

A Protocol for Measurement and Monitoring Soil Carbon Stocks in Agricultural Landscapes



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Can we measure and monitor soil carbon cost effectively?

Monitoring soil carbon important for multiple objectives:

- critical soil health indicator
- models currently difficult to apply in data poor countries
- carbon trading/credits

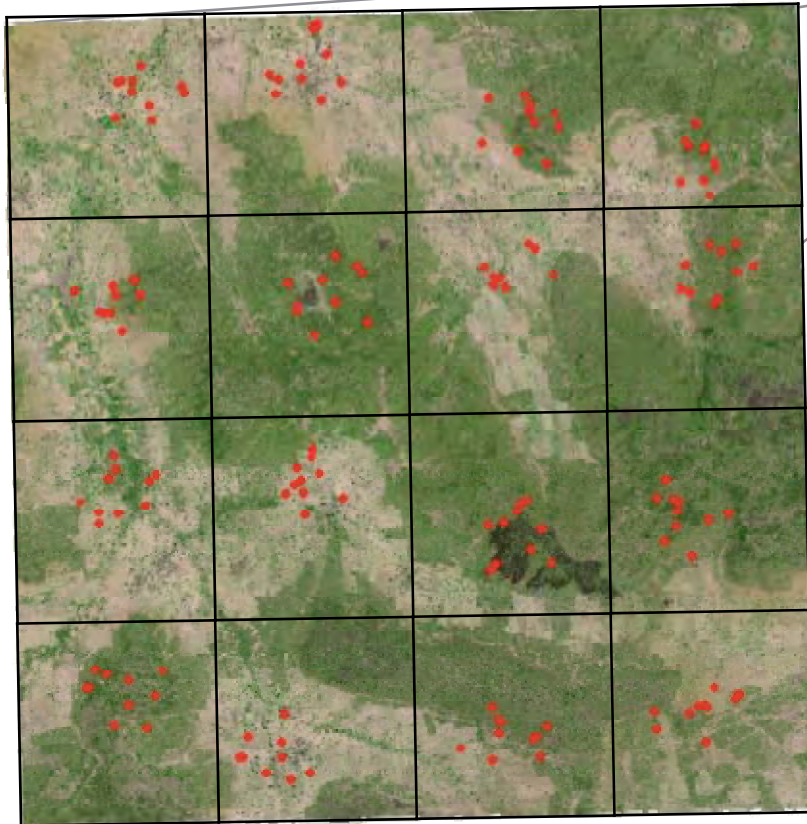
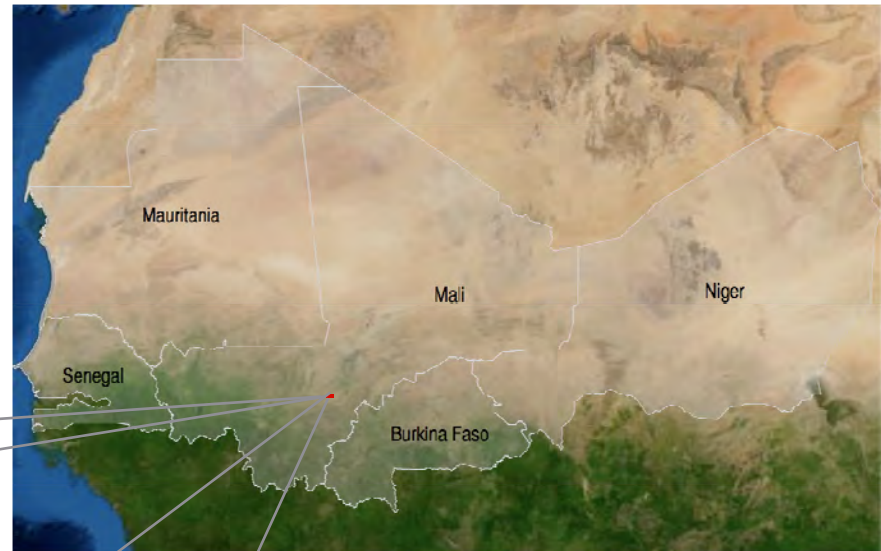
Sampling challenges



- Large local scale spatial variability
- Remote areas/marginal soils
- Long travel times; often on foot
- Mechanized or core sampling impossible

AfricaSoils Sentinel Site

a spatially stratified, hierarchical, randomized sampling framework



Sentinel site (100 km²)

