UNFCCC Webinar on Soil Organic Carbon to Support National Greenhouse Gas Inventories from Developing Countries under the Enhanced Transparency Framework of the Paris Agreement

Session 4: MRV4SOC. Conceptual approach for establishing MRV systems for SOC in developing countries

Content

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- Key concepts
- Objectives of MRV systems
- Types of Carbon Markets

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Introduction

What is MRV?

Types of MRV systems

Objectives

Types of Carbon Markets

What is MRV?

- **Widely used after the Bali Action Plan in 2007**
- **No universally accepted definition: initially ambiguous and used in different contexts**

"MRV stands for **Measurement/Monitoring, Reporting, and Verification**. This term is used in **diverse contexts**, but most frequently in the context of greenhouse gas (GHG) emissions and their reduction. In essence, MRV is a **series of processes to quantify GHG emission and their change overtime**. Quantified values that have passed through robust MRV processes can represent accurate levels of GHG emission."

"For developing country Parties implementing REDD+ activities (referred to in paragraph 71 of decision 1/CP.16), to obtain and receive **results-based payments**, anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from implementing those actions (REDD+ results) should be fully measured, reported and verified."

Sources: IGES, 2013, REDD+ web platform

Types of MRV systems

National level "aims at determining the **GHG emission in each country**. **Its methodologies are well established through guidelines by the Intergovernmental Panel on Climate Change (IPCC)**. As the methodologies primarily rely on **national statistics**, its accuracy requirement is not as strict as organizational and project levels. Although most of developed countries established their national MRV schemes through their GHG inventories, many developing countries have yet to institutionalize such systems. Furthermore, **national level MRV could potentially be applied to regional and local levels, but the methodologies and applications at subnational levels are limited at the moment**."

Sources: IGES, 2013

Types of MRV systems

Project level "aims to **quantify GHG reductions associated with a project for the purpose of crediting,** most commonly through the implementation of the **Clean Development Mechanisms** (CDM) but also through other crediting schemes such as **Verified Carbon Scheme** (VCS). As at the organizational level, it requires a high level of accuracy. Although its **methodologies are already well developed**, there is a continued **challenge to accurately estimate "baseline emission**", which enables the **comparison between scenarios within and outside the project.**"

Sources: IGES, 2013

Objective of MRV systems

Activity

- Avoided - Removed GHG emissions

Credits

- One ton of reduced GHG emissions expressed in tCO_2eq

Payments

- Credits sold through a legally binding contracts
- 5-10 years
- Payments according to reported and verified results.

Types of Carbon Markets

- **Compliance markets: participation in response to a regulation.**
- **Voluntary markets: no formal obligation to reach specific goals.**
  - Different methodologies / standards have been developed.
  - A current certification framework is being developed by the European Commission to improve transparency.

Measurement, Reporting, and Verification

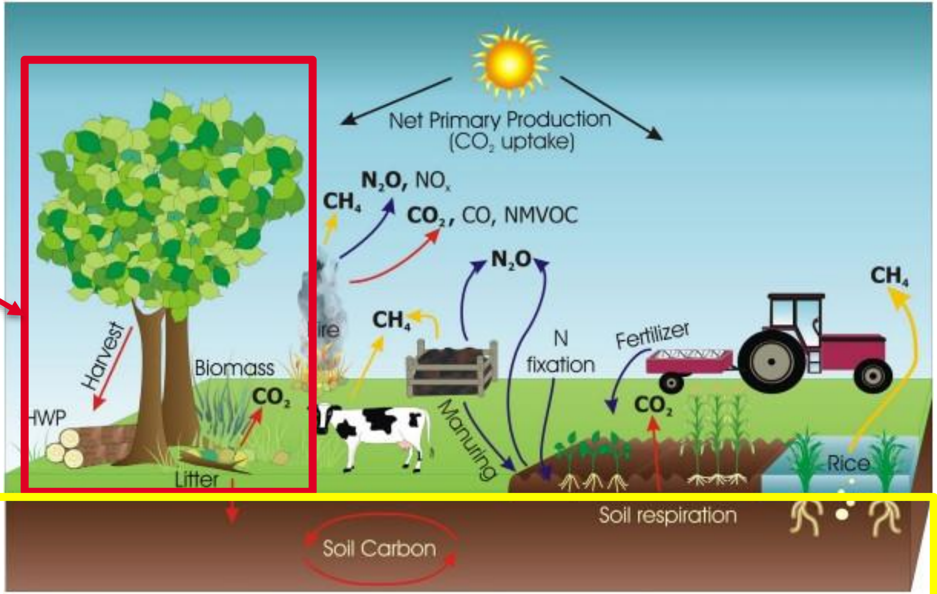
What does an MRV system measure? The concept of carbon pools

The **IPCC identifies five carbon pools,** which can be measured and reported as part of national GHG inventories:

(i) above-ground biomass (AGB);
(ii) below-ground biomass (BGB);
(iii) dead wood;
(iv) litter (DOM);
(v) and soil organic matter (SOC),

Parties are encouraged to report on as **many of their significant carbon pools as possible**, according to national circumstances.

Countries should remain methodologically consistent.



Source: IPCC, 2006

Source: FAO, 2013

Evolution of Voluntary MRV systems: UNFCCC context

- National communications
- Biennial update reports (BUR)
- International consultation analysis
- Domestically supported Nationally Appropriate Mitigation Actions (NAMAs)
- Undertaking MRV REDD+ activities for results-based payments – Report REDD + results in the BUR

