# Dealing with soil organic carbon mapping at different levels in Madagascar

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# Introduction

**Soil Organic Carbon stocks ($SOC_s$)**
- Soil productivity
- Sequestration of GHG
  (MEA, 2005)

Climate

**Food security**

**Madagascar $SOC_s$ mapping**

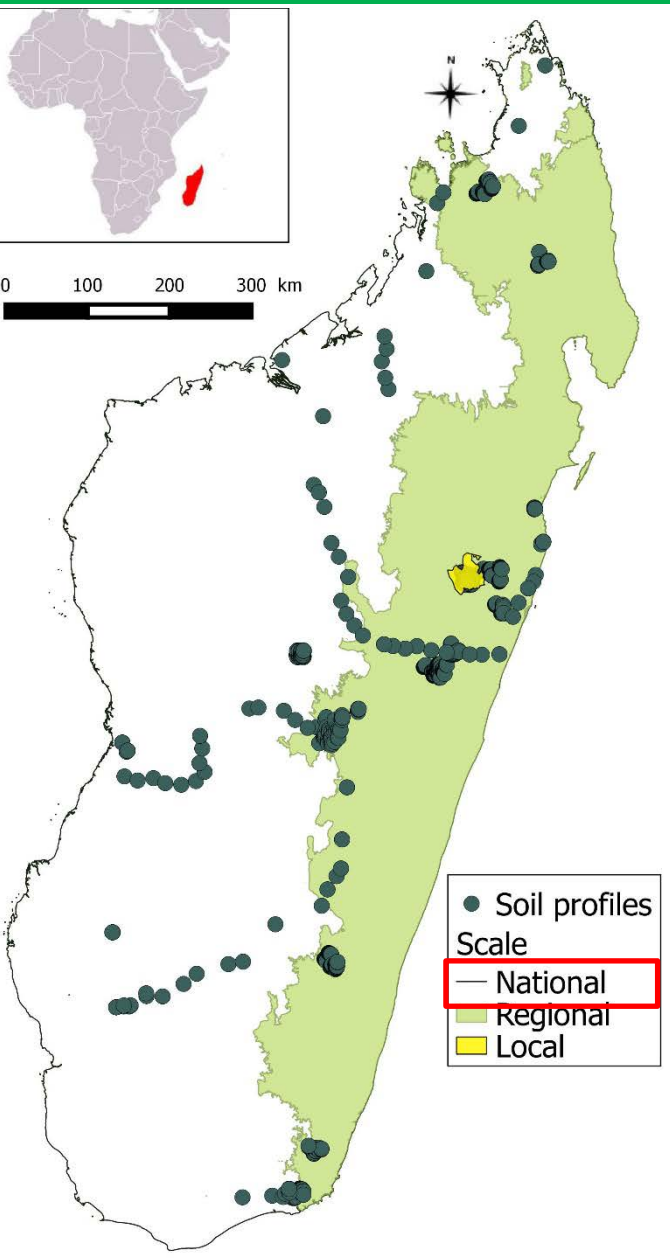
| | |
|---|---|
| **Multiscale**<br>National<br>Regional<br>Local | **Improving accuracy** |
| | **Use of Digital Soil Mapping** |

**Objectives**:

(i) model the spatial distribution of $SOC_s$ at local, regional and national scales from the relevant environmental variables

(ii) develop map of $SOC_s$ at this three scales.

# Materials and methods (1/3)




✓ **Use of $SOC_s$ database (0-30 cm of depth):**

***VALSOL-Madagascar database***: 1,196 soil profiles (2010-2015)

| Scale | NATIONAL | REGIONAL | LOCAL |
|---|---|---|---|
| | Madagascar | Eastern humid Ecoregion | County of Didy |
| Area ($km^2$) | 587,000 | 205,858 | 1,416 |
| $n_{Total}$ | 1,196 | 800 | 213 |
| $n_{calibration}$ | 837 | 560 | 149 |
| $n_{validation}$ | 359 | 540 | 64 |

