C/ha (with most data being distributed between 0 to +1)
- RSR SSM1: usually most values range from 0 to + 0.6, with median near 0 or higher (similar to BAU)
- RSR SSM2: usually most values range from 0 to + 0.7
- RSR SSM3: usually most values range 0 to + 0.8
- -999 and -49.95 Values (-999/20) indicate no data values. Values <= -49.95 will be excluded from Global product
- There should not be negative values other than -999 and -49.95:
- Maximum values should usually not exceed +4.
- Mean SOC values in order of size SSM3 > SSM 2 > SSM 1

The Global Soil Organic Carbon Sequestration Potential Map



- Based on the **process-based model RothC**
- **3 SSM scenarios and 1 business as usual**
- Uncertainty based on the uncertainties of the input data

- **Agriculturally managed lands** where SSM can be implemented
- **20 years** into the furute (t0=2020, t=2020)
- **1 km resolution**

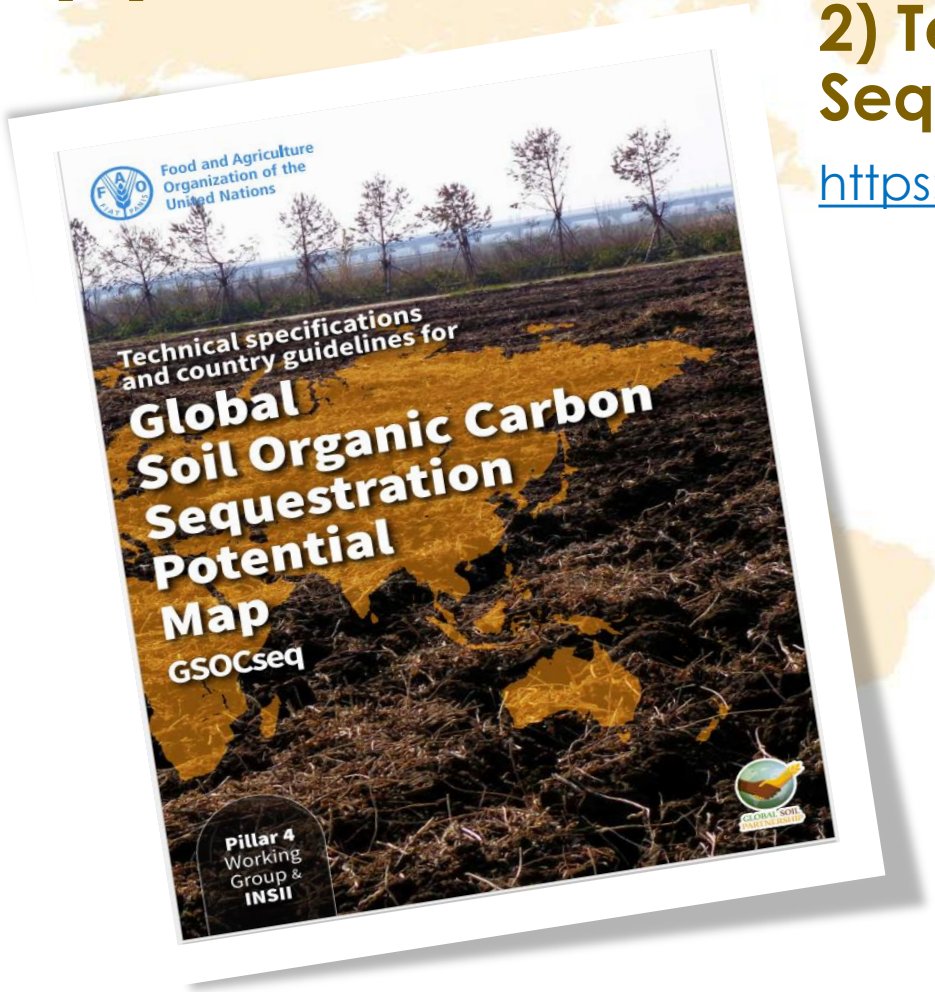
- **Country-driven** (global map based on national submissions)
- Launched in 2021, continously updated following a **Versoning system**

Following FAO members request, Global Soil Partnership (GSP) has started the GSOCseq initiative to:

Why **GSOC**seq?

1. **Set** attainable and evidence based **national targets for carbon sequestration**;
2. **Identify areas** that have high SOC sequestration **for SSM projects**
3. **Enhance National capacities** on sustainable soil management, soil data management, digital soil mapping and modelling; as inputs for NDCs and reporting

The GSOCseq approach



1) Technical Specifications and Country guidelines

http://www.fao.org/documents/card/es/c/cb0353en/

2) Technical Manual Global Soil Organic Carbon Sequestration Potential Map GSOCseq

https://www.fao.org/documents/card/en/c/cb2642en/

Contributors and reviewers

Professor Pete Smith – University of Aberdeen

INSII - International Network of Soil Information Institutions

ITPS - Intergovernmental Technical Panel on Soils

4per1000 SCT - 4 per 1000 Scientific and Technical Committee

CIRCASA - (Coordination of International Research Cooperation on Soil Carbon Sequestration in Agriculture)

UNCCD-SPI - The UNCCD Science-Policy Interface

The GSOCseq approach for reporting CSCs in GHGI

- It's important to understand what the GSOCseq approach allows you to report on
  - ✓ CO_2 emission/removals in non-waterlogged* mineral soils in croplands and grasslands
  - ✓ CO_2 emission/removals in paddy field soils* (Shirato & Yokozawa, 2005)

- However, the current GSOCseq has the following limitations:
  - × It does not replace the need for ground data as well as the Tier 1 approach (*the results should be validated with local measurements and compared to the results following the Tier 1 approach*)
  - × Further parametrization might be needed (e.g. SOC dynamics in Vulcanic soils)
  - × It cannot report CO_2 emission/removal for forests
  - × It does not take into account CH_4, NO_2 emissions

- Why take part in the GSOCseq initiative?
  - ↗ If properly parametrized and complemented superior to Tier 1 – local spatially explicit data
  - ↗ Access to capacity development in GIS, mapping and modeling
  - ↗ Scenario-based modeling and mapping for data-driven policy-making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Thank you!
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