Broad context
Voluntary

Deforestation and forest degradation
Voluntary

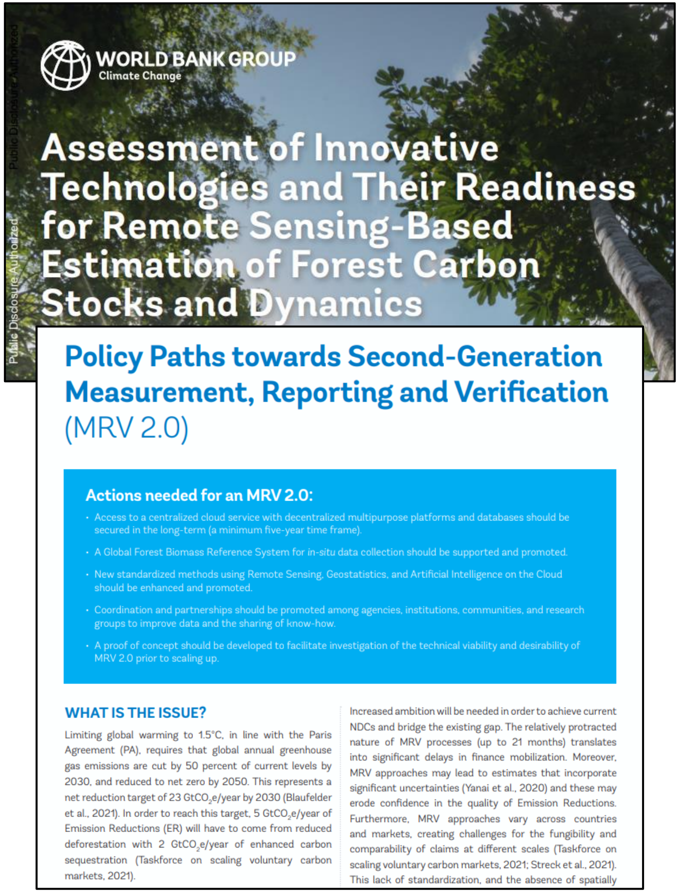
MRV for REDD+: elements to be developed

- A **national strategy** or action plan;
- A **national forest reference emission level and/or forest reference level** or, as an interim measure, subnational forest reference emission levels and/or forest reference levels;
- A **robust and transparent national forest monitoring system** for the measurement and reporting of the related activities, with subnational measurement and reporting as an interim measure, in accordance with the national circumstances;
- A system for providing information on how the **safeguards for REDD-plus activities** are being addressed and respected.

Satellite Monitoring System

Highlighted actions to overcome challenges

1. Access to cloud services with decentralized multipurpose platforms and databases
2. Foster partnerships with research groups, institutions, and agencies involved in the development and maintenance of in-situ plot networks.
3. Enhance and **promote new standardized methods using Remote Sensing, Geostatistics, and AI on the cloud.**
4. Create the necessary enabling environment by fostering coordination and partnership among agencies, institutions, countries, communities, and research groups to improve data and know-how sharing



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Climate Change

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Assessment of Innovative Technologies and Their Readiness for Remote Sensing-Based Estimation of Forest Carbon Stocks and Dynamics

Policy Paths towards Second-Generation Measurement, Reporting and Verification (MRV 2.0)

Actions needed for an MRV 2.0:

- Access to a centralized cloud service with decentralized multipurpose platforms and databases should be secured in the long-term (a minimum five-year time frame).
- A Global Forest Biomass Reference System for in-situ data collection should be supported and promoted.
- New standardized methods using Remote Sensing, Geostatistics, and Artificial Intelligence on the Cloud should be enhanced and promoted.
- Coordination and partnerships should be promoted among agencies, institutions, communities, and research groups to improve data and the sharing of know-how.
- A proof of concept should be developed to facilitate investigation of the technical viability and desirability of MRV 2.0 prior to scaling up.

WHAT IS THE ISSUE?

Limiting global warming to 1.5°C, in line with the Paris Agreement (PA), requires that global annual greenhouse gas emissions are cut by 50 percent of current levels by 2030, and reduced to net zero by 2050. This represents a net reduction target of 23 $GtCO_2e$/year by 2030 (Blaufelder et al., 2021). In order to reach this target, 5 $GtCO_2e$/year of Emission Reductions (ER) will have to come from reduced deforestation with 2 $GtCO_2e$/year of enhanced carbon sequestration (Taskforce on scaling voluntary carbon markets, 2021).

Increased ambition will be needed in order to achieve current NDCs and bridge the existing gap. The relatively protracted nature of MRV processes (up to 21 months) translates into significant delays in finance mobilization. Moreover, MRV approaches may lead to estimates that incorporate significant uncertainties (Yanai et al., 2020) and these may erode confidence in the quality of Emission Reductions. Furthermore, MRV approaches vary across countries and markets, creating challenges for the fungibility and comparability of claims at different scales (Taskforce on scaling voluntary carbon markets, 2021; Streck et al., 2021). This lack of standardization, and the absence of spatially

Source: World Bank 2021

MRV for SOC

The soil carbon stock to a certain depth is a standardized metric comparable across sites, time steps, and carbon pools.

Hybrid approach

Field methods	Modeling	Remote sensing
▪ Soil sampling at least 30 cm ▪ Measuring C stocks at the lab (bulk density, carbon content) ▪ Measuring C fluxes	▪ Empirical ▪ Process-based models	▪ Proximal ▪ Airborne ▪ Satellite

Source: World Bank, 2021c., Smith et al. 2019

Hybrid approach: Tier 3 methodology

Tier 3 methods require **detailed data** with derived emission factors from models and **inventory measurement systems**:

- Source specific
- Technology specific
- Region specific
- Country specific

Source: UNFCCC, 2009

Before selecting a tool / method (Tier 1, Tier 2, Tier 3), let's consider…

- Availability of data: historic data (soil samples, management practices)
- Scale of implementation and accuracy
- Robustness: consistent datasets and methodologies
- Transparency: assumption and methods clearly explained
- Standardization: scale up results
- Cost-effectiveness

MRV for SOC: Key elements to be developed

- High resolution soil / land cover / drainage maps: National soil sampling monitoring system

- High resolution activity data: *Spatially and temporarily referenced observations of land use and land management practices that can be used to inform model-based estimation of soil carbon stock changes*

- Country specific emission / removal factors for soil types and management practices

Sources: World Bank, 2021 c

Why is an MRV system including SOC relevant?

To limit global warming to 1.5°C, greenhouse gas emissions must peak before 2025 at the latest and decline 43% by 2030.

- Soils are the largest active terrestrial carbon pools.
- Agricultural management practices highly impact on the carbon cycle and the storage of Soil Organic Carbon.
- Low Soil Organic Carbon can reduce crop and land productivity.
- Build trust in result-based payments mechanisms.
- Increase the robustness, standardization, transparency, and cost-effectiveness of Tier-3 methodologies.

Source: World Bank, 2021a,b, MRV4SOC

Practical implementation

Rewarding farmers and foresters for implementing climate-friendly practices (carbon farming) that enhance carbon sequestration and storage in forests and soils, or that reduce GHG emissions from soils.

- **Rewetting and restoring peatlands** and wetlands to reduce carbon oxidation and increase carbon sequestration potential.
- **Agroforestry and mixed farming**, integrating trees or shrubs with crop and/or animal production.
- Implementing catch crops, **cover crops**, **conservation tillage**, and **landscape features to protect soils and enhance soil organic carbon**.
- **Reforestation** respecting ecological principles for biodiversity and sustainable forest management.
- Making **more efficient use of fertilizers** to reduce emissions of nitrous oxide from agricultural soils.

Questions?

