

International Technical Webinar
Climate change and agriculture: Quantifying carbon stocks in soils and their evolution

Wednesday 14 April 2021
14:30 - 16:00 (Rome time)

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Food and Agriculture
Organization of the
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Climate change and agriculture: Quantifying carbon stocks in soils and their evolution

International Technical Webinar – Wednesday 14 April 2021

Tools and methods for quantifying soil carbon stocks in a climate change context

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Food and Agriculture Organization
of the United Nations



Climate change and agriculture: Quantifying carbon stocks in soils and their evolution

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Tools and methods for quantifying soil carbon stocks in a climate change context

Why soil carbon stocks are important for climate change?

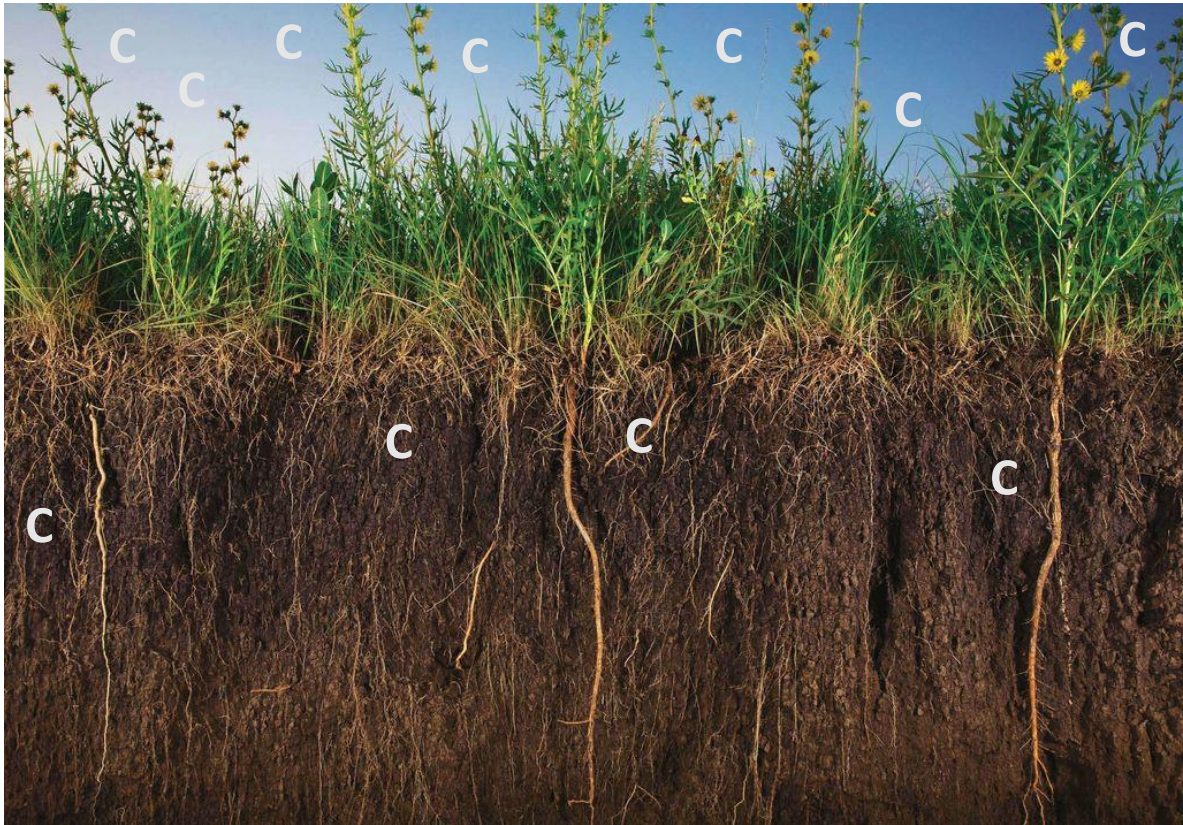
Are the soils considered by the UNFCCC?