# Materials and methods (2/3)

## ✓ Collection and harmonization of spatial variables dataset

| **Topography data** *(CNES, 2014)* | **Climate data** (Hijmans et al., 2005) | **Soil map** (Delenne et al., 2005) | **Vegetation data** (Hansen et al., 2013). | **Satellite data** (Hansen et al., 2013) |
|---|---|---|---|---|
| Elevation (m) | Mean annual Temperature (MAT, °C) | Soil type* | Tree cover percent(TCP,%) | NDVI |
| Slope (%) | Mean annual Precipitation (MAP, mm) | | Above Ground Biomass (AGB, $MgC.Ha^{-1}$) | NDWI |
| | | | Land cover* | NIRI |

* Qualitative data

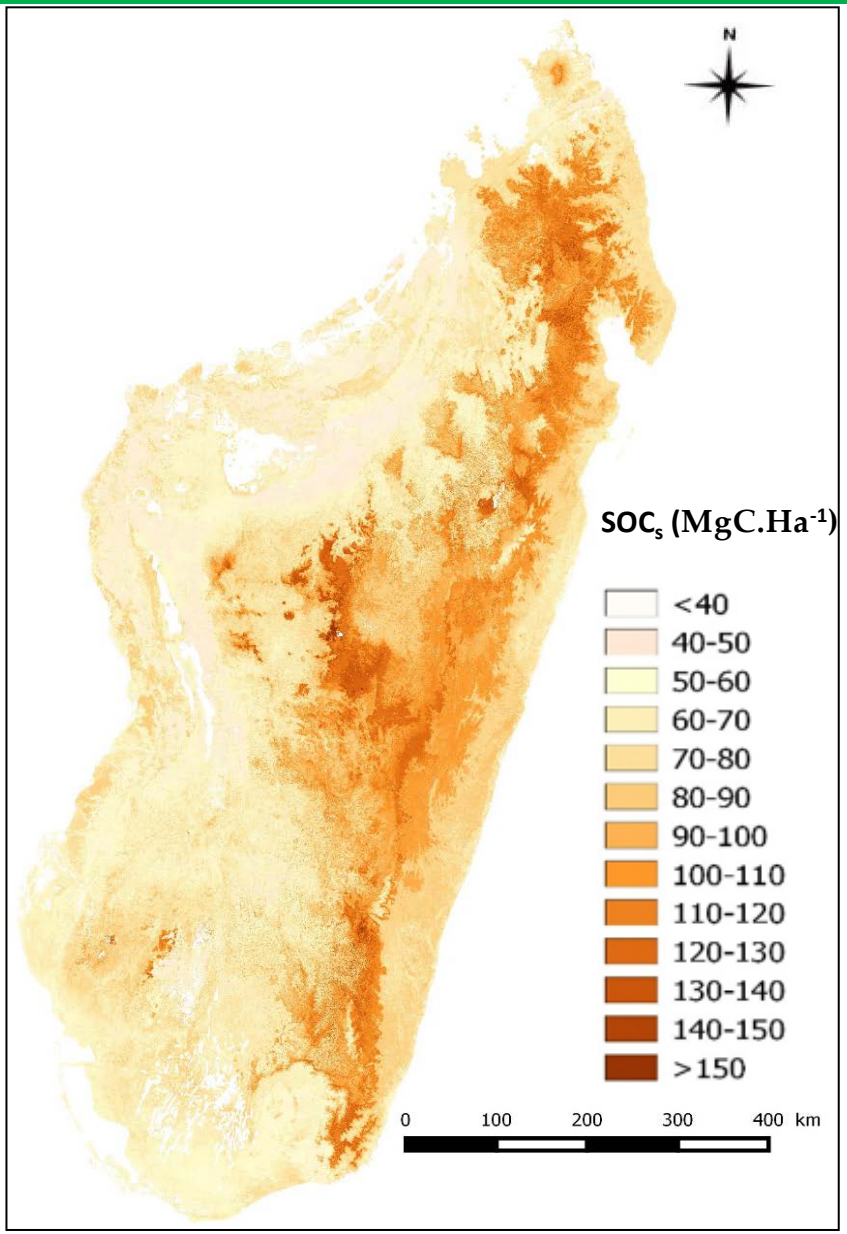
- Projected in the same spatial reference system (WGS84/UTM 38S)
- resampled at 30 m x 30 m resolution