Example in the European Union

Developing an MRV system for the EU land sector

MRV4SOC PROJECT

Funded by the European Union GA 101112754

Policy context

- First climate neutral continent by 2050
- At least 55% less net greenhouse gas emissions by 2030, compared to 1990 levels
- 3 billion trees to be planted in the EU by 2030

Source: EU Climate Law, Biodiversity Strategy

Policy context

European Commission

EN English

Search

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Home > Press corner > Commission proposes certification of carbon removals

Available languages: English

PRESS RELEASE | 30 November 2022 | Brussels

European Green Deal: Commission proposes certification of carbon removals to help reach net zero emissions

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Today the European Commission adopted a proposal for a **first EU-wide voluntary framework to reliably certify high-quality carbon removals**. The proposal will boost innovative carbon removal technologies and sustainable carbon farming solutions, and contribute to the EU's climate, environmental and zero-pollution goals. The proposed regulation will significantly improve the EU's capacity to quantify, monitor and verify carbon removals. Higher transparency will ensure trust from stakeholders and industry, and prevent greenwashing. Carbon removals can and must bring clear benefits for the climate, and the Commission will prioritise those carbon removal activities which will provide significant benefits for biodiversity. Moving forward, the Commission, supported by experts, will develop tailored certification methods for carbon removal activities delivering on climate and other environmental objectives.

To ensure the transparency and credibility of the certification process, the proposal sets out **rules for the independent verification of carbon removals**, as well as **rules to recognise certification schemes** that can be used to demonstrate compliance with the EU framework. To ensure the quality and comparability of carbon removals, the proposed regulation establishes **four QU.A.L.ITY criteria**:

Goals of the proposal

- Accelerate the deployment of **verifiable, high-quality carbon removals**
- Encourage industries, farmers and foresters to **adopt effective carbon removal solutions**
- **Counter greenwashing**, focus on high quality removals and **build trust** by focusing on trustworthy removals
- **Ensure the EU's capacity to quantify, monitor and verify carbon removals**
- Stimulate a wide variety of **result-based financing options by private or public sources**

Source: EC, 2022

The regulation relies on four pillars

Quantification

The net carbon removal benefit' should be quantified in a **robust** and accurate way.

Additionality

Carbon removal activities must go beyond **standard practices** and what is required by law.

Long-term storage

Carbon removal activities must ensure that **the carbon removed is stored for as long as possible** and the **risk of release of carbon should be minimized**.

Sustainability

Carbon removal activities must have a neutral impact on, or generate a **co-benefit** for, other environmental objectives.

Source: EC 2022/0394 (COD)

Key definitions

Carbon removals: "**Anthropogenic removal of carbon from the atmosphere** and its durable storage in geological, terrestrial or ocean reservoirs, or in long-lasting products"

Carbon farming: "means **any practice or process, carried out over an activity period of at least five years**, related to terrestrial or coastal management and resulting in capture and temporary storage of atmospheric and biogenic carbon into biogenic carbon pools or the reduction of soil emissions."

Activity period: "a period over which the **activity generates a net carbon removal benefit or a net soil emission reduction benefit**, and which is determined in the applicable certification methodology."

Monitoring period: "a period over which **the soil emission reduction or storage of carbon is monitored by an operator or a group of operators** and which covers at least the activity period as determined in the applicable certification methodology."

Certification scheme: "an **organization that certifies the compliance of activities and operators with the quality criteria and certification rules** set out in this Regulation."

Source: EC 2022/0394 (COD)

Certifying carbon farming practices

- **Soil emissions reduction units**
  - Rewetting peatlands or more efficient use of fertilizers: Activity period of at least 5 years
- **Carbon farming sequestration units**
  - Temporary carbon removals in soils and forests: Activity period of at least 5 years

Source: EC 2022/0394 (COD)

Policy context in Agriculture and LULUCF sector

UNFCCC / Paris Agreement

EU Climate and Energy – LULUCF regulation

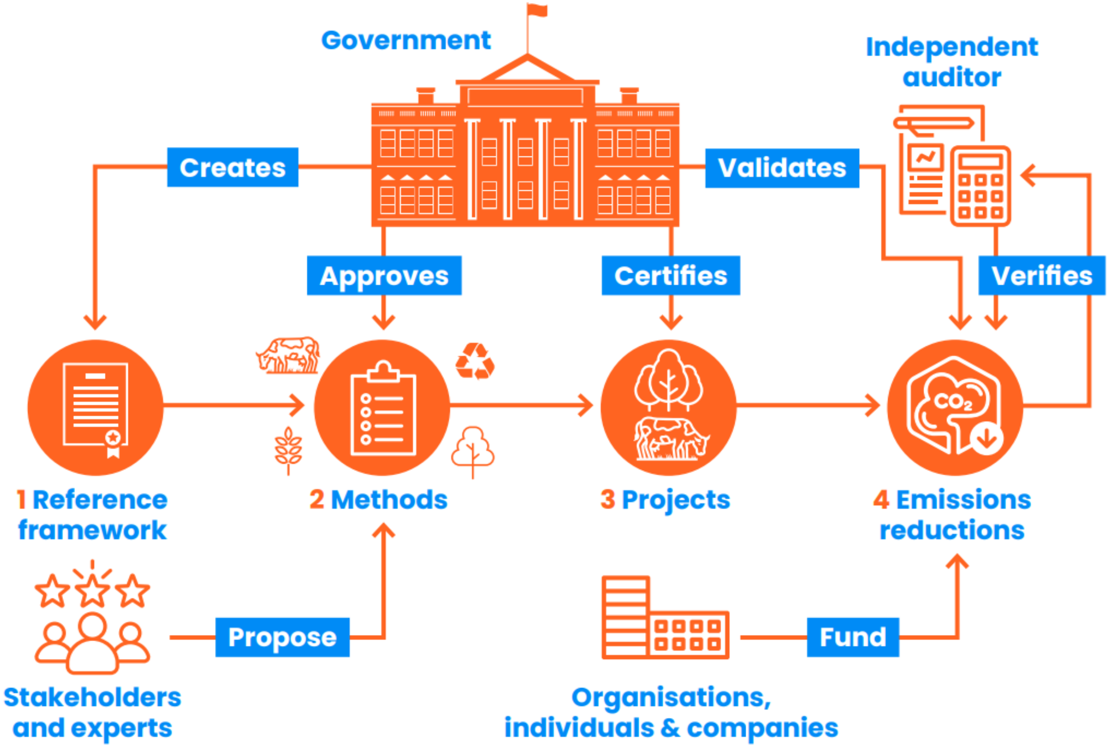
Common Agricultural Policy

EU MRV for carbon farming

- Certification methodology
- Methodologies recognized by an authority
- Independent auditing certification bodies
- Certification registries