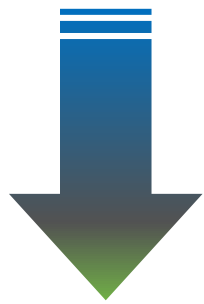
United Nations
Framework Convention on
Climate Change

Do we have tools and methods for quantifying soil carbon stocks?

Why soil carbon stocks are important for climate change?



The less, the better



Organic Matter

The more, the better



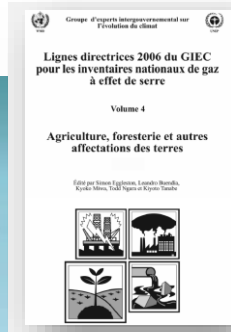
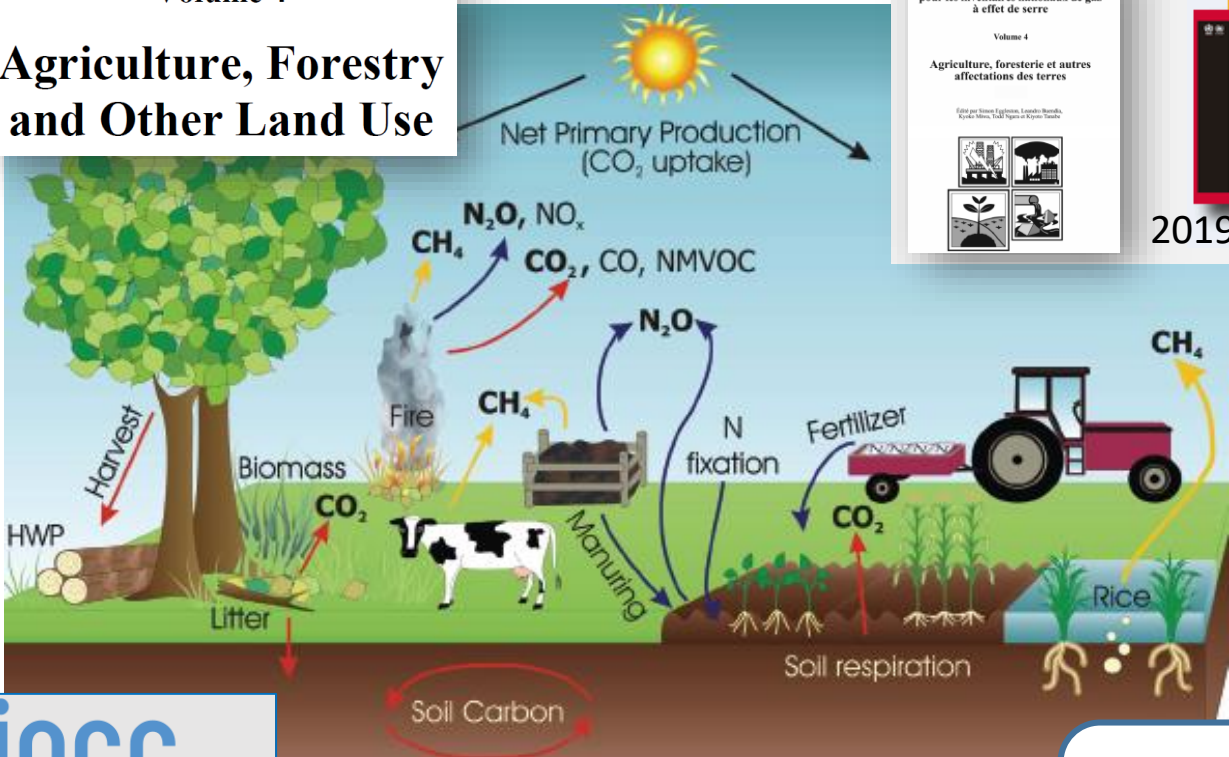
Are the soils considered by the UNFCCC?