16 Clusters (1 km²)

10 Plots (1000 m²)

4 Sub-Plots (100 m²)

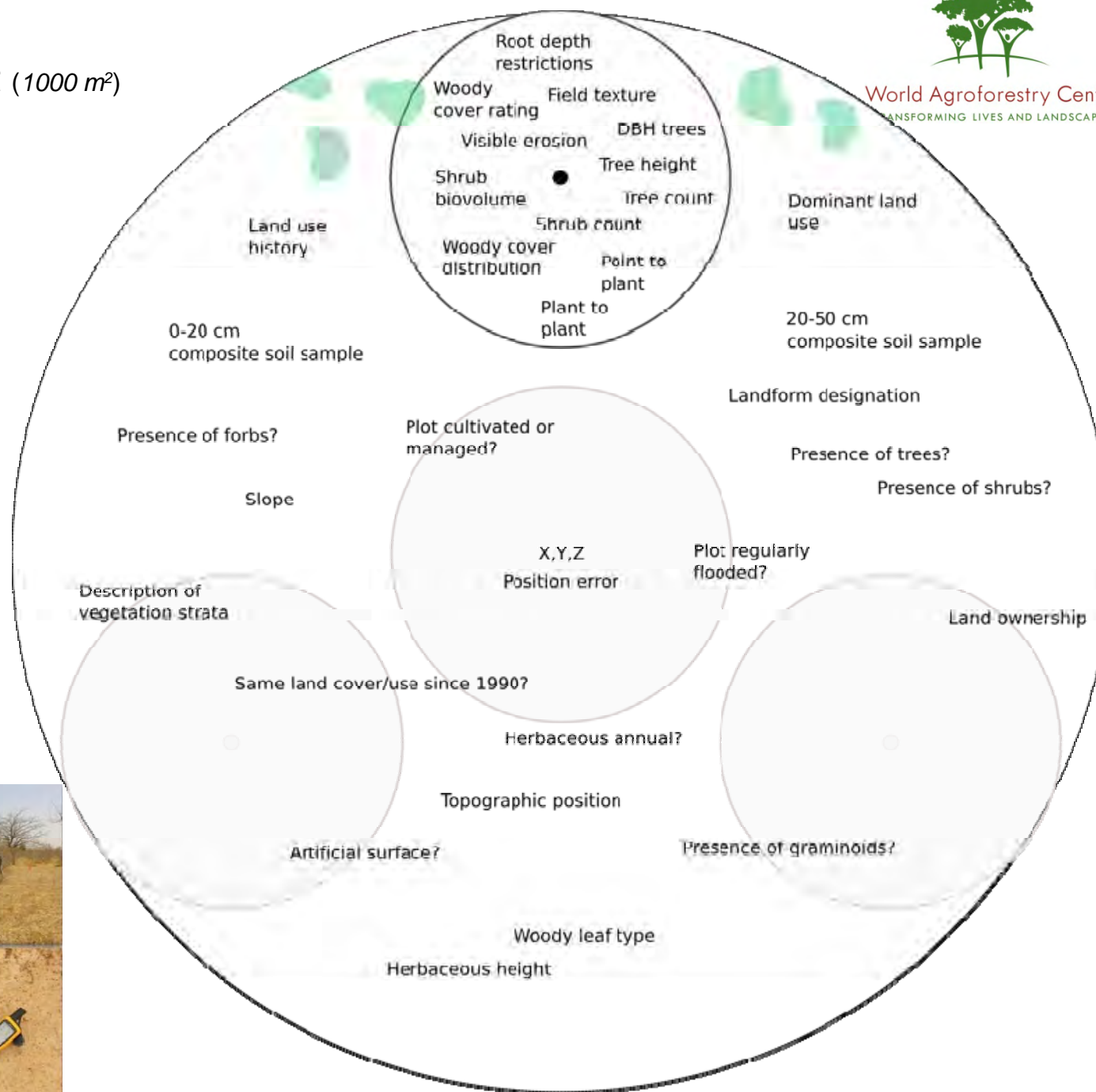


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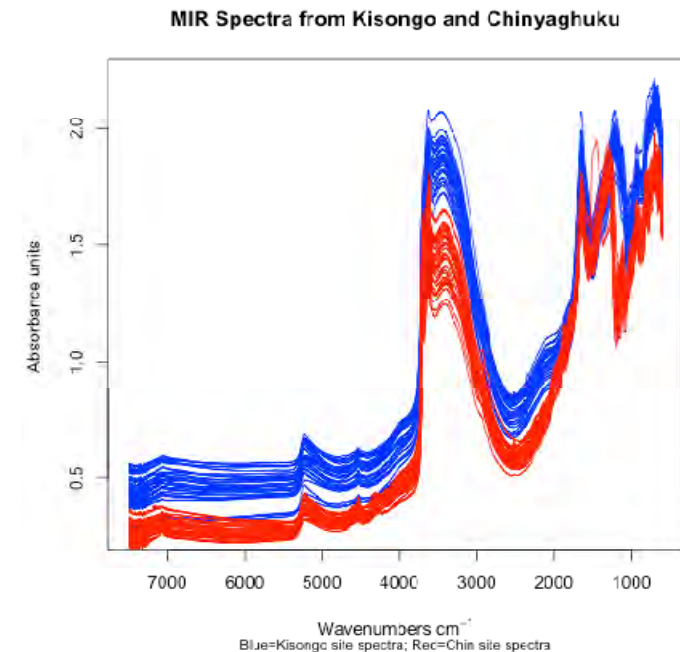