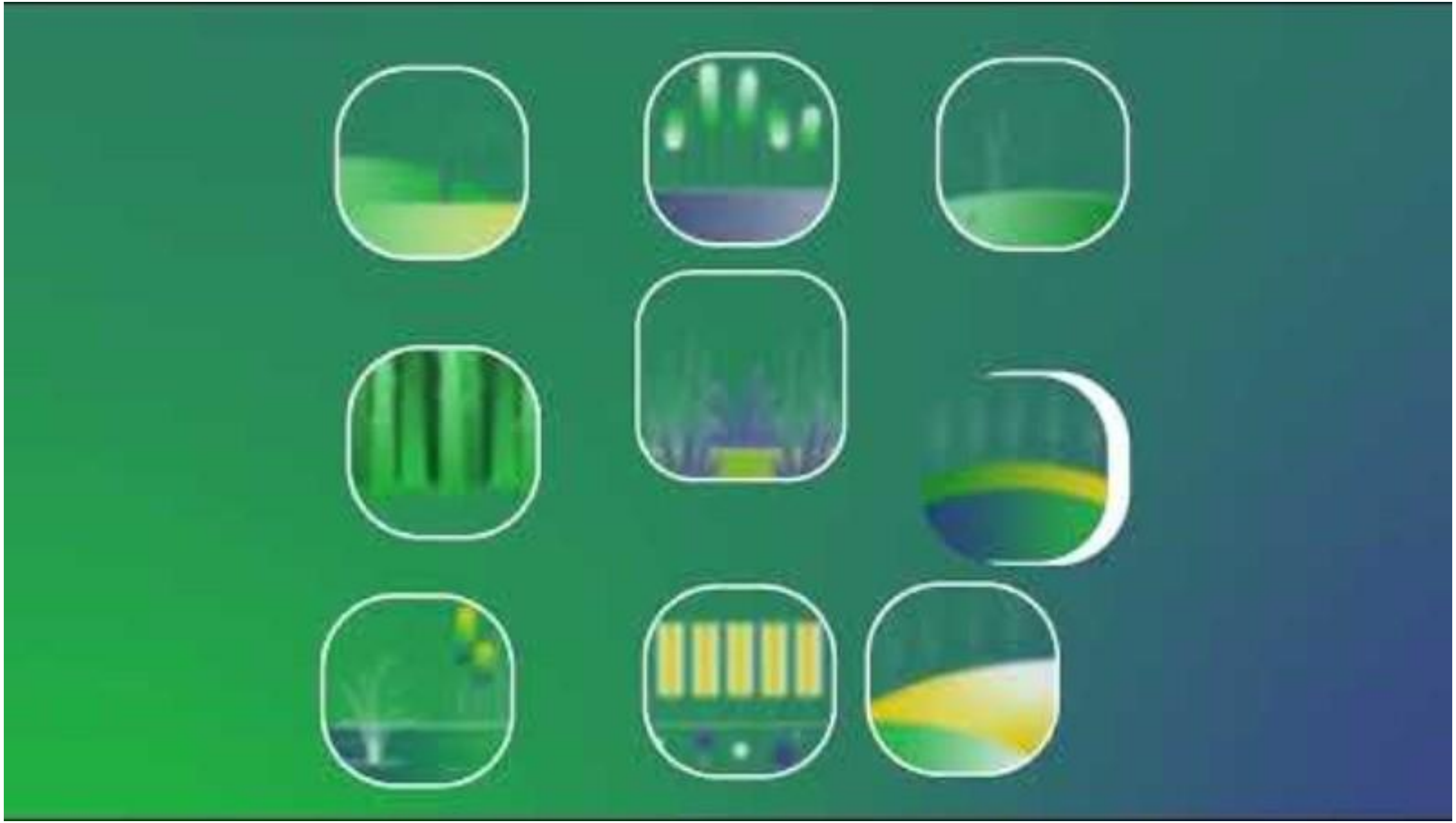
Source: EC 2022/0394 (COD)

Example of a Voluntary Carbon Market implemented at a national level (Label-bas Carbone)



Source: Carbon Gap, 2023.

The MRV4SOC project in a nutshell



 https://youtu.be/CNhjo-Rjihk https://mrv4soc.eu/

General objective

Designing a **comprehensive and robust Tier 3 approach*,** accounting for changes in **as many C pools** as possible, to estimate **GHG and full C budgets**, couple **C and N cycles**, **quantify C accumulation** (Soil Organic Carbon -SOC- and Soil Organic Matter -SOM-), and **assess the results of traditional management practices and C farming.**

- Scalable, accurate, transparent, standard, cost-effective, and reliable.

Specific objectives

MRV4SOC PROJECT

- To measure long-term **SOC accumulation in 9 EU representative LULC classes**.
- To assess how **C farming practices drive C flux dynamic**s in the 9 LULUCF classes.
- To assess the impact of **climate change on SOC accumulation** associated with **C farming practices**.
- To develop a **robust, transparent, standard, and cost-effective MRV** to facilitate results-based payments
- To seek out revenue opportunities to **unlock results-based payments**.
- To increase **stakeholders' faith in Voluntary Carbon Markets**.