United Nations
Framework Convention on
Climate Change

- Soils are considered in the reporting (national communication of GHG emissions, etc)

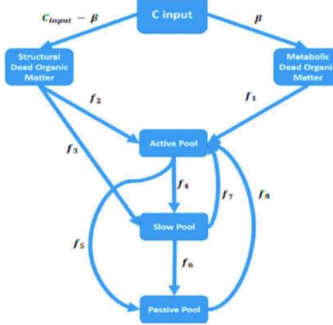
Volume 4 Agriculture, Forestry and Other Land Use



A set of different methods and default figures (reference values, scaling factors for management and for inputs, simplified modelling approach, etc)

TABLE 2.3 (UPDATED)
DEFAULT REFERENCE CONDITION SOIL ORGANIC CARBON STOCKS (SOCREF) FOR MINERAL SOILS (TONNES C HA⁻¹ IN 0-30 CM DEPTH)^{1,2}

IPCC Climate Zone ⁵	IPCC soil class ⁶		
	High activity clay soils (HAC) ⁷	Low activity clay soils (LAC) ⁸	Sandy soils (SAN) ⁹
Polar Moist/Dry (Px - undiff) ¹³	59 ± 41% (24)	NA	27 ± 67% (18)
Boreal Moist/Dry (Bx - undiff) ¹³	63 ± 18% (35)	NA	10 ± 90% ⁴
Cool temperate dry (C2)	43 ± 8% (177)	33 ± 90% ³	13 ± 33% (10)
Cool temperate moist (C1)	81 ± 5% (334)	76 ± 51% (6)	51 ± 13% (126)
Warm temperate dry (W2)	24 ± 5% (781)	19 ± 16% (41)	10 ± 5% (338)
Warm temperate moist (W1)	64 ± 5% (489)	55 ± 8% (183)	36 ± 23% (39)
Tropical dry (T4)	21 ± 5% (554)	19 ± 10% (135)	9 ± 9% (164)
Tropical moist (T3)	40 ± 7% (226)	38 ± 5% (326)	27 ± 12% (76)
Tropical wet (T2)	60 ± 8% (137)	52 ± 6% (271)	46 ± 20% (43)
Tropical montane (T1)	51 ± 10% (114)	44 ± 11% (84)	52 ± 34% (11)
	Spodic soils (POD)¹⁰	Volcanic soils (VOL)¹¹	Wetland soils (WET)¹²
Polar Moist/Dry (Px - undiff) ¹³	NO	NA	NA
Boreal Moist/Dry (Bx - undiff) ¹³	117 ± 90% ³	20 ± 90% ⁴	116 ± 65% (6)
Cool temperate dry (C2)	NO	20 ± 90% ⁴	87 ± 90% ³
Cool temperate moist (C1)	128 ± 14% (45)	136 ± 14% (28)	128 ± 13% (42)
Warm temperate dry (W2)	NO	84 ± 65% (10)	74 ± 17% (49)
Warm temperate moist (W1)	143 ± 30% (9)	138 ± 12% (42)	135 ± 28% (28)
Tropical dry (T4)	NA	50 ± 90% ⁴	22 ± 17% (32)
Tropical moist (T3)	NA	70 ± 90% ⁴	68 ± 17% (55)
Tropical wet (T2)	NA	77 ± 27% (14)	49 ± 19% (33)
Tropical montane (T1)	NA	96 ± 31% (10)	82 ± 50% (12)