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Sampling plot (1000 m^2) sub-plots (100 m^2)

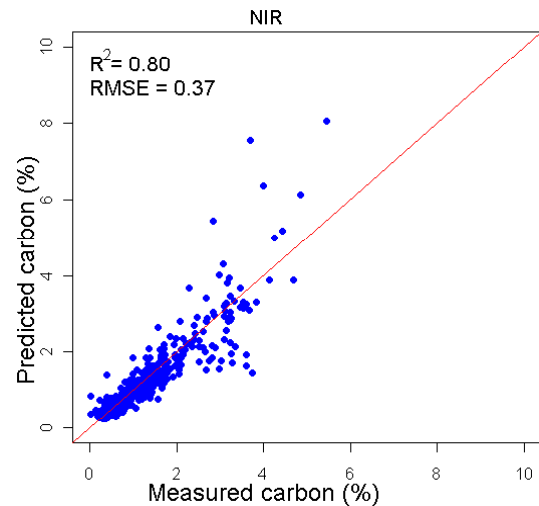


Soil Infrared Spectroscopy for rapid soil characterization

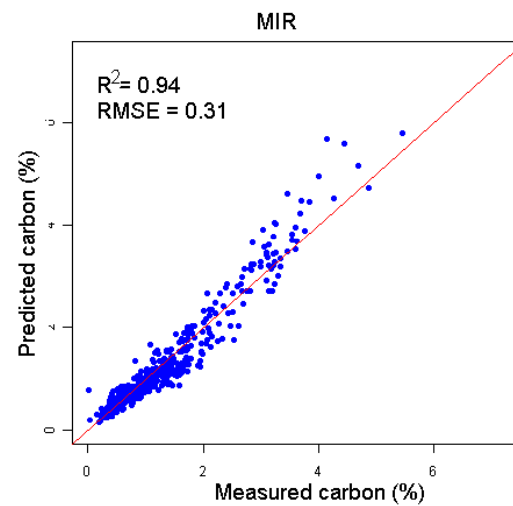


- Rapid
- Low cost
- Reproducible
- Predicts many soil functional properties

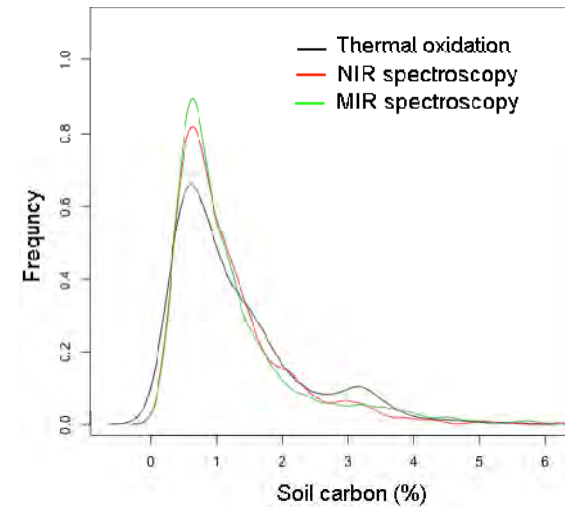
Predicting SOC stocks using soil infrared spectroscopy



(a)



(b)