Demonstration Sites

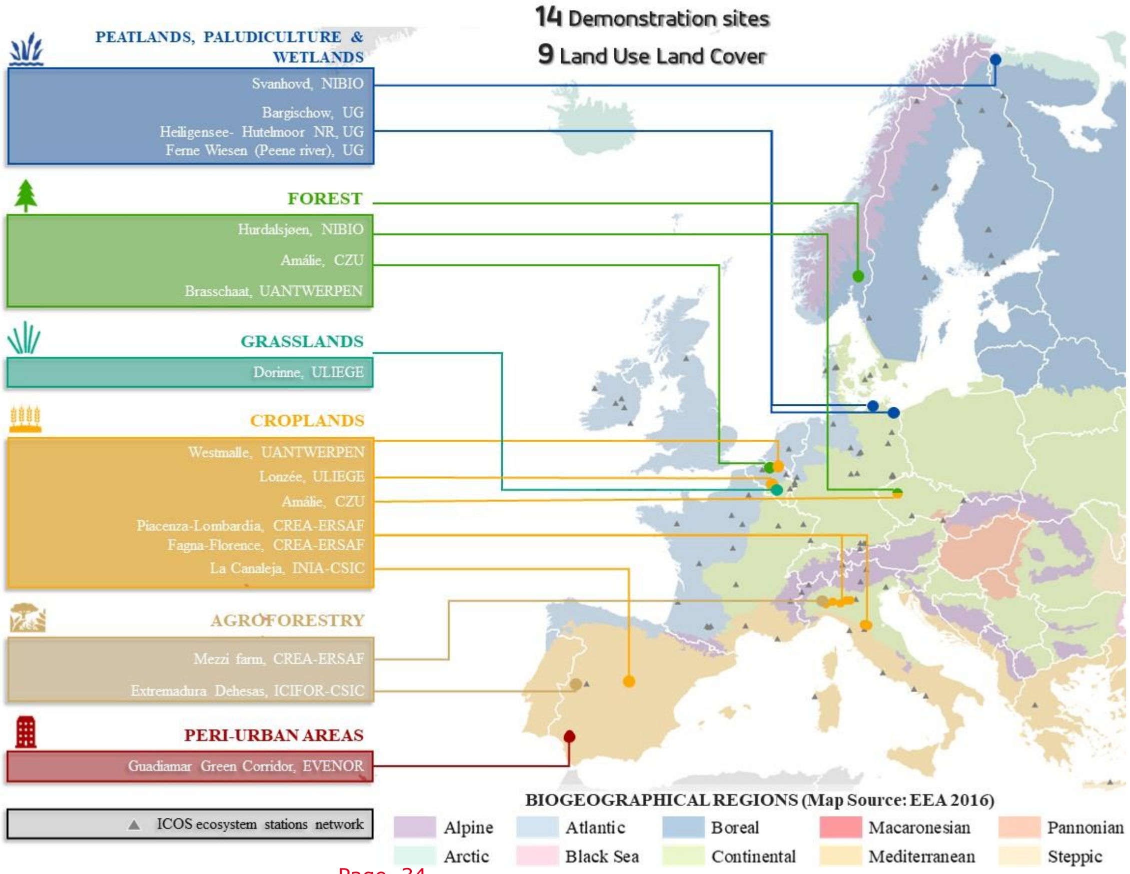
MRV4SOC PROJECT

5 EU countries: DE, CZE, IT, BE, SP

1 Associated country: NOR

5 biogeographic regions: Mediterranean, Atlantic, Continental, Artic-Alpine, Boreal,

Different pedo-climatic conditions



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Land use/ cover classes

Grassland and pasture

Peatlands, paludiculture and wetlands

Agroforestry

Peri-urban areas

Croplands

Forest

Highlighted challenges

MRV4SOC PROJECT

QUantification

- Tier 3 frameworks are not standardized or validated in many cases.
- Lack of case studies:
  - Large spatial variability in SOC.
  - Multitude of land use, climate, and soil combinations to be tested.

Additionality

- Go beyond standard practices.
- Difficulties to measure C added into the soil directly related to the land management practice.
- Avoid C leakage through incentivised C farming.

Long-term storage

- Ensuring permanence of reported C removals.
  - Lack of effective long-term monitoring.
- Natural and anthropogenic disturbances.

SustainabilITY

- Accounting for co-benefits derived from C removal activities.
- Increase trust in Voluntary Carbon Markets

Highlighted solutions

MRV4SOC PROJECT

QUantification

- Development of scientifically sound Tier 3 methodologies.
- Assimilation of high-quality **in-situ** (long-term experiments) and **RS data** for testing methods and scale up purposes.
- Standardization of MRV schemes to ensure transparency, accuracy, and cost-effectiveness.

Additionality

- Wide range of time frames to assess different contexts.
- C farming vs traditional management practices.
- MRV schemes to ensure robustness.

Long-term storage

- Long-term experiments and future climate change scenarios will be considered.
- Estimation of deep SOC whenever possible.
- Accounting for biotic and abiotic disturbances

Sustainabil**ITY**

- Reporting co-benefits of C farming practices
- Increasing transparency in VCM.
- Reliable measurements.

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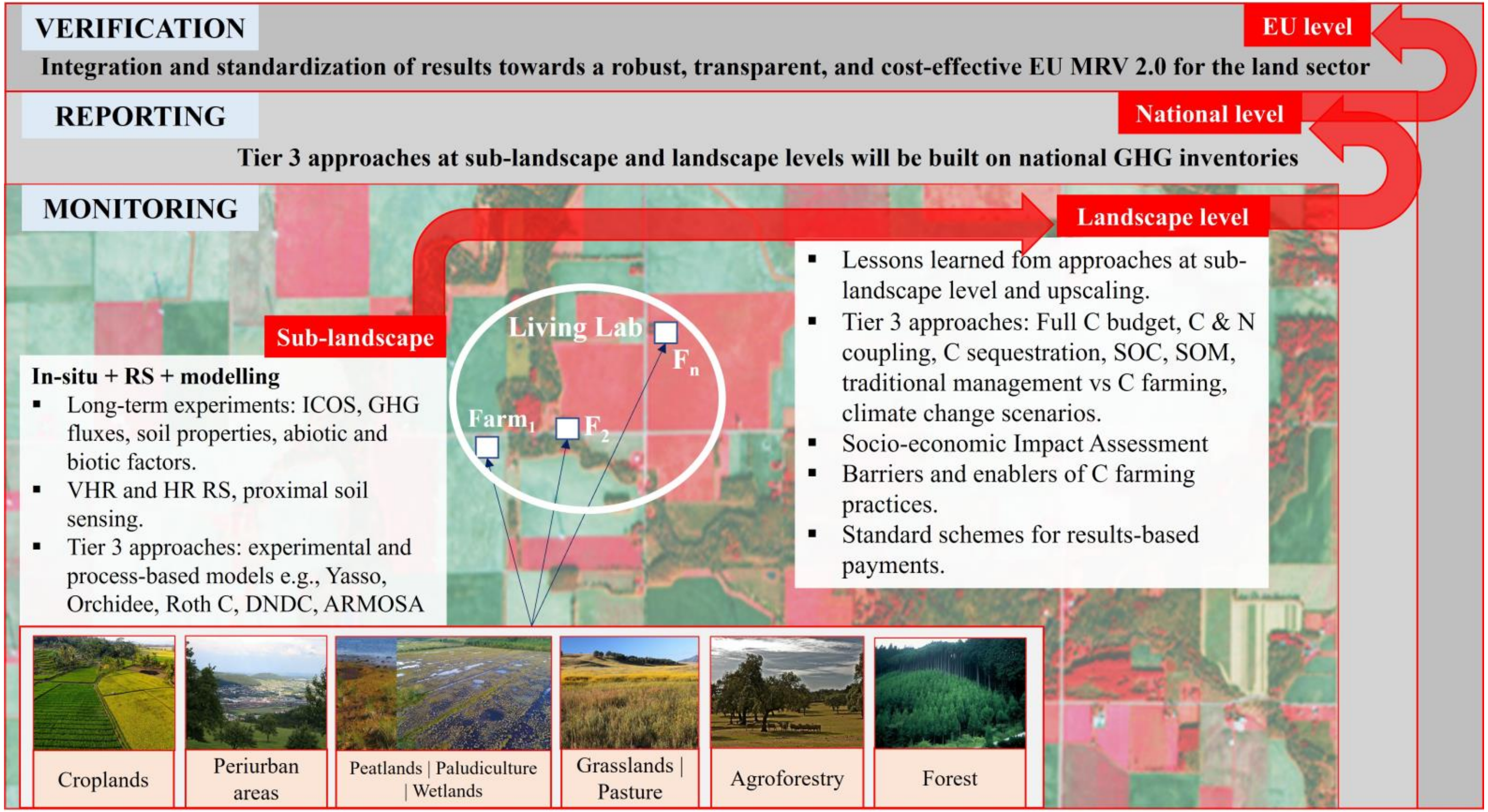
Implementation



Expected results

MRV4SOC PROJECT

- EO and in-situ data inventory
- Prototypes for space-based RS products
- Simulations and SOC uncertainty estimation
- ORCHIDEE new version and new modules
- Standard requirements
- Transparent and trustworthy MRV methods
- Policy recommendations towards an MRV 2.0 system for the EU land sector

Why are these results important?

