



Food and Agriculture
Organization of the
United Nations

Training Workshop for Reporting Soil Carbon Stock Change in National Greenhouse Gas Inventories

1st December 2022

**Setting up a Monitoring, Reporting and Verification
(MRV) system for soil organic carbon in agricultural
lands:**

RECSOIL Protocols

Guillermo Peralta – FAO GSP

Promoting sustainable soil management for all



Why an MRV ?

- **SOC** stocks and other soil properties usually show a **high spatial variability**
- **Changes** in **SOC** stocks and other soil health indicators **cannot be easily measured**

Smith et al., 2021 (Global Change Biology)

- Absence of harmonized **measurement / monitoring, reporting and verification (MRV) platforms** ...a **key barrier** to implementing programs to increase SOC at large scale.
- Urgent need! Without such platforms, **investments could be considered risky.**

But also...

- Multiple MRV Protocols (at least 20; public/private sector), vary from one carbon offset program to another
- Many of them complex, extremely costly to implement
- Need for a “common language” between different projects from different countries, but flexible enough to adapt to local conditions.

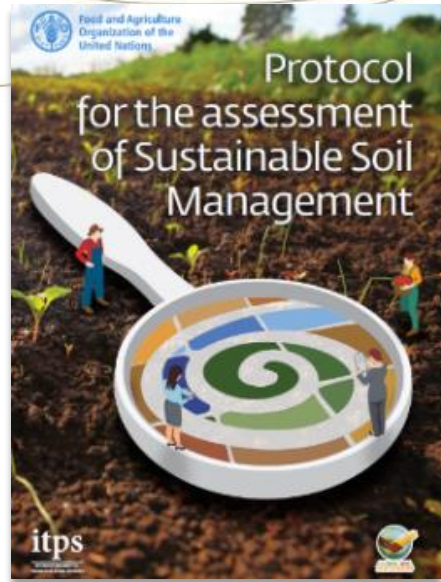
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Since 2017 FAO - ITPS - GSP ... development of MRV Protocols and Platforms

SSM Protocol

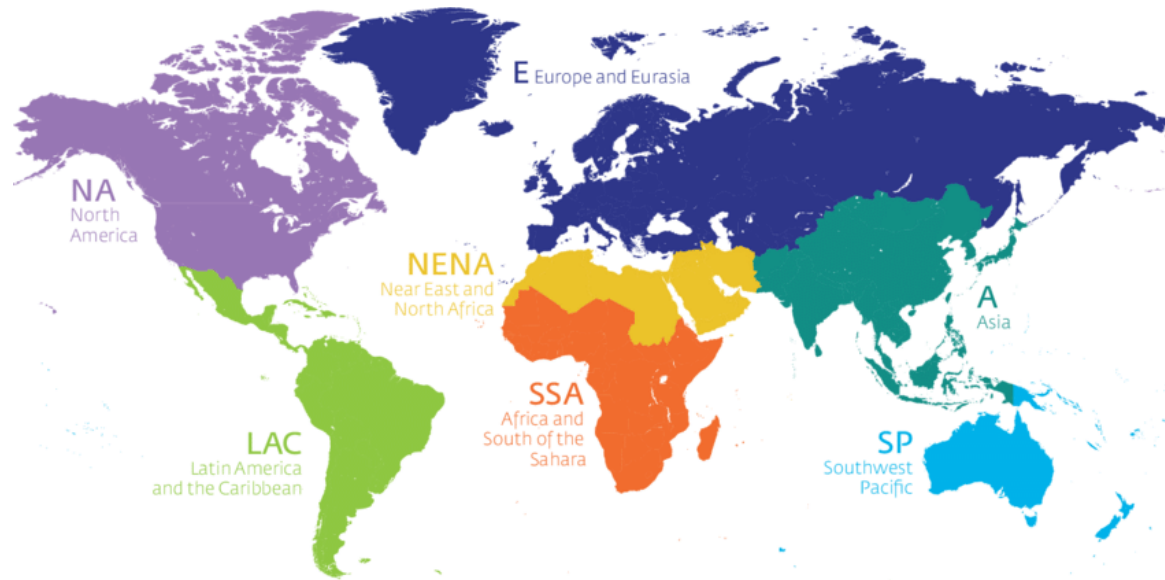
+ 200 experts from all regions in the world



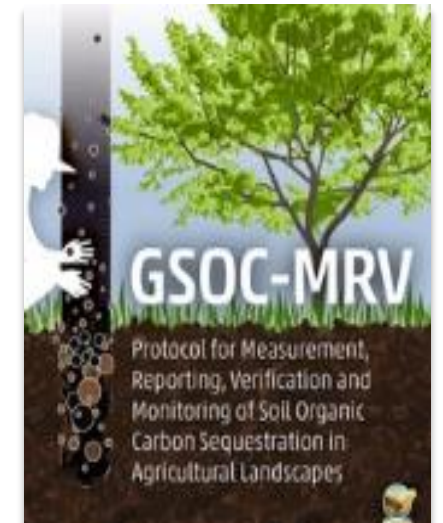
RECISOIL Green Path

Focus:

- ✓ Soil health and Ecosystem services (SOC as an indicator)



GSOC MRV Protocol



RECISOIL Carbon Path

Focus:

- ✓ Carbon credits (Through MRV of SOC sequestration and GHG reductions)



RECISOIL Green Path -SSM Protocol - Key Steps

Implementation steps of the RECISOIL GREEN PATH

Technical training and capacity building

- Farmers (Global Soil Doctor Programme)
- Soil laboratories (through GLOSOLAN)
- National technical support (through GSP Secretariat)

PHASE III

Definition of project area and priorities to implement RECISOIL

- Selection of project area and land uses
- Definition of objectives: evaluation of SOC sequestration, addressing of other soil threats
- Identification of national stakeholders and distribution of responsibilities
- Gathering of spatial, management and socioeconomic data of the project area - Metadata
- Stratification of the project area
- Definition of the sampling design and density

PHASE II

PHASE I

Identification of priority countries to implement RECISOIL

Based on the GSOCseq map and country readiness

Baseline assessment and identification of soil management interventions

- Baseline assessment through three datasets
- Identification of soil management interventions

PHASE IV

PHASE V

Implementation of SSM, monitoring, measuring, and reporting

- Implementation of sustainable soil management practices
- Annual monitoring
- Mid-term reporting

PHASE VI

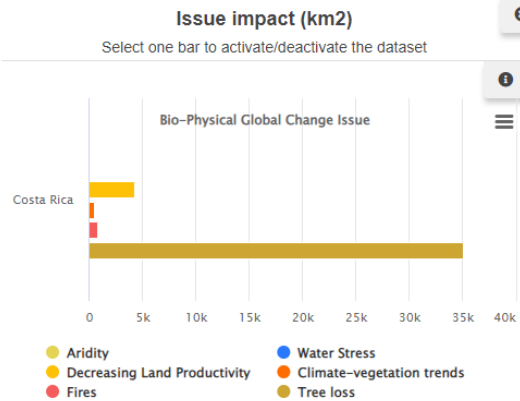
Soil organic carbon sequestration and soil health final verification