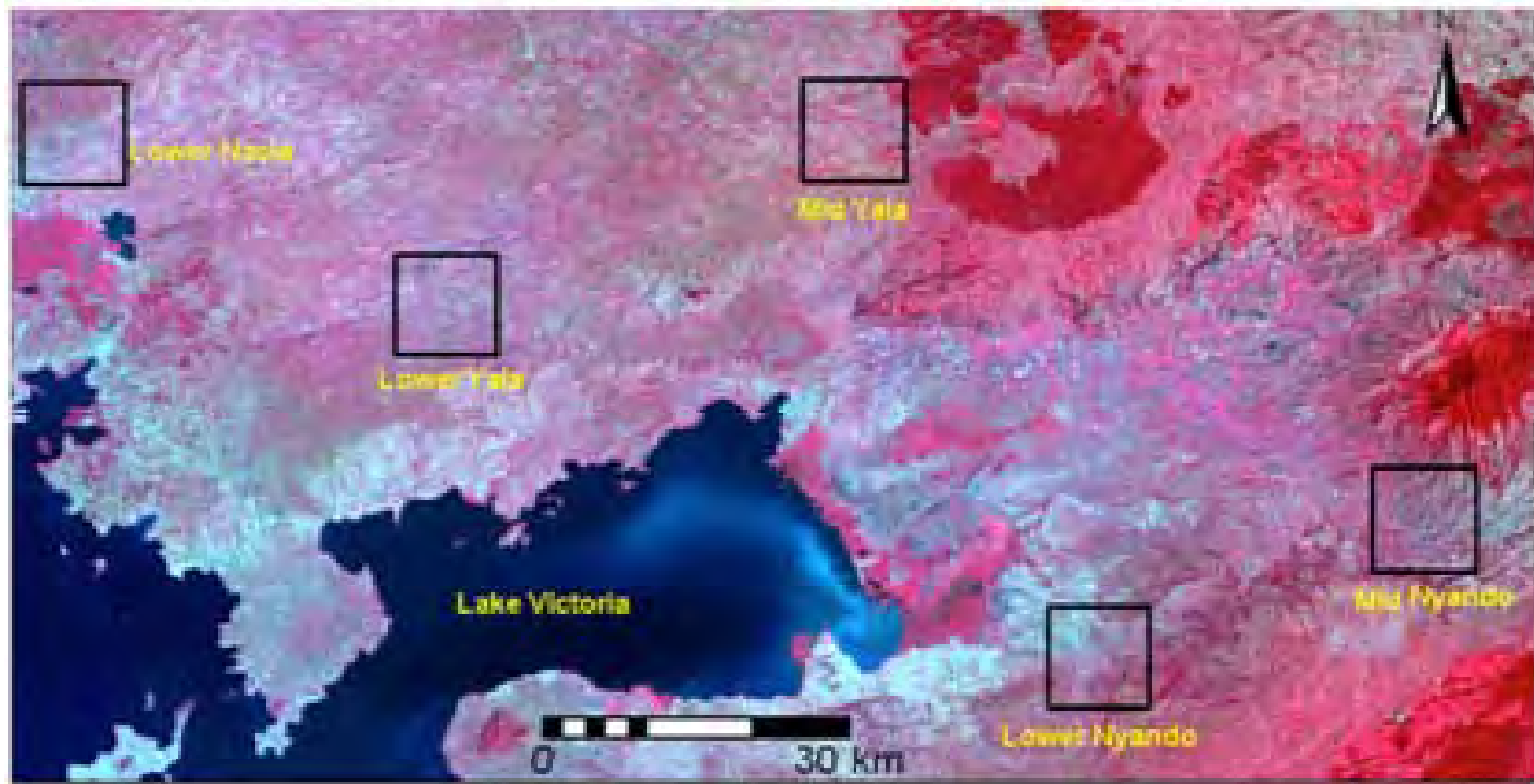
(c)

Partial least squares (PLS) regression analysis:

(a) NIR and (b) MIR cross-validation

(c) density plot showing the reference data using the thermal oxidation and the predicted values using NIR and MIR spectroscopy