The expected results will help us identify robust, standard, transparent, and cost-effective Tier 3 methodologies considering:

- Different pedo-climatic conditions

- Different national contexts: data, levels of MRV development…

- Different scales of implementation

Contribution to the EU Technical Focus Group on carbon removals

Questions?

Example in Nigeria, by courtesy of ESA GDA Climate resilience cluster

Digital soil organic carbon mapping to design SOC programs

Building climate resilience for Nigerian farmers

World Bank and Cluster Collaboration

Productivity of major crops in Nigeria has been steadily declining over the past two decades in part due to climate change.

The World Bank approved in December 2021 a $700 million credit for the Nigeria Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) Project with the development objective to

- increase the implementation of sustainable landscape management practices in targeted watersheds in northern Nigeria and
- strengthen Nigeria's long-term enabling environment for integrated climate-resilient landscape management.

A rice paddy field in Nigeria

→ THE EUROPEAN SPACE AGENCY

Source, ESA: https://gda.esa.int/story/soil-monitoring-helps-build-climate-resilience-for-nigerias-farmers/

A SOC MRV system for Nigeria

World Bank and Cluster Collaboration

The cluster supports the ACReSAL component: dryland management, by setting up a service to support the World Bank in the definition of a Soil Organic Carbon (SOC) Measurement Reporting Verification (MRV) system for Nigeria.

The focus on this activity is on estimating changes in soil carbon in crop lands that are a direct consequence of land management.

The results report high spatially resolved soil carbon stock, and the carbon loss from the baseline scenario that can be used for the measurement/monitoring and verification components of the MRV.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Who We Are / News

PRESS RELEASE | DECEMBER 14, 2021

New Project to Build a Climate-Resilient Landscape in Nigeria

WASHINGTON, December 14, 2021 – The World Bank today approved a $700 million credit from the International Development Association (IDA)* for the Nigeria **Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) Project**. The project will increase the implementation of sustainable landscape management practices in northern Nigeria and strengthen the country's long-term enabling environment for integrated climate-resilient landscape management.

The productivity of major crops in Nigeria has been steadily declining over the past two decades, in part due to climate change, forcing an expansion of the area under agriculture and increased imports to meet the food needs of Nigeria's growing population. Persistent water shortages, especially in the extreme north, continue to exacerbate land degradation, desertification, and habitat loss. Resource shortages, violent conflict, outdated agricultural systems not adapted to changing dryland conditions, lack of access to finance, weak value chain linkages, an uncompetitive environment for agribusiness, and poor market access are other key barriers to increased agricultural productivity in Nigeria. Better environmental and water resources management and resilience against disaster and climate risks (largely water-

RELATED

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The World Bank in Nigeria

The World Bank in Africa

Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL)

Snapshot of World Bank website announcement

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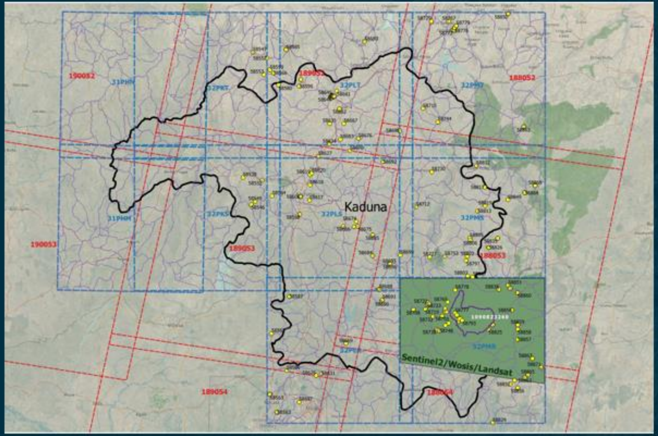
Subset in Kaduna region

Study area

Selection based on the highest availability of soil profile data from WoSIS, and the abundance of crops in the northern regions of Nigeria, focus of ACReSAL.

Kaduna was the state with the highest number of soil profile measurements. The micro-watershed with the largest number crops, and with more WoSIS soil profiles having available SOC measurements was selected.

- Kaduna state administrative boundary.
- Soil organic carbon samples from World Soil Information Service (WoSIS), a long-term storage of soil information at a global scale.
- Sub-basin delineation from WWF's HydroBASINS watershed boundaries at a global scale.
- Satellite images from Landsat and Sentinel-2 missions.



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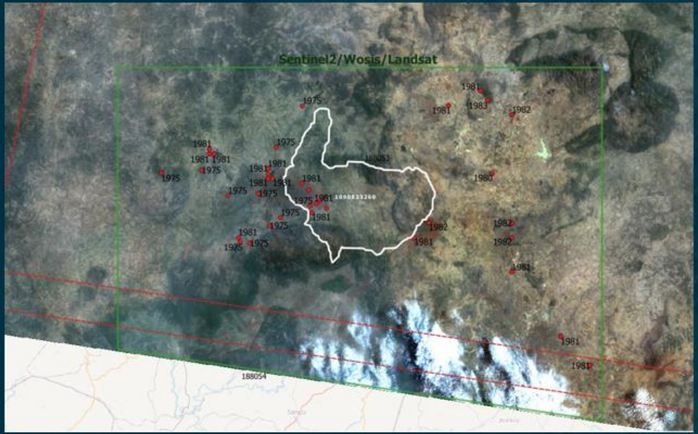
Selection of satellite images

Data Collection

- **Landsat-4/5 for SOC estimation**
  - Satellite acquisitions from 1985 to “match” WoSIS data
  - Not possible to observe annual dynamics due to low satellite revisit and high cloud presence
- **Sentinel-2 to analyse crop phenometry and extent**
  - Crop extent derived
  - Different crop observed
  - WoSIS points filtered to consider only SOC over crops
  - Bare soil period of crops detected for 2019-2021 (agri practices assumed to be similar by 1985)