FAO eLearning ACADEMY

NEW

Preparing a greenhouse gas inventory under the Enhanced Transparency Framework

OCTOBER 2020 1 h 30 m

NEW

The national greenhouse gas inventory for agriculture

NOVEMBER 2020 5 h 30 m

The national greenhouse gas inventory for land use

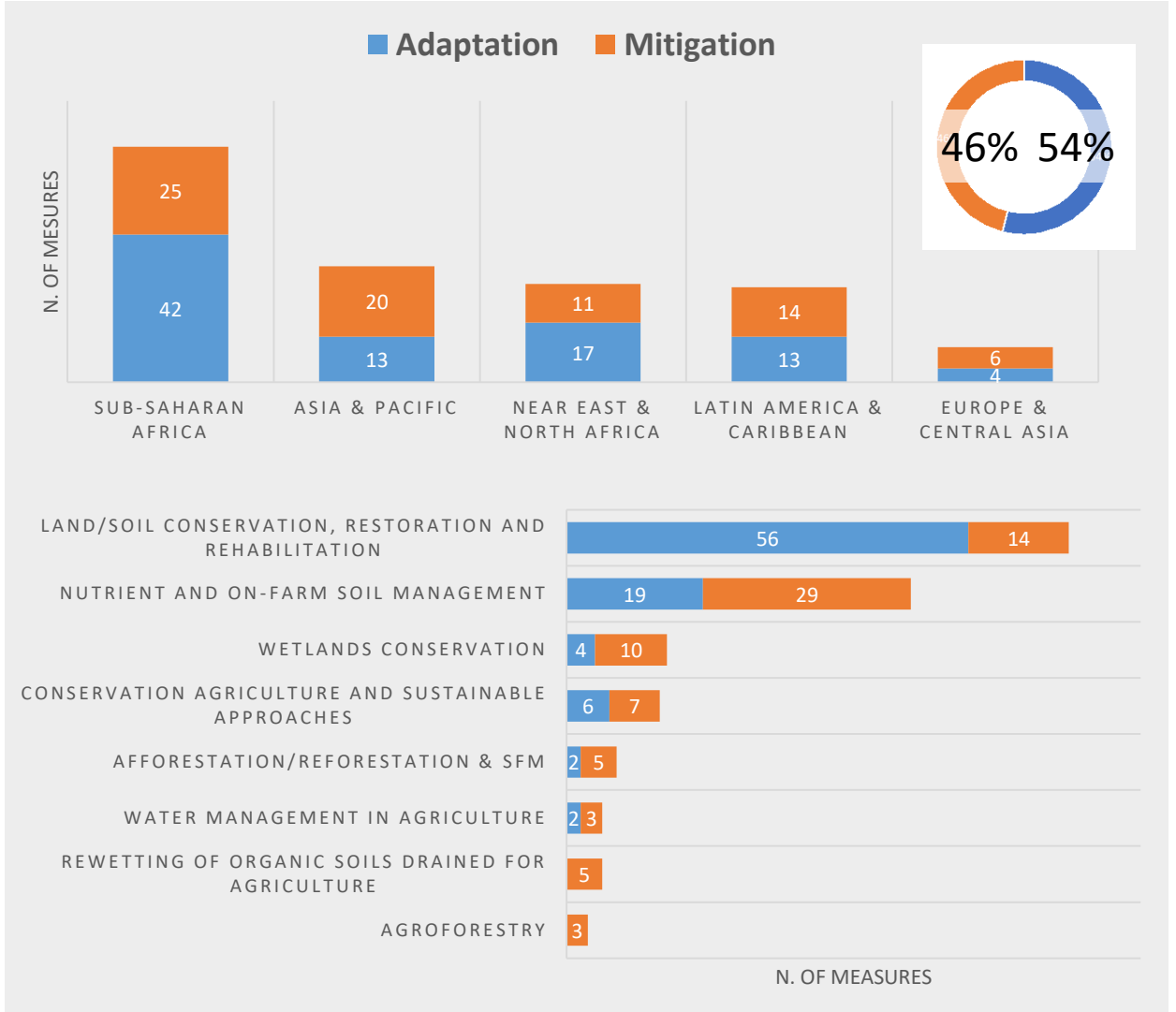
MARCH 2019 17 h

Are the soils considered by the UNFCCC?