- Final assessment of soil health status (4 years after the implementation of SSM practices):
- Final estimation of SOC changes
- Final project report

RECISOIL Green Path -SSM Protocol - Key Steps

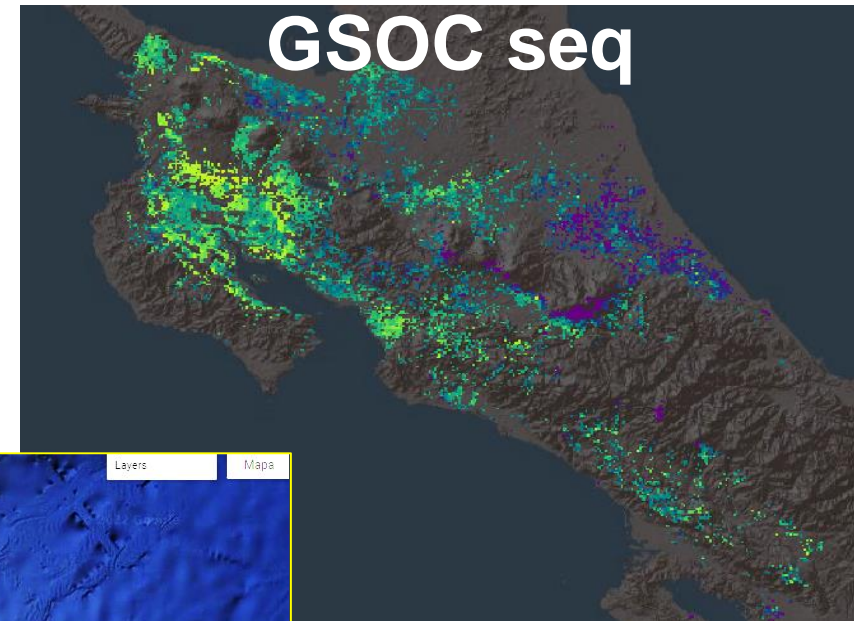
Identification of **Priority** areas and Definition of Project Areas

Convergence of Global Change Issues



Biophysical + socio-economic

<https://wad.jrc.ec.europa.eu/countryreport>



Earth Engine Apps

Select Issues

- | | | | |
|---|--|---|---|
| <input checked="" type="checkbox"/> N deficit | <input checked="" type="checkbox"/> N surplus | <input checked="" type="checkbox"/> Aridity | <input checked="" type="checkbox"/> Built |
| <input checked="" type="checkbox"/> Fires | <input checked="" type="checkbox"/> GNI | <input checked="" type="checkbox"/> Livestock exess | <input checked="" type="checkbox"/> LPD |
| <input checked="" type="checkbox"/> Neg. Veg. Trend | <input checked="" type="checkbox"/> Population | <input checked="" type="checkbox"/> Pop. change | <input checked="" type="checkbox"/> Forest loss |
| <input checked="" type="checkbox"/> Water Stress | | | |



Identification of **"HOTSPOTS"** with greater convergence of issues + Greater Sequestration Potential

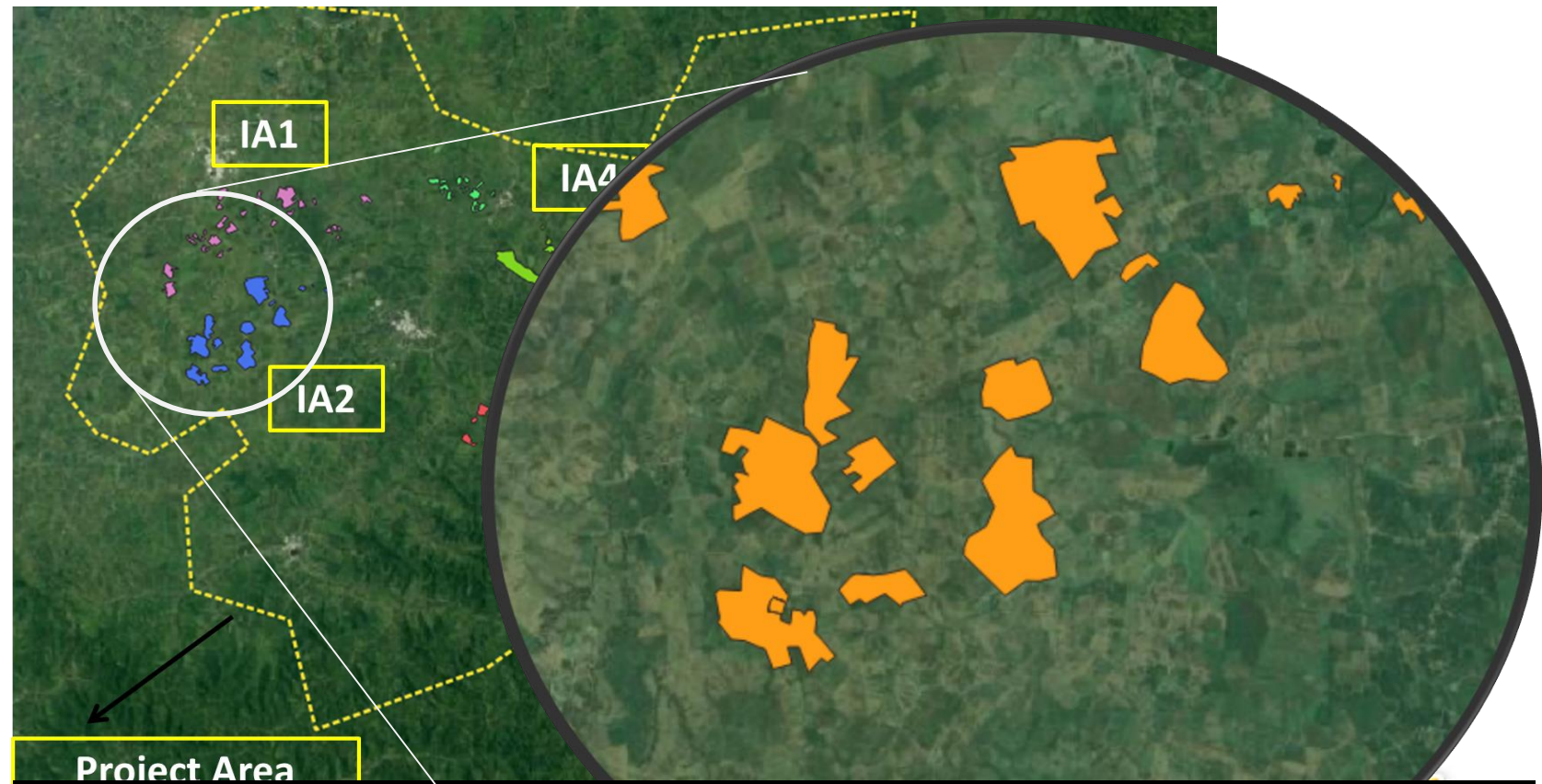
... Once the Total Area of the Project has been identified ... Identification of **Intervention Areas (IAs)**