Available SOC measurements on croplands in the study area

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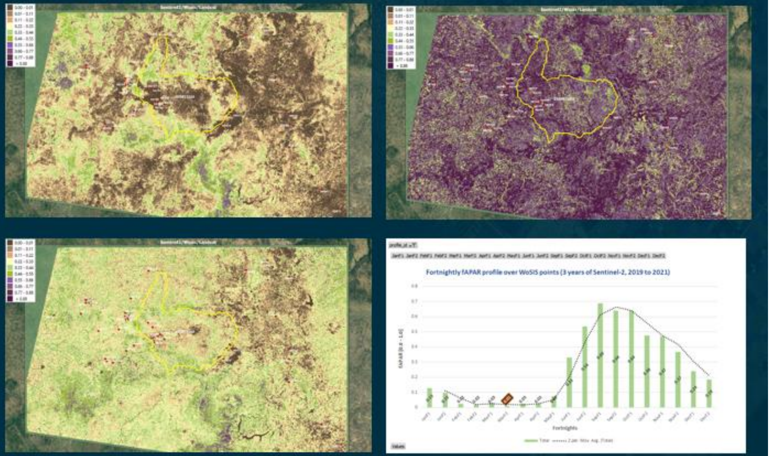
Selection of proxies

Crop Practices

Lowest fAPAR values in March indicate that tillage activity is high with soil preparation for wet season crops. A threshold at the lowest fAPAR values is a first criterion to detect the agricultural area.

But bare soils or water surfaces also have low fAPAR values and would be identified as agricultural land. However, these low fAPAR values are maintained the whole year, whereas the fAPAR values of crops have a large amplitude in the phenological curve. A threshold in the amplitude of the phenological curve is the second criterion.

Both criteria used to estimate the extent of the cultivated area.



fAPAR fortnightly between 2019 and 2021.
Top left 2nd half of March, top right 1st half of September, bottom left 1st half of December
Bottom right behaviour of the fAPAR index at a WoSIS point

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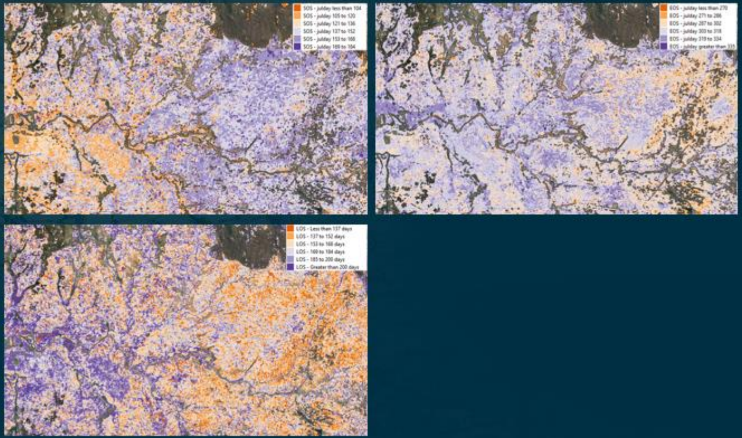
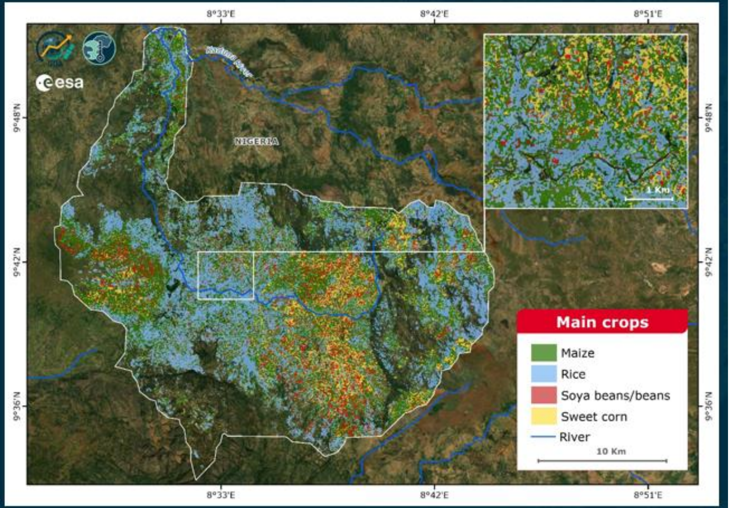
Selection of proxies

Crop Practices

In the absence of ground truth, the crop types that predominate during the wet season are distinguished according to the analysis of three phenological products: Start of season (SOS), end of season (EOS), and longitude of the season (LOS)





The assignment of the different crop behaviours identified in the analysis to specific crops types is done based on the statistics available in the Kaduna Bureau of Statistics (KDBS) by 2016 (*Kaduna State Agricultural Structure Survey 2017 report*)

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SOC estimation

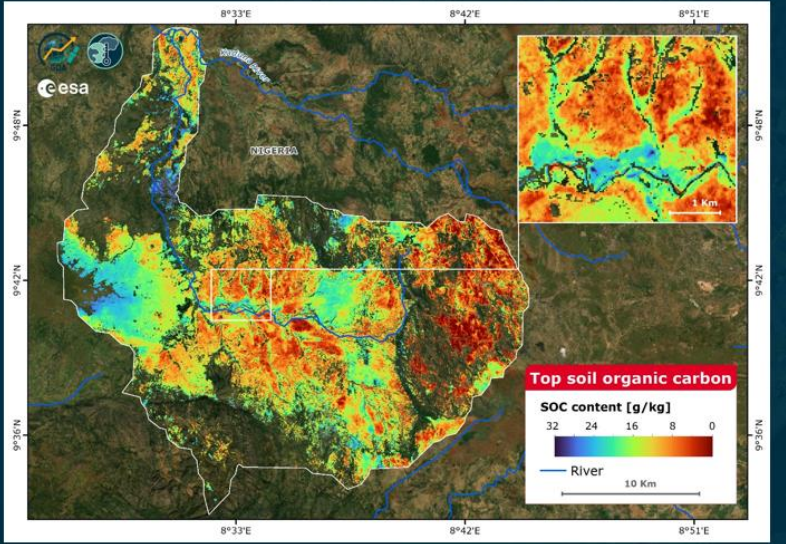
SOC the topsoil layer

GDA esa

Testing a wide range of linear and non-linear regressors on the WoSIS sample

Index	Equation
Bareness index	BI = (R+SWIR1-NIR)
Bare soil index	BSI = ((SWIR2+R) - (NIR+B)) / ((SWIR2+R) + (NIR+B))
Bare soil index 1	BSI1 = ((SWIR1+R) - (NIR+B)) / ((SWIR1+R) + (NIR+B))
Bare soil index 2	BSI2 = 100 * sqrt((SWIR2-G)/(SWIR2+G))
Bare soil index 3	BSI3 = (((SWIR1+R) - (NIR+B)) / ((SWIR1+R) + (NIR+B))) * 100 + 100
Dry bare-soil index	DBSI = ((SWIR1–G) / (SWIR1+G)) – ((NIR-R) / (NIR+R))
Modified bare soil index	MBI = ((SWIR1–SWIR2-NIR) / (SWIR1+SWIR2+NIR)) + 0.5
Normalized difference soil index 1	NDSI1 = (SWIR1-NIR) / (SWIR1+NIR)
Normalized difference soil index 2	NDSI2 = (SWIR2-G) / (SWIR1+G)
Tasseled Cap Brightness index	TCAP-BI = 0.3037*B1 + 0.2793*B2 + 0.4743*B3 + 0.5585*B4 + 0.5082*B5 + 0.1863*B7