Application test site

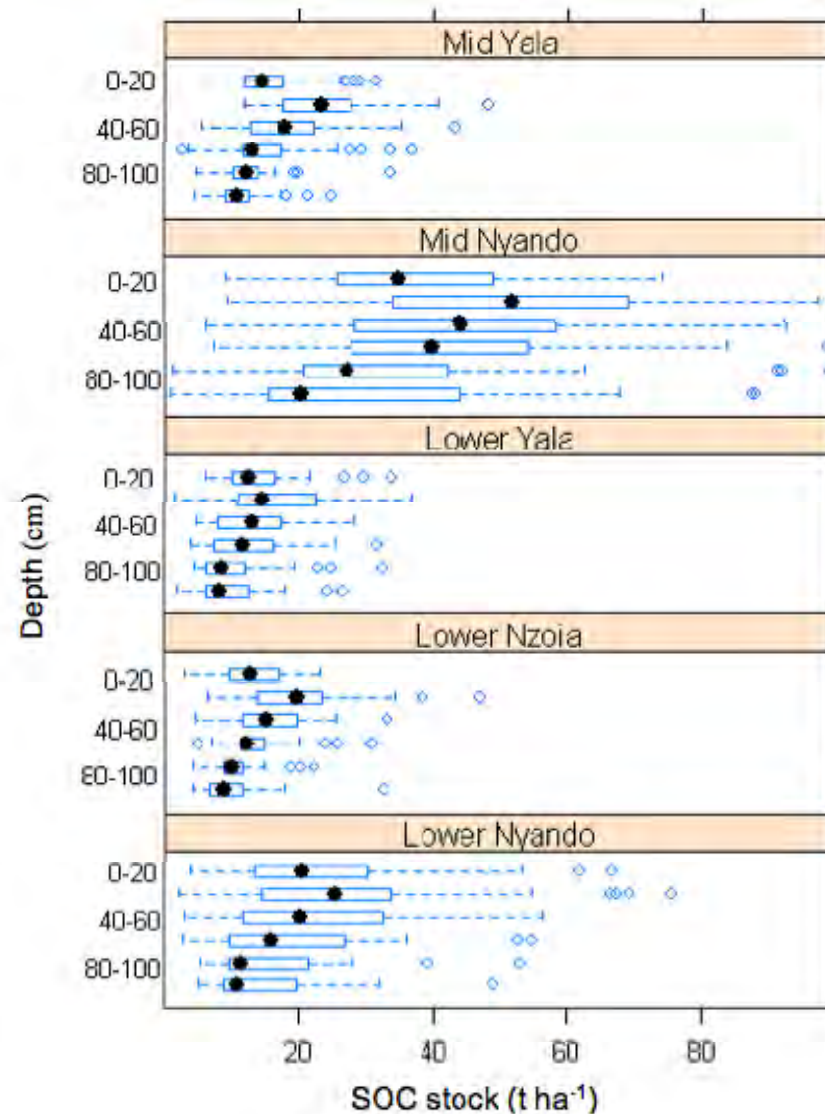


The five sentinel sites in western Kenya. The background is a Landsat MSS (1973) False Colour Composite

SOC stocks



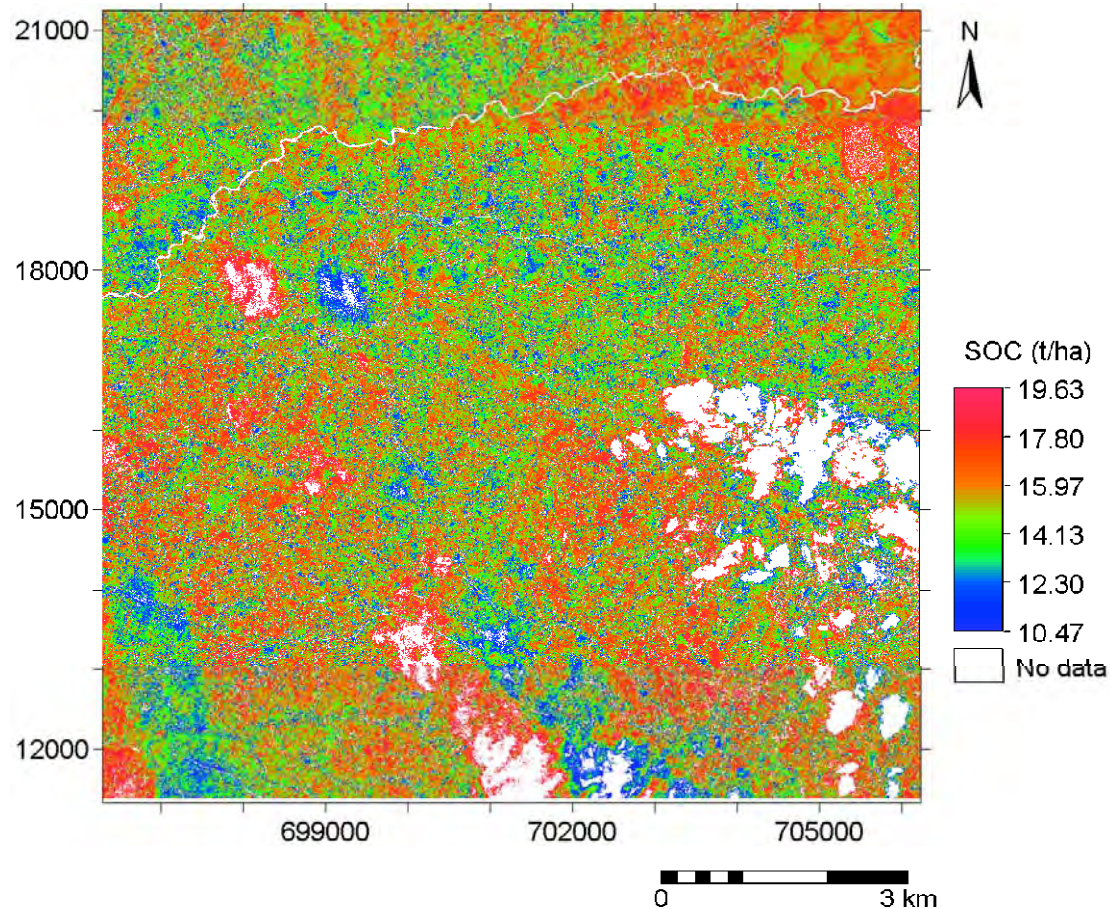
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SOC stocks (t ha⁻¹) in Western Kenya

SOC stocks is highest in the subsoil (20-40 cm) than for the topsoil (10-20 cm) due to low soil mass (bulk density) in the topsoil.