- Represent the **specific areas** where similar sustainable soil management (**SSM**) practices will be **implemented**; where **SOC changes and GHG emissions will be estimated**
- same agro-ecological zone, with similar land use and farming system



1 IA = 1 Field/ Ranch / Farm

Contiguous IA



Project Area

One IA = multiple Fields / Ranches / Farms / Paddocks with similar systems, within the same agro-ecological region. Non-contiguous IAs

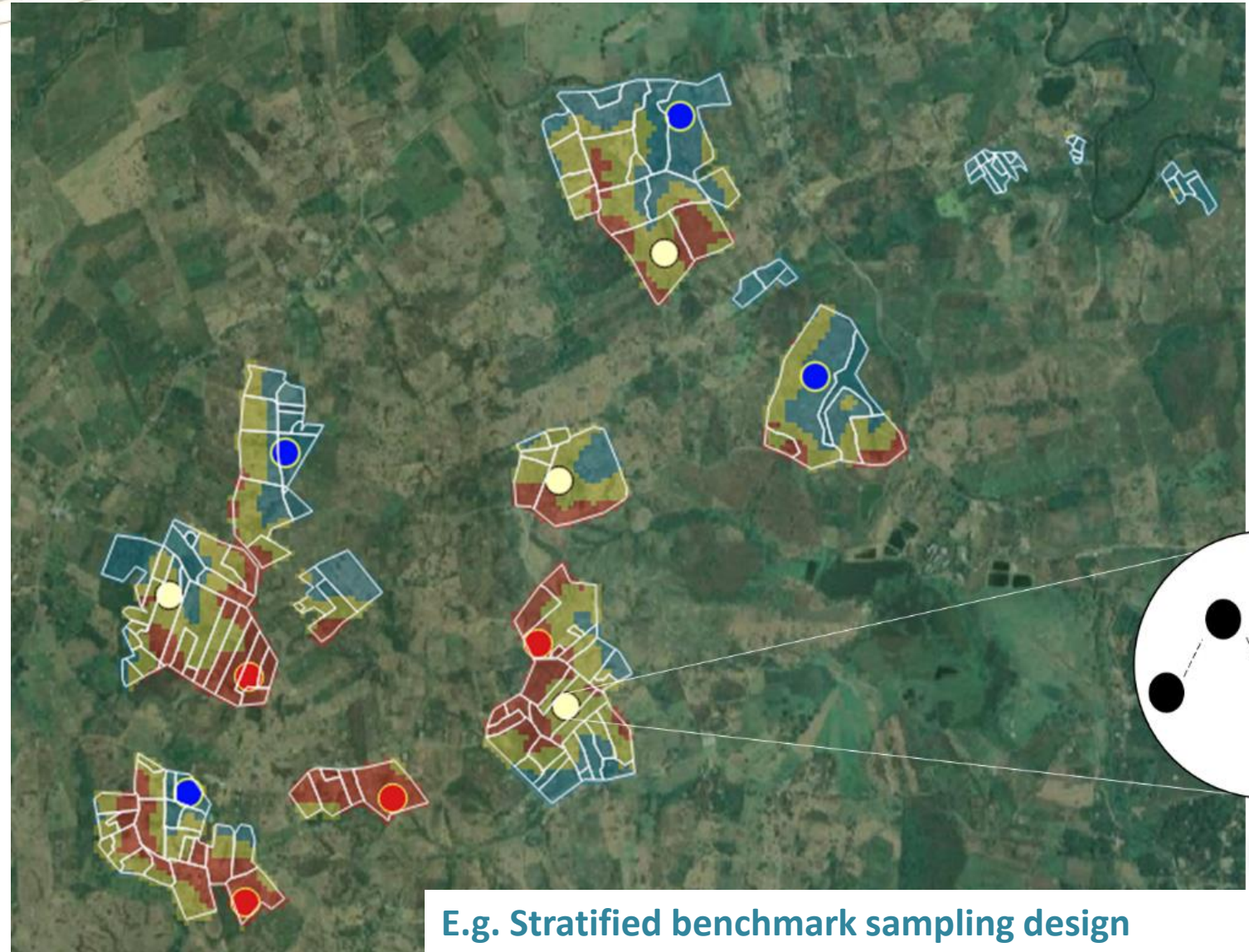
RECISOIL Green Path -SSM Protocol - Key Steps

Definition of Project Areas, Intervention Areas, **Strata - Assessment Units**

IAs are then
Divided into Strata -
Assessment Units (AUs)

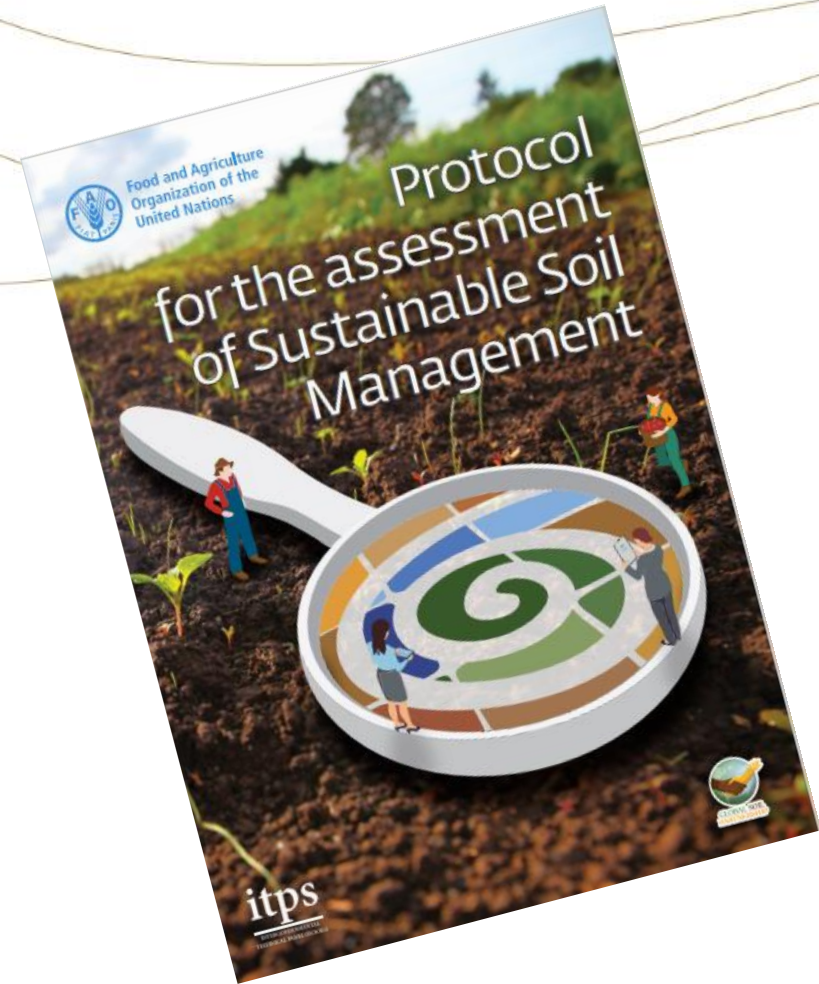
An AU or stratum represents a land area being relatively homogenous in terms of biophysical features, including:

- climate,
- soil type, topography (e.g. slope position), hydrology,
- **historic land use and management, among other factors**





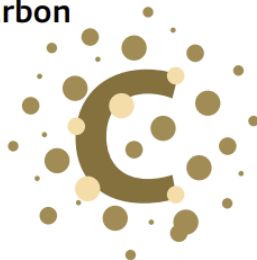

E.g. Stratified benchmark sampling design

RECISOIL Green Path -SSM Protocol - Monitoring Phase



SSM Protocol - Based on the assessment of :

- **4 key indicators (common to all RECISOIL projects)**
- **Visual Soil Health Assessment (VSA)**
- and a set of **additional indicators** to assess soil health (physical, chemical and biological indicators)

Soil productivity	Agricultural productivity or biomass in dry matter ($\text{t ha}^{-1} \text{year}^{-1}$)	Soil physical properties	Bulk density (kg dm^{-3}) In some cases, bulk density can be complemented by available water capacity, or other relevant soil physical properties <i>(See additional indicators)</i>
			
Soil organic carbon	Organic carbon (%)	Soil biological activity	Soil respiration rate ($\text{gCO}_2 \text{ m}^{-2} \text{d}^{-1}$) Ideally combined with at least one other biological indicator <i>(See soil biological activity p. 4 and 5)</i>
			

https://www.fao.org/fileadmin/user_upload/GSP/SSM/SSM_Protocol_EN_006.pdf

Being updated!!!

RECISOIL Green Path -SSM Protocol - Monitoring

Additional Indicators -

(depending on the main threats to soil health)



Soil Nutrients
(P, N, K, etc)



Available water capacity
(FC-PWP)
Water infiltration



Biological activity
(Enzymatic activity, microbial biomass, etc.)



Soil salinity
(EC- Electrical conductivity)



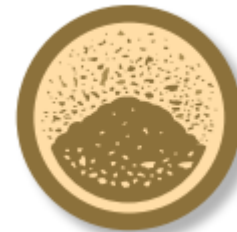
Soil penetration resistance



Diversity
(e.g. pitfall traps, etc)



Acidity – Alkalinity
Soil pH



Erosion
(USLE, erosion pins, Gerlach boxes, etc)



Soil pollution
(concentration, trace elements, pesticides, etc)

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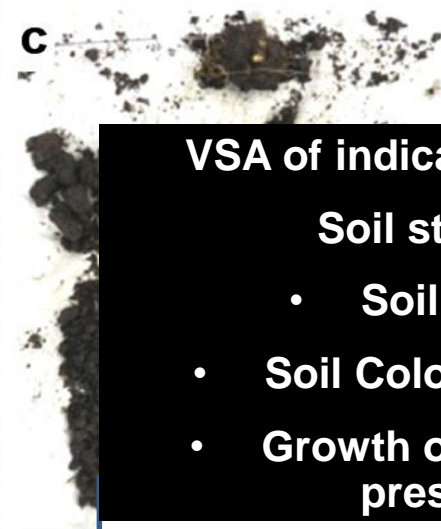




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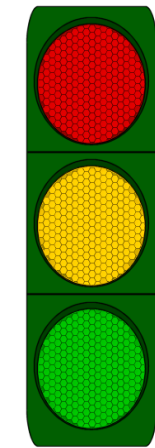


Visual Soil Health assessment – (quali – quantitative) (Based on Shepherd 2008 – FAO Guidelines)



VSA of indicators such as:

- Soil structure
 - Soil Porosity
 - Soil Color and mottles
 - Growth of roots, fauna presence etc



Poor condition

Moderate condition

Good condition

RECSOIL Green Path –SSM Protocol - Monitoring

- Countries have started to introduce their additional indicators.
- Costa Rica RECSOIL Pilot



Example. Grassland CR pilot:

- Vegetation cover %
- % Living Fences
- % Area Improved Pastures ,
- Applied compost (0=none; 1=5 t/ha; 2=5-10 t ha; 3=>10 t/ha)
- And other specific indicators!

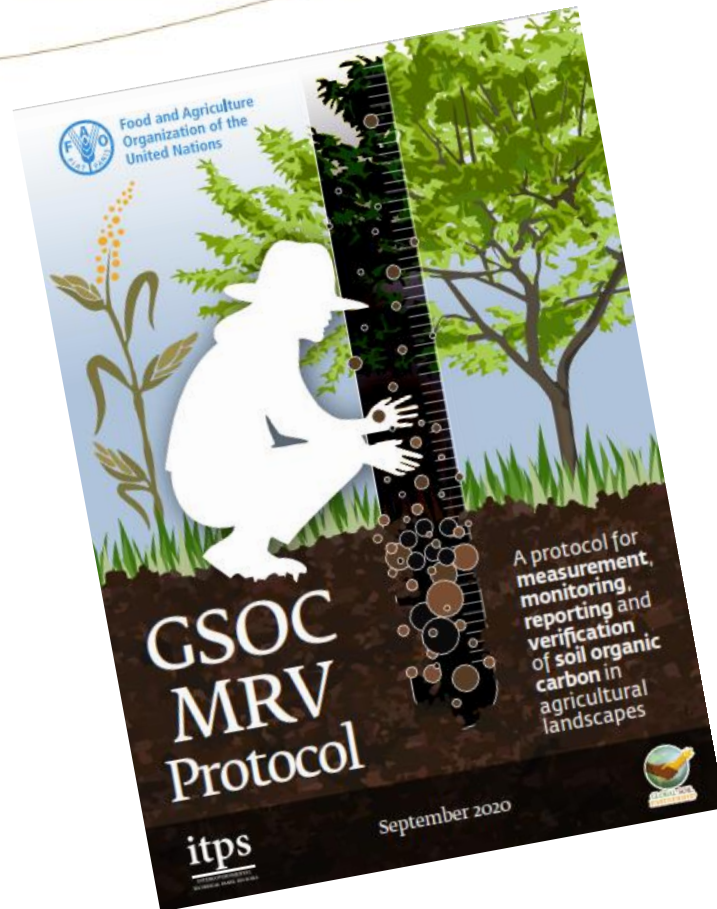
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GLOBAL SOIL
PARTNERSHIP

2. GSOC MRV Protocol -Carbon Path

Objective: provide standard methodologies for the monitoring, reporting and verification SOC stock changes and GHG emissions/removals from agricultural projects.