# Materials and methods (3/3)

✓ **Soil organic carbon modelling**

- **Using of randomForest Algorithm**
- **Set of calibration:** 70% of $SOC_s$ data
- **Set of external validation:** 30% of $SOC_s$ data
- **Model evaluation**
  - Coefficient of determination of external validation ($R^2$)
  - Root Mean Squared Error of external validation (RMSE, $MgC.Ha^{-1}$)
- **Relative importance of variable:** using of VSURF package: (Variable Selected Using randomForest)

# Results (1/4)



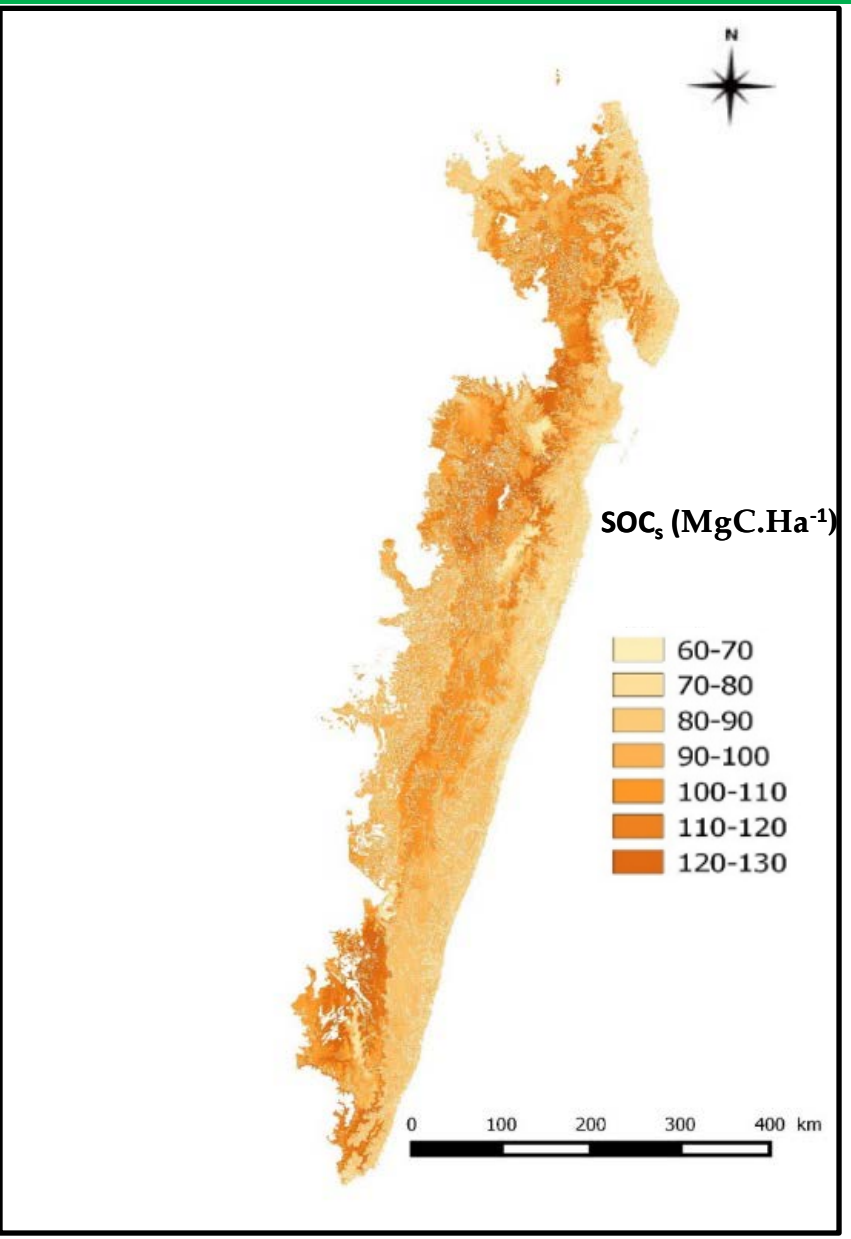

✓ **Map of $SOC_s$ on national scale (0-30 cm)**

- $R^2$ = 0.59
- RMSE = 25.81 $MgC.ha^{-1}$

- Relevant predictor variable by importance:
  - MAP
  - MAT
  - Elevation
  - NDVI