Mapping SOC stocks



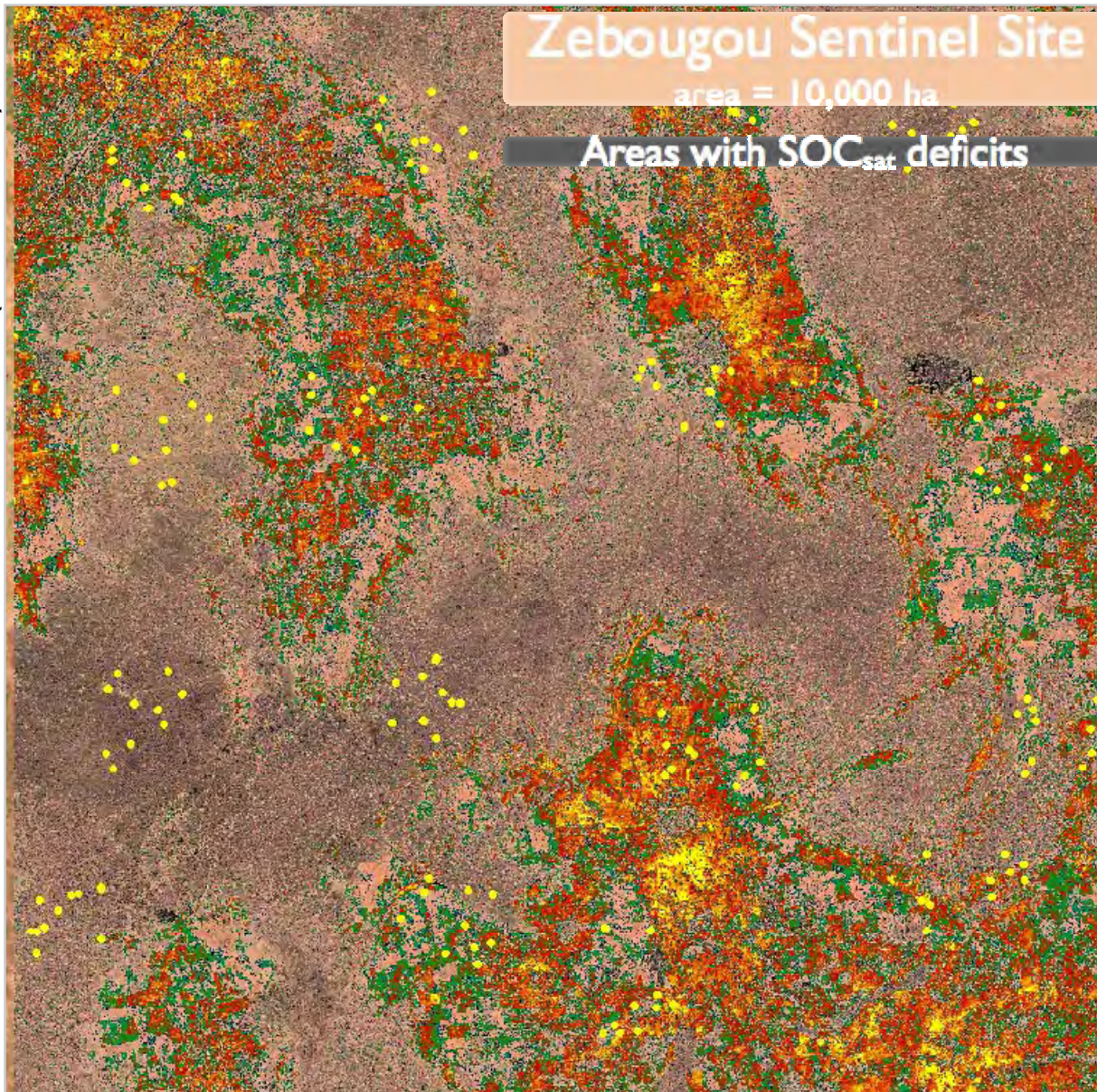
Mapping SOC Stocks using high resolution (QuickBird) satellite image

A landscape level SOC stocks mapping can be made using medium resolution satellite imagery such as ASTER and Landsat

SOC stocks in the mid Yala, western Kenya. The effect of cloud is masked as no data