Key aspects of GSOC MRV

- Only applicable to certain lands and activities
- Minimum of 8 years to be applied.
- General methodology:
 - Soil Measurements : SOC, BD, POC (optional) baseline, and every 4 years
 - + SOC Modeling (bi-annual)
 - + GHG estimates (IPCC, 2019 GL) (bi-annual)
 - periodic auditable reports.

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Applicability conditions: Eligible Lands

GSOC MRV

The FAO protocol restricts its applicability to these conditions:

- a) **wetlands** and **peatlands**, or lands that have been subject to the **drainage** of a wetland or peatland during a baseline period (past 10 years)
- b) **organic soils**, Histosols, or soils having a histic or folic horizon (FAO, 2015);
- c) current native **forest lands**, or lands that have been native forest lands and were converted to grasslands or croplands / **defforested**, at any point during a baseline period (at least past 10 years)



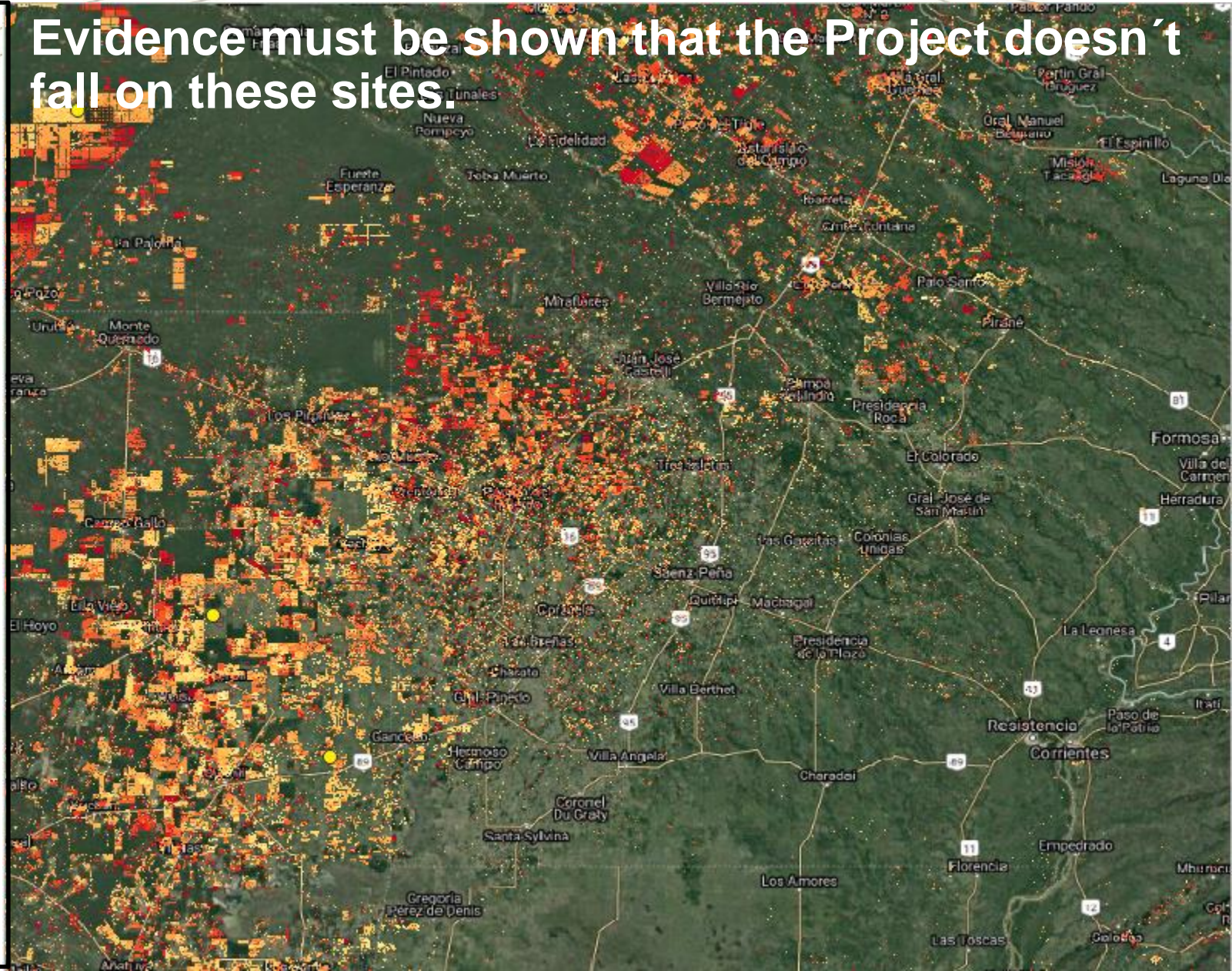
Applicability conditions: Eeligible Lands GSOC MRV

Evidence must be shown that the Project doesn't fall on these sites.

Recently Deforested Areas

Example Global Forest Change Database

Global Forest Change Database v1.8 (2000-2020), downloadable from Google Earth Engine at a 30 m resolution. This datasets includes forest loss during the study period, defined as a stand-replacement disturbance (a change from a forest to non-forest state); Tree canopy cover for year 2000, defined as canopy closure for all vegetation taller than 5m in height; and the year of gross forest cover loss event. Potapov et al. (2020).

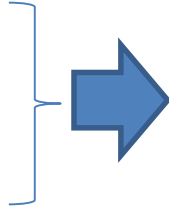


Carbon Path - GSOC MRV Protocol

Monitoring: Soil sampling

What to Measure?

- Total SOC (%)
- Bulk density (t / m³)
- Particulate Organic Carbon (POC, optional)



- C stocks (t C / ha)
Adjusted by Equivalent Soil Mass (ESM)

How to Measure?



+



- SOC %
- POC %

- Bulk density

or



- SOC + Bulk density (soil mass)



With soil augers which do not disturb the sample and with a diameter > 3.5-4 cm

Carbon Path - GSOC MRV Protocol

Monitoring: Soil sampling

Sampling Depth?

- **Minimum: 0-30 cm**
- optimal: up to 100 cm
- Recommended: 0-10 cm + 10-30 cm

Or Adaptations (e.g. to provide samples for additional indicators)

E.g. 0-20 cm + 20-40 cm (+40-60 cm)

Frequency?