The machine learning model found high correlation between organic carbon content in the 0 to 8 centimetres depth interval and several Landsat indices



Soil organic carbon content (0 to 8 centimetres depth) on cropland soil in the sub-basin analysed

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SOC estimation

SOC baseline estimation

Baseline for the AOI in 2022 established through the implementation of the Tier-3 process-based model (ArcAPEX).

Model has been set-up to **simulate SOC for the 1985-2022 period** over the AOI, which has been subdivided in a total of **21 subareas**.

These areas represent homogeneous hydrologic response units. These HRUs are used as modelling units and have **unique combinations of soil, land use and management practices.**

Maximum	Minimum	Mean	Standard Deviation
t C/ha			
10.79	22.05	13.90	4.10

Summary of the SOC baseline values (2022)

	Variable	Source
Land Use Land Cover	Land class	ESA CCI Land Cover
Soil layer information	Bulk density	FAO/UNESCO Soil Map of the World
	Sand and silt content	FAO/UNESCO Soil Map of the World
	Organic carbon concentration	Ad-hoc SOC EO-based baseline
	Coarse fragment content	FAO/UNESCO Soil Map of the World
	Soil pH	FAO/UNESCO Soil Map of the World
	Saturated Conductivity	FAO/UNESCO Soil Map of the World
	Field Capacity	FAO/UNESCO Soil Map of the World
Climate data	Temperature	ERA-5 Land
	Precipitation	
	Solar radiation	
	Wind speed / direction	
	Relative humidity	
Crop management practices	Crop Rotation	Ad-hoc EO-derived information
	Crop type	
	Tillage Dates	
	Planting Dates	
	Harvesting dates	
	Fertilization practices	
	Planting density	
	Irrigation	

ArcAPEX inputs

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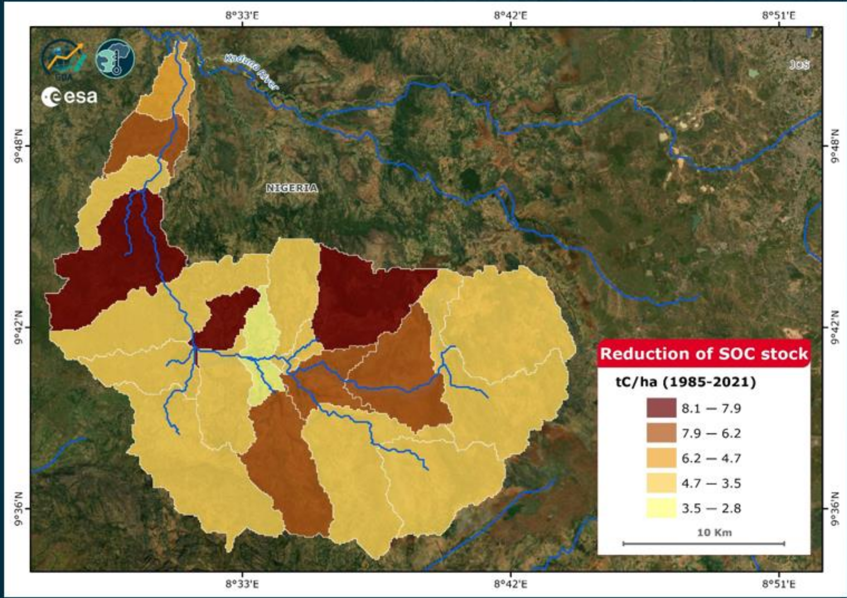
SOC estimation

SOC baseline estimation

The results obtained show a consistent reduction on the soil carbon stocks across the AOI ranging from 3-8 t C/ha.

The carbon stocks at the end of the simulation set the SOC baseline for 2022, and present values ranging from 10 tC/ha to 22 tC/h.

These results are broadly consistent with other SOC estimations for the area such as SoilsGrids that estimate the current SOC stocks in 20t C/ha in the area.



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Key takeaways

- The European Space Agency's Global Development Assistance Programme Climate Resilience Consortium supported the studies for a monitoring, reporting and verification system for changes to soil organic carbon.
- Working with the World Bank in target watersheds in northern Nigeria, the project understood how satellite data and machine learning could help building climate resilience for Nigeria's farmers.
- The work increased the awareness among Nigerian counterparts on the use of Earth Observation to monitor soil organic carbon.
- The consortium's work provides detailed information on soil carbon stock and loss, supporting planning sustainable farming practices.
- The work proved that EO techniques can improve sustainable landscape management practices and prevent soil degradation through Integrated watershed management plans.

Source: ESA, 2024,

Building further capacity

UNFCCC Support

Up to USD 500,000 for National Communications and USD 352,000 for Biennial Update Reports via the Global Environment Facility.

Technical

Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention (CGE)

Financial

The Global Environment Facility provides financial support for the preparation of national communications and BURs in accordance with guidance from the COP to non-Annex I Parties either through its agencies (UNDP, UNEP and the World Bank) or directly (since 2011).

Capacity building

Paris Committee on Capacity Building (PCCB)

Source: UNFCCC, 2014

Successful stories

- **Mozambique and Democratic Republic of Congo signed landmark agreements with the World Bank in 2019** to implement programs by 2024.
- Up to **USD 50 million for verified emission reductions in Mozambique**
- Up to **USD 55 million for verified emission reductions in DRC**
- To be paid through the **Carbon Fund of the Forest Carbon Partnership Facility**
- FCPF works with 47 developing countries and 17 donors providing
- FCPF Carbon Fund: **current funding USD 900 million**.

Take-home messages

- **A drastic reduction in GHG emissions is necessary to limit global warming to 1.5 ºC**
- **Agricultural management practices highly impact on the carbon cycle and the storage of Soil Organic Carbon**
- **A hybrid approach using remote sensing and process-based models is requested to build Tier-3 methods**
- **New approaches much rely on robustness, transparency, standardization, and cost-effectiveness**
- Opportunities of **result-based financing options by private or public sources**
- **Check possibilities to build further capacity in your country**

Questions?

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