• Soils are referenced in adaptation/mitigation policies (NDCs under the Paris Agreement)

- **Almost half of all NDCs reference soils** as part of their mitigation and/or adaptation priorities – **the majority in SSA and Asia-Pacific**
- **Agricultural soils, wetlands and organic soils are the prominent focus** of soil-related adaptation and mitigation measures in the NDCs.
- **Adaptation efforts focus on conserving, restoring and rehabilitating agricultural soils and managing on-farm nutrients.**
- **Mitigation efforts focus on reducing emissions from agricultural soils, enhancing soil organic carbon in natural and managed landscapes, including wetlands and organic soils, as well as protecting and restoring forest land.**



Are the soils considered by the UNFCCC?



United Nations
Framework Convention on
Climate Change

- Soils are one of the topic discussed by the Koronivia Joint Work on Agriculture

Decision 4/CP.23

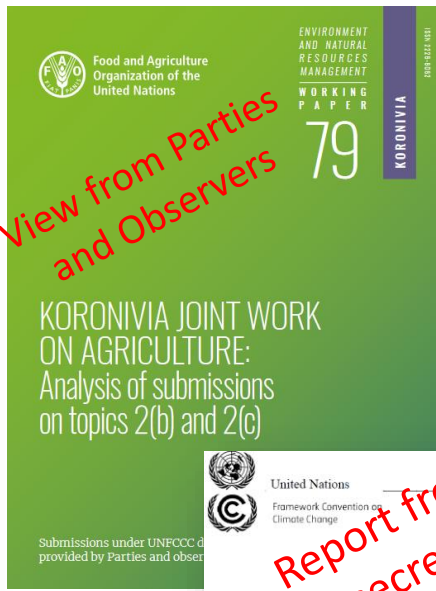


Koronivia joint work on agriculture

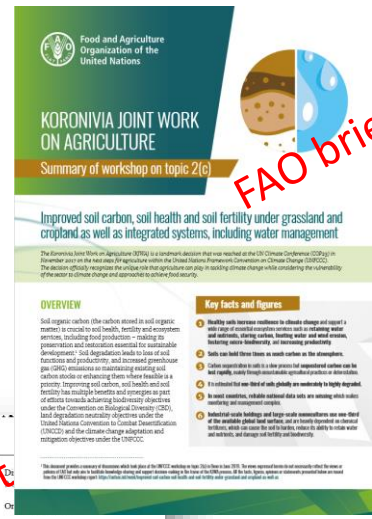
The Conference of the Parties,
Recalling decision 2/CP.17, particularly paragraphs 75–77,
Having considered the reports to the Subsidiary Body for Scientific and Technological Advice on the five in-session workshops on issues related to agriculture,¹

- Requests the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation to jointly address issues related to agriculture, including through workshops and expert meetings, working with constituted bodies under the Convention and taking into consideration the vulnerabilities of agriculture to climate change and approaches to addressing food security;
- Invites Parties and observers to submit,² by 31 March 2018, their views on elements to be included in the work referred to in paragraph 1 above for consideration at the forty-eighth session of the subsidiary bodies (April–May 2018), starting with but not limited to the following:
 - Modalities for implementation of the outcomes of the five in-session workshops on issues related to agriculture and other future topics that may arise from this work;
 - Methods and approaches for assessing adaptation, adaptation co-benefits and resilience;
 - Improved soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems, including water management;**
 - Improved nutrient use and manure management towards sustainable and resilient agricultural systems;
 - Improved livestock management systems;
 - Socioeconomic and food security dimensions of climate change in the agricultural sector.
- Requests that any actions of the secretariat resulting from the provisions in paragraph 1 above be undertaken subject to the availability of financial resources;
- Also requests the subsidiary bodies to report to the Conference of the Parties on the progress and outcomes of the work referred to in paragraph 1 above at its twenty-sixth session (November 2020).