- Baseline (time= 0) Mandatory
- 2 years (optional; POC)
- 4 years (mandatory)

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Carbon Path - GSOC MRV Protocol

Monitoring: Laboratory analysis

GLOSOLAN SOPs (Standard operating Procedures) (FAO, 2019)

Recommended option:

- **Dry combustion (Dumas)**

- Autoanalyzer for C.
- Analytical balance, ± 0.0001 g, to weigh samples and reference materials.
- Milling system that meets the requirements of the autoanalyzer manufacturer.

Alternative options :

- **Wet oxidation** (Walkley and Black, 1934)
- **Spectroscopy** (Evidence shall be attached)

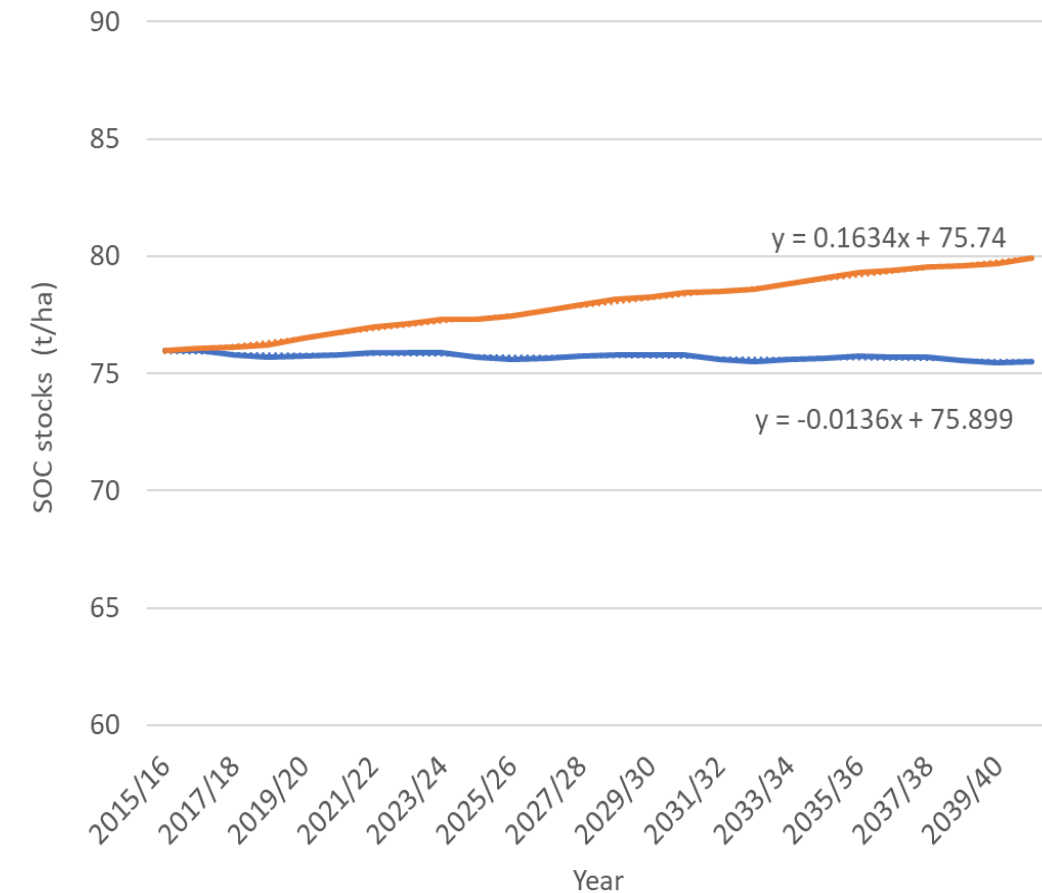
- **POC Particulate Organic Carbon** (Cambardella and Elliot, 1993): 2 mm and 53 μ m sieves.



Carbon Path - GSOC MRV Protocol

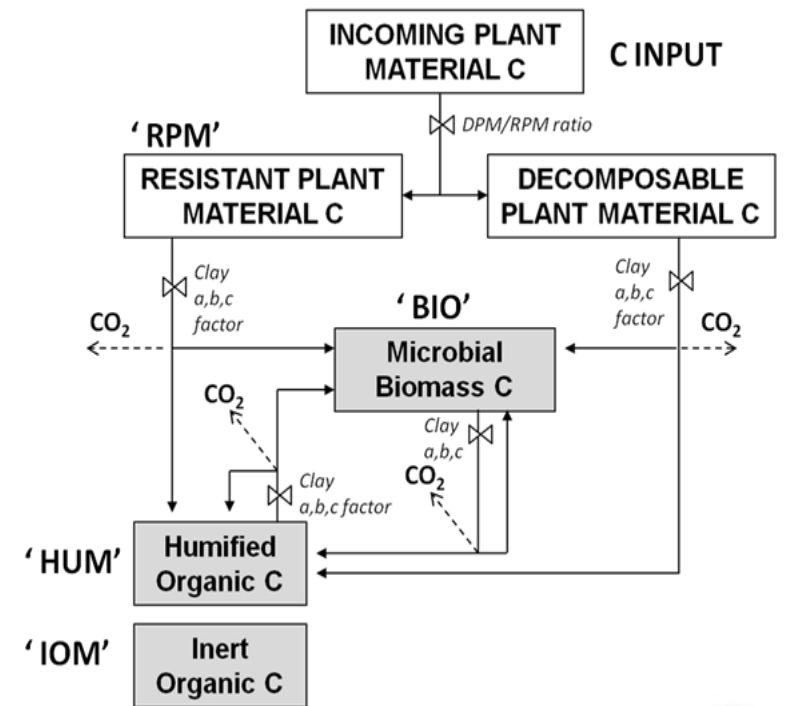
Monitoring: SOC projections using SOC simulation models

20-year projection for BAU and Project



- Business As Usual Management
- Proposed Management

Models - No specific model recommended... but Guide using RothC Model is provided



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Carbon Path - GSOC MRV Protocol

Monitoring: GHG projections using simulation models

- Ej. GHG emissions (IPCC 2019):
- CO₂; CH₄; N₂O, (using EXACT or peer reviewed tool)