- Range : 40 to 150 $MgC.ha^{-1}$

# Results (2/4)



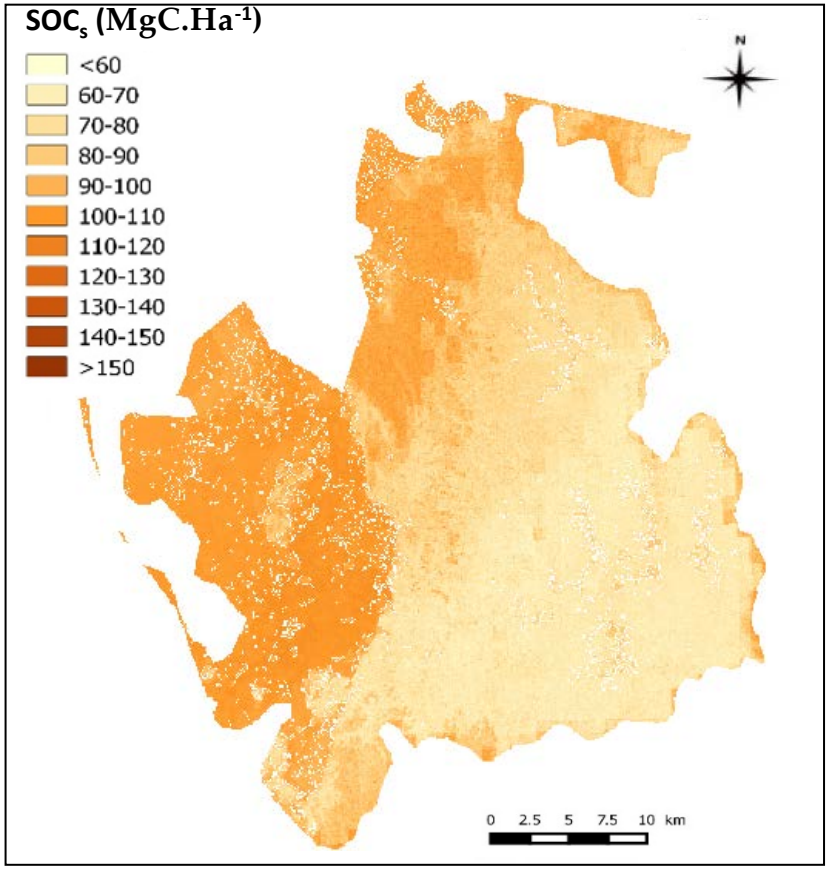

✓ **Map of $SOC_s$ on regional scale (0-30 cm)**

- $R^2$ = 0.55
- RMSE = 24.56 $MgC.ha^{-1}$

- Relevant predictor variable by importance:
  - MAP
  - MAT
  - Elevation

- Range : 60 to 130 $MgC.ha^{-1}$

# Results (3/4)



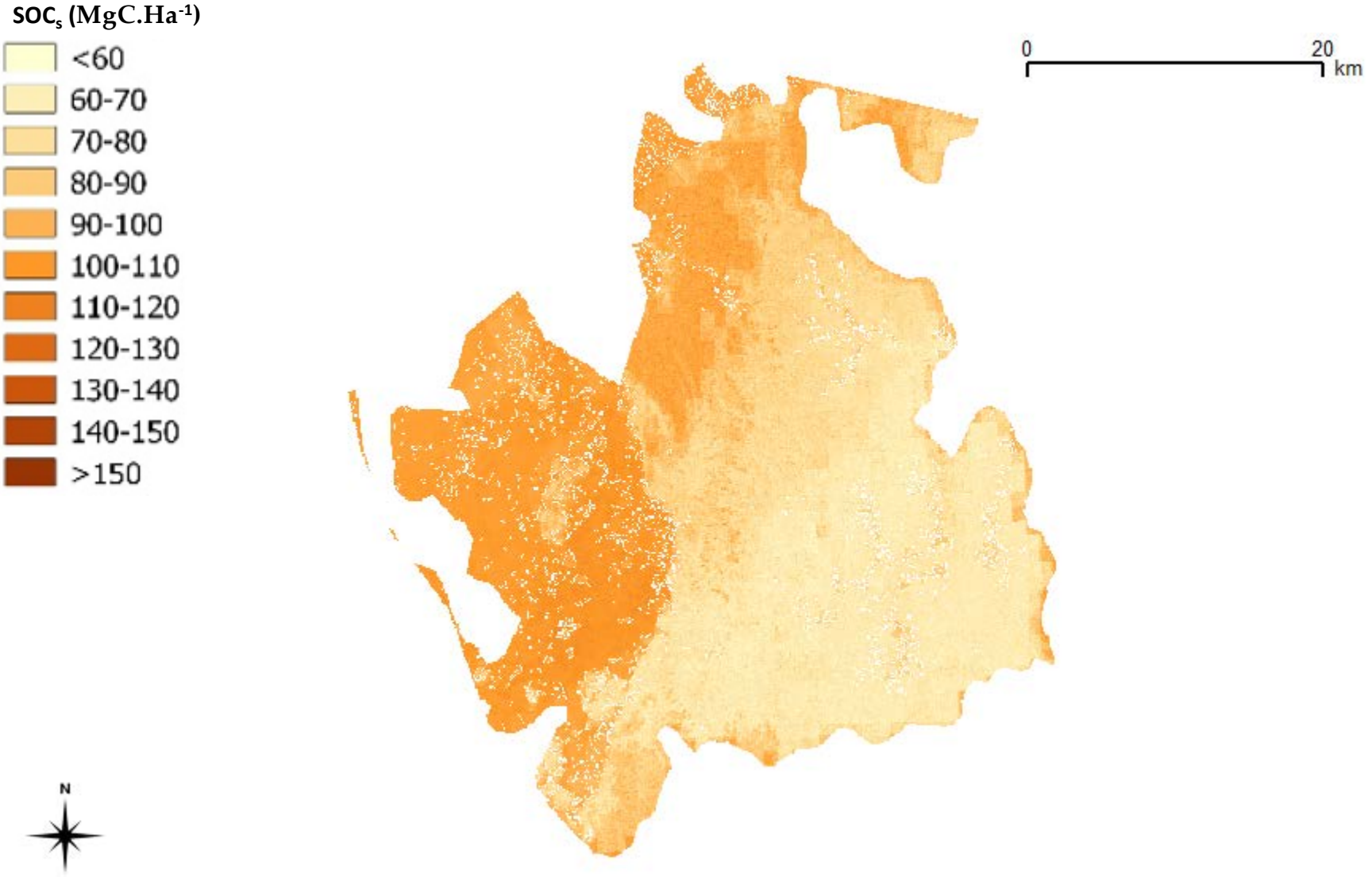

✓ **Map of $SOC_s$ on local scale (0-30 cm of depth)**