Examples from UNEP-ICRAF West Africa Drylands Project

Local (site-level) C_{ref}



Quickbird

10 km

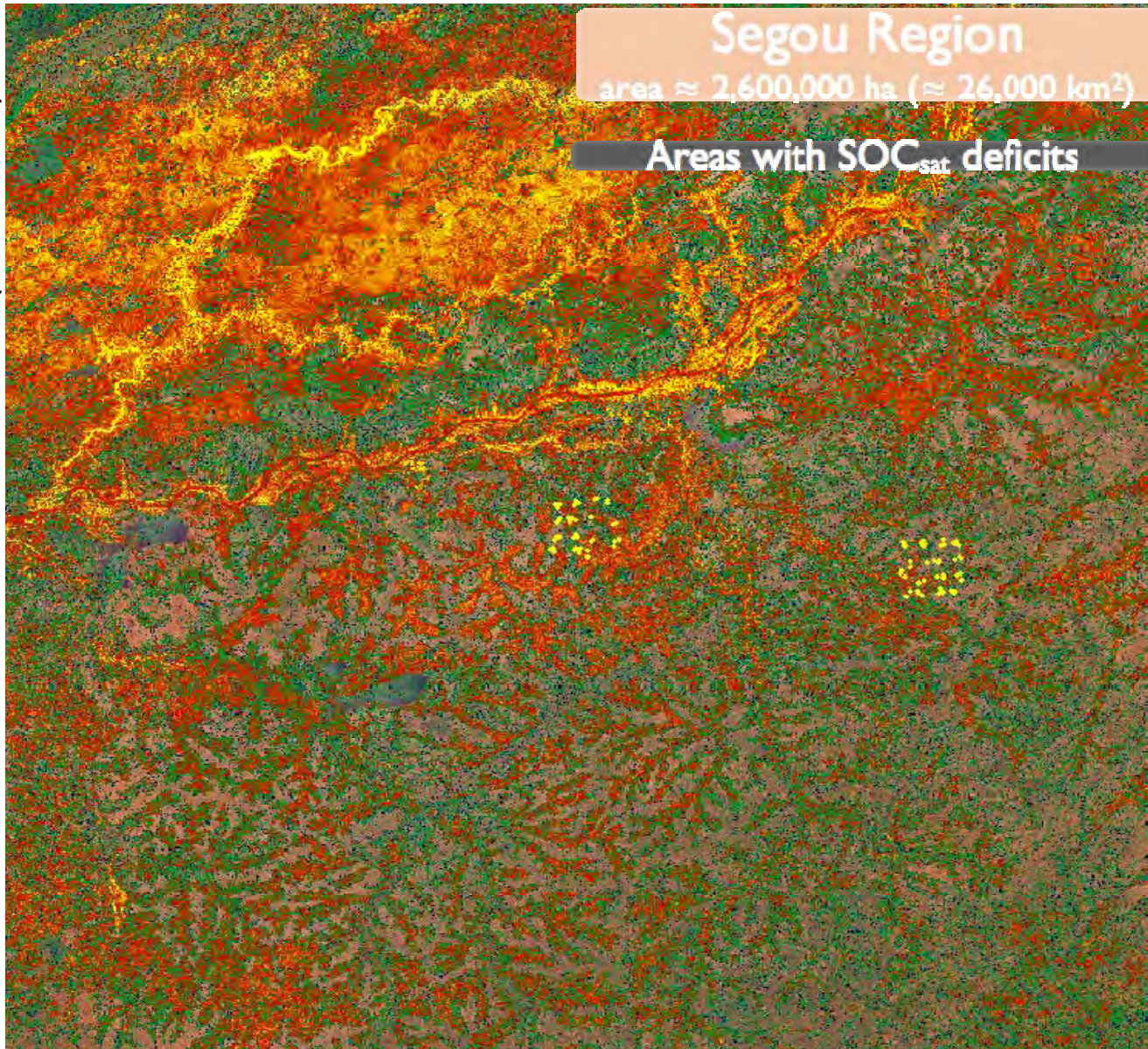
0.064% measured

Very high resolution

Extrapolation to
Landsat

Examples from UNEP-ICRAF West Africa Drylands Project

Local (site-level) C_{ref}



Landsat ETM+

160 km



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Soil organic matter and non-CO₂ GHGs



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Soil Organic Carbon and Non-CO₂ GHGs | CBP +

http://www.goes.msu.edu/cbp/soils.html



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Carbon Benefits Project: Modelling, Measurement and Monitoring

You Are Here: [Home](#) » [Measurement Guidelines for Soil Organic Carbon and Non-CO₂ GHGs](#)

Measurement Guidelines for Soil Organic Carbon and Non-CO₂ GHGs

The documents on this page provide specific guidelines for field, laboratory and remote sensing measurements of soil organic carbon and other non-CO₂ greenhouse gases. These guidelines require extensive field measurements to measure soil organic carbon stocks and emissions of methane and nitrous oxide within the project area. The data derived from measurements can be used directly for reporting GHG emissions or the measurement data may be used as inputs for CBP modelling assessments.

Guidelines to Measure Soil Organic Carbon

A methodology to measure soil organic carbon stocks in agriculture, forestry and other land uses incorporating field measurements, laboratory analysis, remote sensing, data management, and reporting forms. [Click HERE](#) to download an Excel file with sample calculations.

Guidelines to Measure Non-CO₂ Greenhouse Gases

A methodology to measure soil emissions of methane and nitrous oxide in agriculture, forestry and other land uses incorporating field measurements and laboratory analysis.