Enteric fermentation



Manure left on pasture



Manure management



Synthetic fertilizers



Crop residues



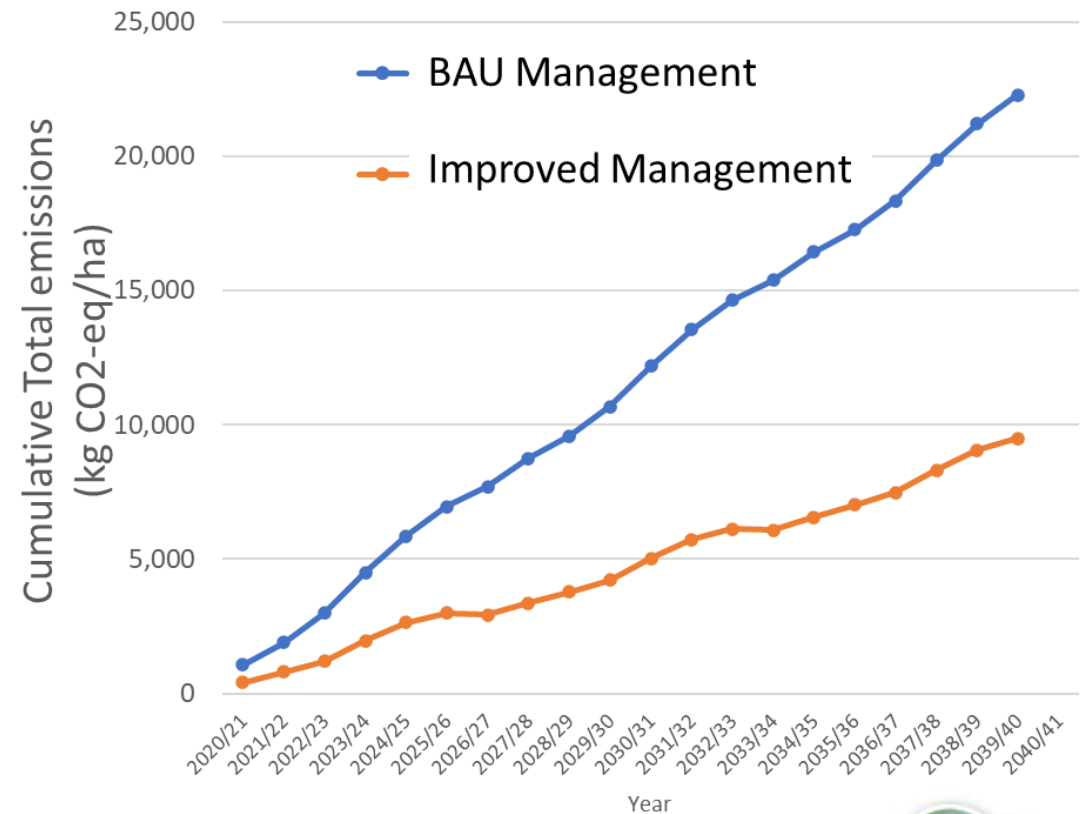
Paddy rice



Burnings



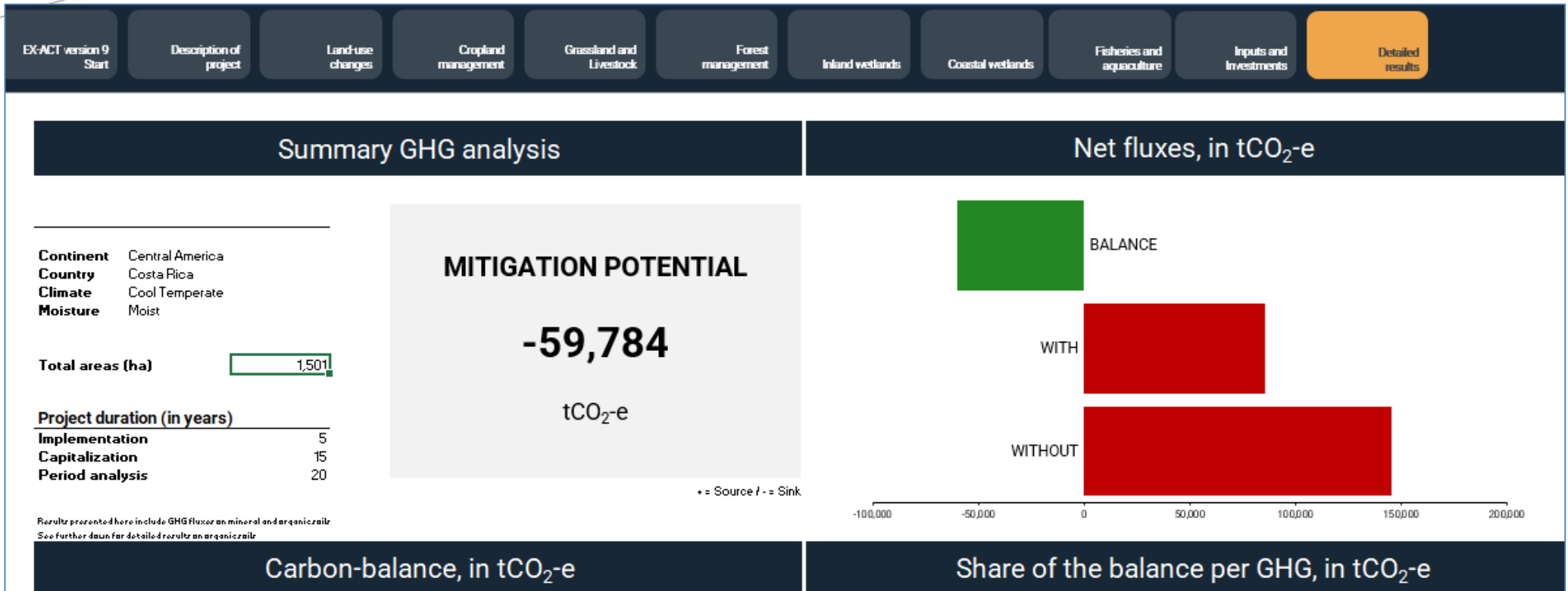
Fuel consumption



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GHG emissions balance - (E.g. EXACT)



<https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/>

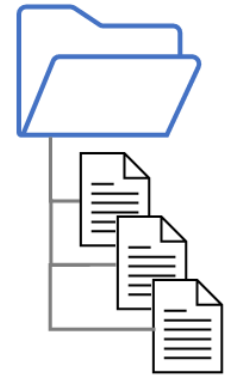
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In both Protocols ...