- $R^2$ = 0.44
- RMSE = 15.47 $MgC.ha^{-1}$

- Relevant predictor variable by importance:
  - AGB
  - MAP
  - Land cover

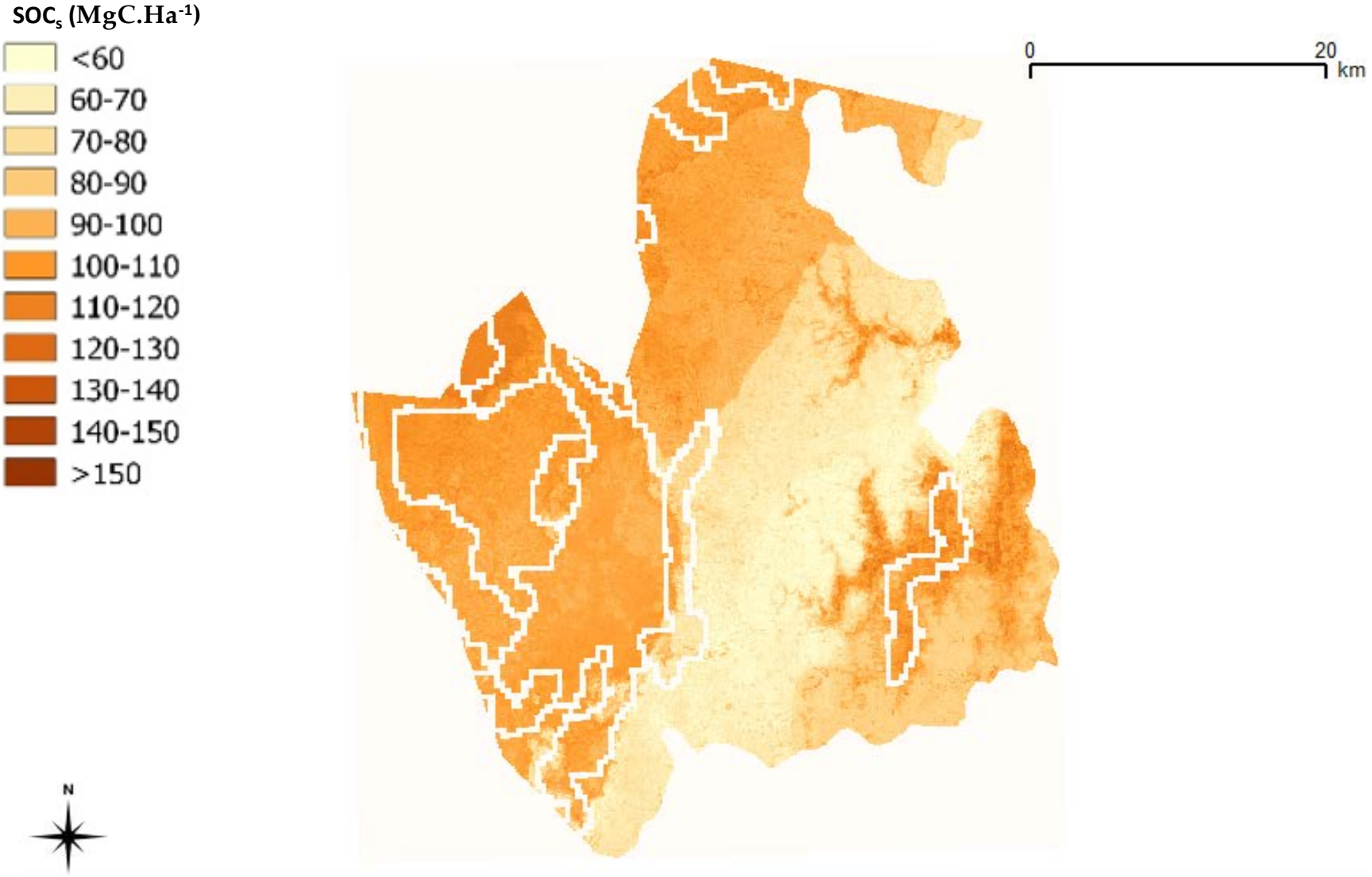
- Range : 60 to 150 $MgC.ha^{-1}$

# Results (4/4)



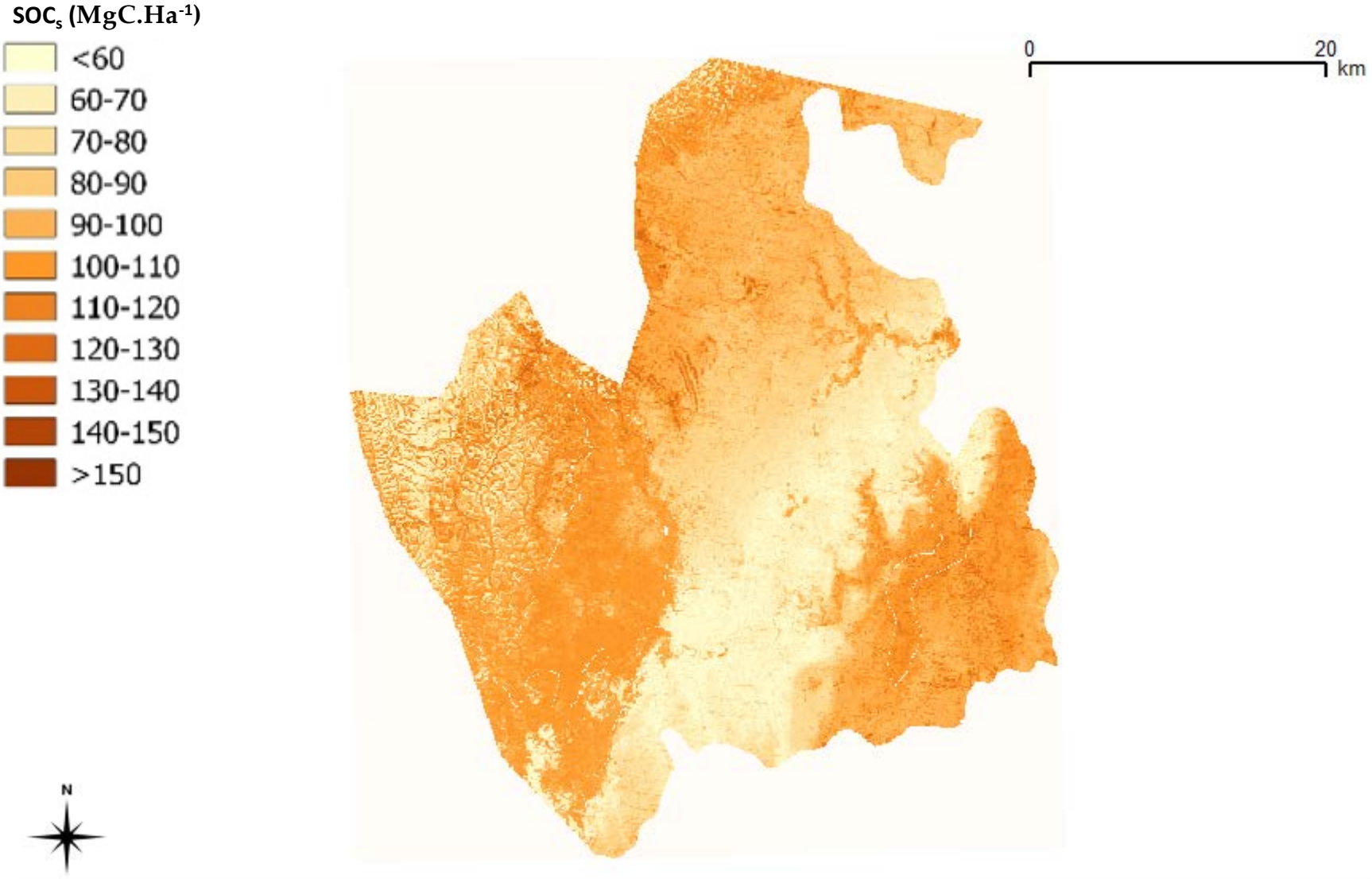

**Didy SOC$_s$ map (0-30 cm) according the local scale (MgC.ha$^{-1}$)**

# Results (4/4)




**Didy SOC$_s$ map (0-30 cm) according the Regional scale (MgC.Ha$^{-1}$)**

# Results (4/4)




**Didy SOC$_s$ map (0-30 cm) according the national scale (MgC.Ha$^{-1}$)**

# Discussion

- **the relevant variable for prediction of $SOC_s$ varied according to level of scale:**
  - range of spatial variable between the scale
  - Number of soils profiles used on the calibration

- **unpredicted pixels :** lack of $SOC_s$ values on the qualitative data

# Conclusion

- Improving of knowledge of $SOC_s$ distribution beetween the scale by using updated database
- Assessing with more precision soil responses to environmental changes
- Work on a local scale for improving map accuracy

**NB: Submission on SI: DSM across the globe (Geoderma Regional)**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