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Project Planning Tools

Project Planning | CBP
<http://www.goes.msu.edu/cbp/planning.html>

Project Planning Tools

Project Planning Tools provide supporting information for project managers during the development phase of biocarbon and other sustainable land management projects. The information provided is useful for making decisions on which trees to plant based on a large database of agroforestry trees, to estimate the economic benefits that can be expected from participating in the carbon markets by planting trees and support in setting up project boundaries using available maps.

Agroforestry Database

Detailed information for 670 agroforestry trees.



Useful Tree Species for Africa

A species selection tool based on "The Vegetation Map of Africa" website.



Multi Criteria Tree Species Selection Tool

Click here to download the spreadsheet tool to prioritize tree species for planting. Click here for guidelines to use the MCTS tool.



Project Boundary Tool

A tool to help define project boundaries.



Stratification Tool

A tool to help stratify land cover classes within the project boundaries.



Data Management Tool

Click here for guidelines to set up a structured data management system. Click here to download sample databases.



Community Participation Manual

A manual to engage local communities in carbon measurement and monitoring.



Training the Trainers Manual

A manual to train extension workers who are training local communities for landscape carbon measurement.



CBP and other Carbon Standards

A manual to compare the CBP with other existing carbon standards.



AgroforestTree data base updated to include socioeconomic information

Agroforesttree Database | World Agroforestry Centre

http://www.worldagroforestry.org/resources/databases/agroforesttree

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Search

Distribution Range


--Select-- ☒ Native ☐ Exotic

Products and Services

<input type="checkbox"/> Food	<input type="checkbox"/> Intercropping
<input type="checkbox"/> Fodder	<input type="checkbox"/> Shade/shelter
<input type="checkbox"/> Apiculture	<input type="checkbox"/> Reclamation
<input type="checkbox"/> Fuel	<input type="checkbox"/> Boundary/Barrier
<input type="checkbox"/> Timber	<input type="checkbox"/> Ornamental
<input type="checkbox"/> Wax	<input type="checkbox"/> Soil Fertility
<input type="checkbox"/> Lipids	<input type="checkbox"/> Poison
<input type="checkbox"/> Gums/Resins	<input type="checkbox"/> Latex/Rubber
<input type="checkbox"/> Tannin_Dyestuff	

Species name (Starts with..)

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z



Decision support tool for selecting which trees to plant

Microsoft Excel - Appendix 4.4-MCTS tool.xls

File Edit View Insert Format Tools Data Window Help

Type a question for help

Arial 8

C41 =1.INPUT.Species.Score!P\$5

115%

1 **Remarks:**

2 sum of criterium group weights should be equal to 1 (pink cells)

3 sum of individual criterium weights per criterium group should be equal to 1 (yellow cells)

29

30

31 Scenario description short Scenario detail

32 **SCENARIO 1:** dry forest restoration tree seedling enrichment planting in existing forest patches

33 # groups Σ group weights

34 6 1.000

35

36 **Socio-economic functions** **Socio-cultural values** **Environmental services** **General**

37 # criteria/group group weight # criteria/group group weight # criteria/group group weight # cri

38 13 0.283 3 0.082 11 0.089

39 **Criteria** **weight** **Criteria** **weight** **Criteria** **weight** **Criteria**

40 firewood - charcoal 0.219 ceremonial value 0.168 protection against erosion 0.088 drought

41 construction wood 0.233 ornamental value 0.224 land reclamation 0.037 resist v

42 (agricultural) tools 0.105 considered important 0.608 provision of shadow 0.132 resist c

43 honey production 0.058 effect on soil humidity 0.169 frost re

44 food 0.075 effect on nutrient availability 0.154 perf or

45 resin-gum-latex 0.016 nurse plant effects 0.037 perf or

46 fodder 0.131 intercropping (agroforestry) 0.081 growth

47 medicinal use 0.044 windshelter 0.074 experie

48 dye-tannin-oil 0.014 live fence 0.162 region

49 fibre-rope 0.044 invasiveness 0.029 sexual

50 cosmetic 0.016 pests-diseases 0.037 vegeta

51 toxic 0.014 coppic

52 repellent 0.030

53

54 sum of weights 1.000 sum of weights 1.000 sum of weights 1.000

55

INTRO 1.INPUT.Species.Score 2.INPUT.Crit.Weight 3.OUTPUT.Intern.(Sc.D) 4.OUTPUT

Draw AutoShapes

Ready NUM

start Appendix 4.4 & 4... Inbox - Outlook ... Microsoft Excel - ... Appendix 4.5-MC... Search Desktop NL 10:23

Input sheet for scenarios and criteria weights.

Red circle: new scenario defined (dry forest restoration); **Lower green fields:** criteria weights which can be adapted by the user.

¿ Thanks for a future !?



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