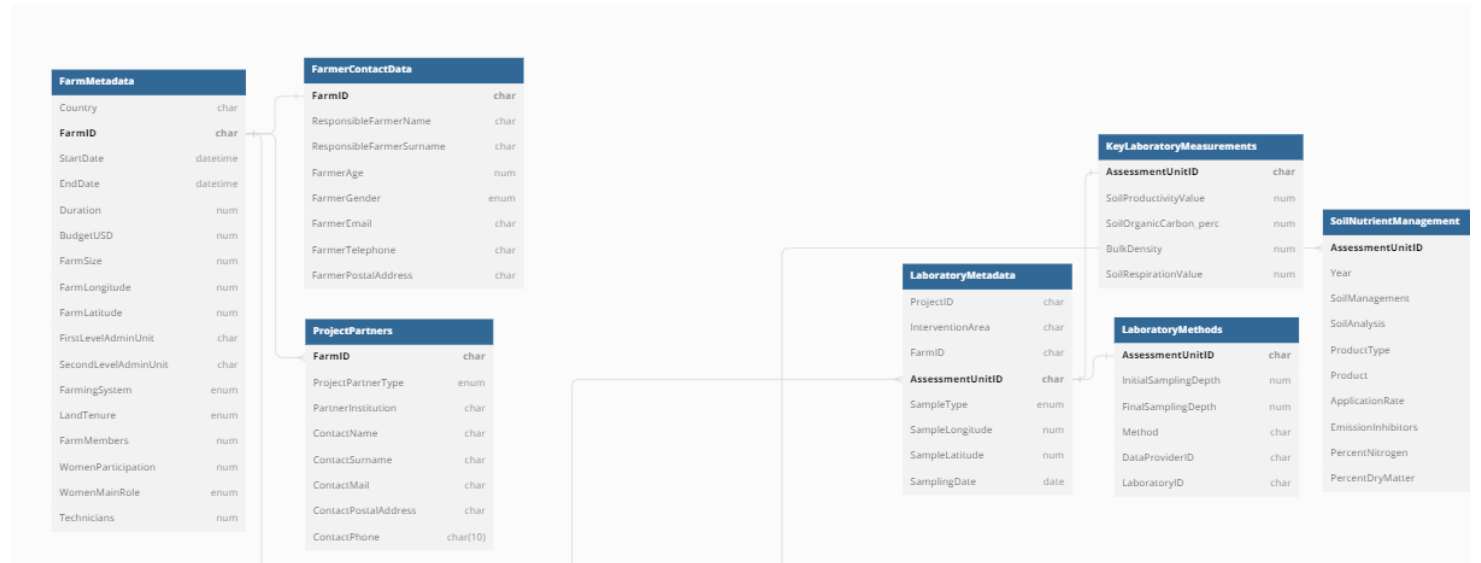
Collecting and Managing Field Activity Data

(e.g. crops, yields, fertilzier dose, livestock heads, etc)



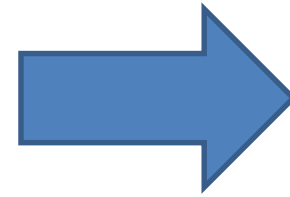
- Key to characterize business as usual and Intervention/Project scenarios
- Key to model SOC changes and GHG emissions
- Key for monitoring process (to verify projected activities and deviations)

Database for all RECISOIL Projects
...under construction



In both cases ...

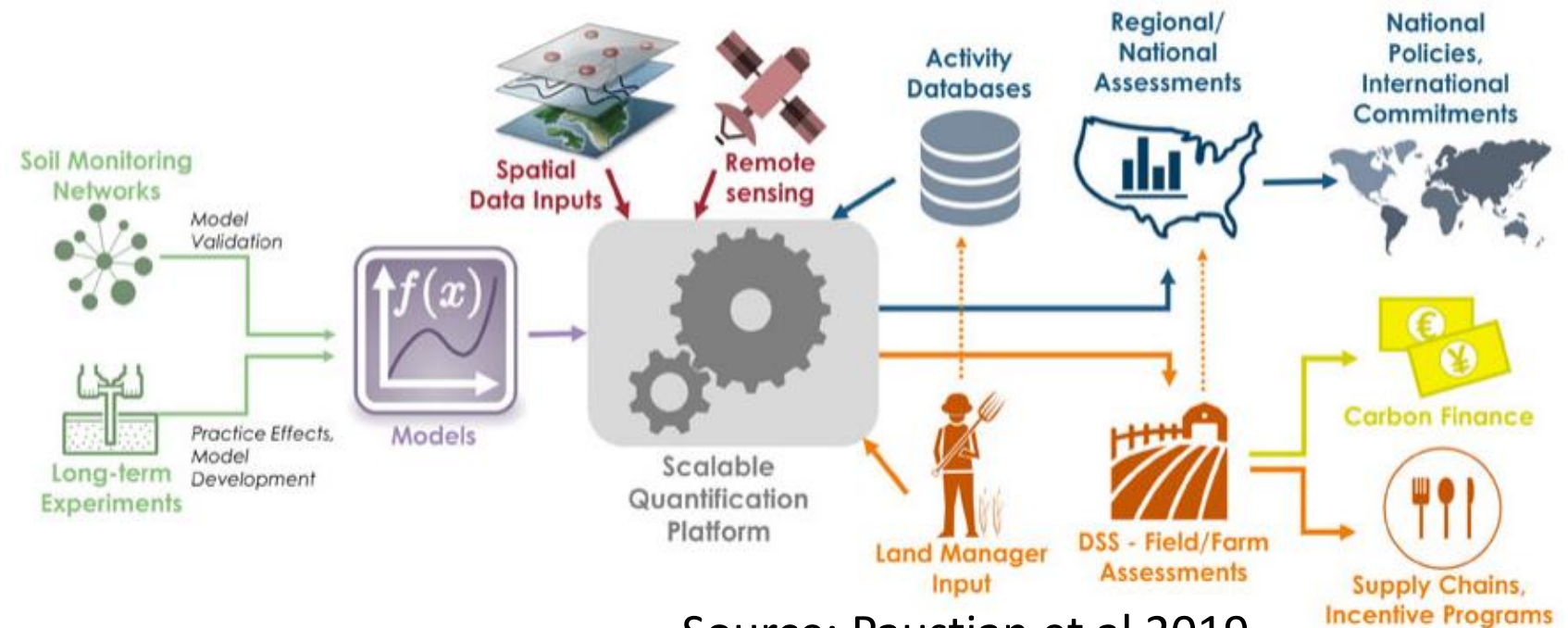
Field **Activity Data** and **SOC**
ground data generated in
Projects



National GHG
inventories

E.g. Data from Georeferenced sampling sites -
Benchmark sites:

- Change in SOC stocks could be used to:
- ground-truth SOC changes estimated by the Tier 1, Tier 2 or Tier 3 model projections over time.
- Calibrate and evaluate models in different regions; derive tier 2 local EF
- Current SOC stocks could be used to update and improve SOC maps (key input for Tier 2-3 estimates of emissions from SOC changes)
- Ground-truthing activity data



Source: Paustian et al 2019

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RECISOIL Protocols

- Developed through an extensive research, consultation and inclusive process, involving scientists, policy makers, FAO Members, and international and intergovernmental panels
- Scientifically **robust** yet **flexible** protocols
- General Framework – Possibility to adapt specificities to local conditions
- Will generate results which can contribute to National GHG inventories

Way forward:

- Currently working on Pilots and Implementation Manuals
- Update - Improvement of the Protocols ... “Living documents” : improved as there are more users worldwide, and more and better data is generated

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1st December 2022

Thank you

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