(2c) Improved soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems, including water management



View from Parties and Observers



FAO brief



Report from the secretariat

The narrative is evolving from “Soil Carbon sequestration” to “heathy soil”

We have never been so close to have a conclusion at next COP that would be a game-changer

A clear signal supporting more investments for healthy soils

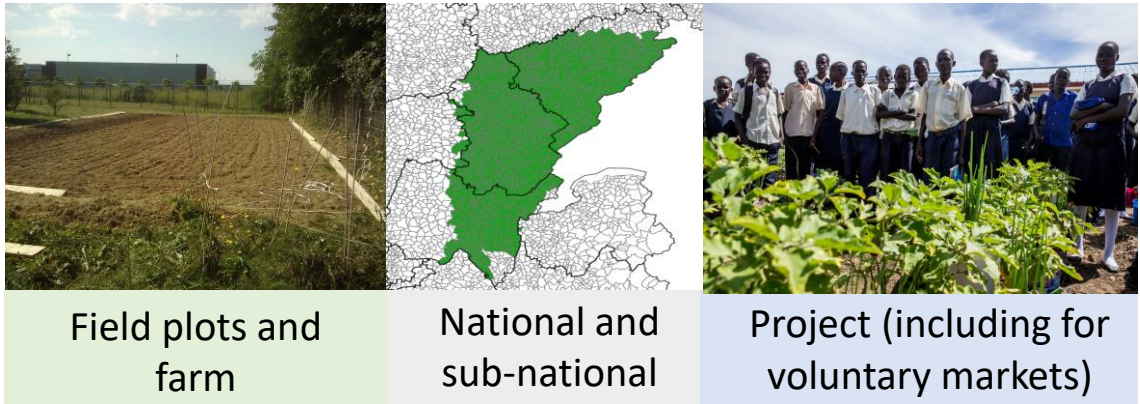
Research, modalities, pilot phases, scaling up....

Soils fully considered in NDC / national policies



Do we have tools and methods for quantifying soil carbon stocks?

Need to consider different scales



frontiers in Environmental Science

REVIEW published: 12 July 2017 doi: 10.3389/fenvs.2017.00041

Accounting for Carbon Stocks in Soils and Measuring GHGs Emission Fluxes from Soils: Do We Have the Necessary Standards?

Antonio Bispo^{1*}, Lizzi Andersen², Denis A. Angers³, Martial Bernoux⁴, Michel Brossard⁵, Lauric Cécillon⁶, Rob N. J. Comans⁷, Joop Harmsen⁸, Knut Jonassen⁹, Frank Lamé¹⁰, Caroline Lhuillery¹¹, Stanislav Maly¹², Edith Martin¹, Angus E. McElnea¹³, Hiro Sakai¹⁴, Yoichi Watabe¹⁵ and Thomas K. Eglin¹

<https://doi.org/10.3389/fenvs.2017.00041>

Received: 13 July 2019 | Accepted: 22 August 2019
DOI: 10.1111/gcb.14815

Global Change Biology WILEY

INVITED RESEARCH REVIEW

How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal

7) Spatial soil re-sampling survey grid (M/V)

- Same sites – resampled each decade
- Used for ground-truthing SOC change
- Used for ground-truthing activity data

t 0 yr
t+10 yr
t+20 yr etc.

6) Remote sensing (M/R/V)

- Verify activity data
- Inputs to run models
- Soils and vegetation

5) Activity data (M/R)

- Management data
- Field / farm level
- Self-reporting

4) Spatial data to drive models (M/R)

- Climate
- Soils
- Land cover etc.

3) SOC / GHG models (M/R)

- Developed using short- and long-term data
- Calibrated using short- and long-term data
- Evaluated against long-term data
- Applied to derive tier 2 EF
- Applied using spatial data as tier 3 methodology
- Verified using survey data and remote sensing

2) Shorter-term experiments (M)

- At long-term sites
- Measure fluxes
- Investigate processes
- Develop novel tools
- Calibrate models

t 0 (days)
t+x (days)
t+y (days) etc.

1) Long-term experiments at benchmark sites (M)

- On different land uses
- Different treatments
- Long term SOC measurement (decades) or chronosequence

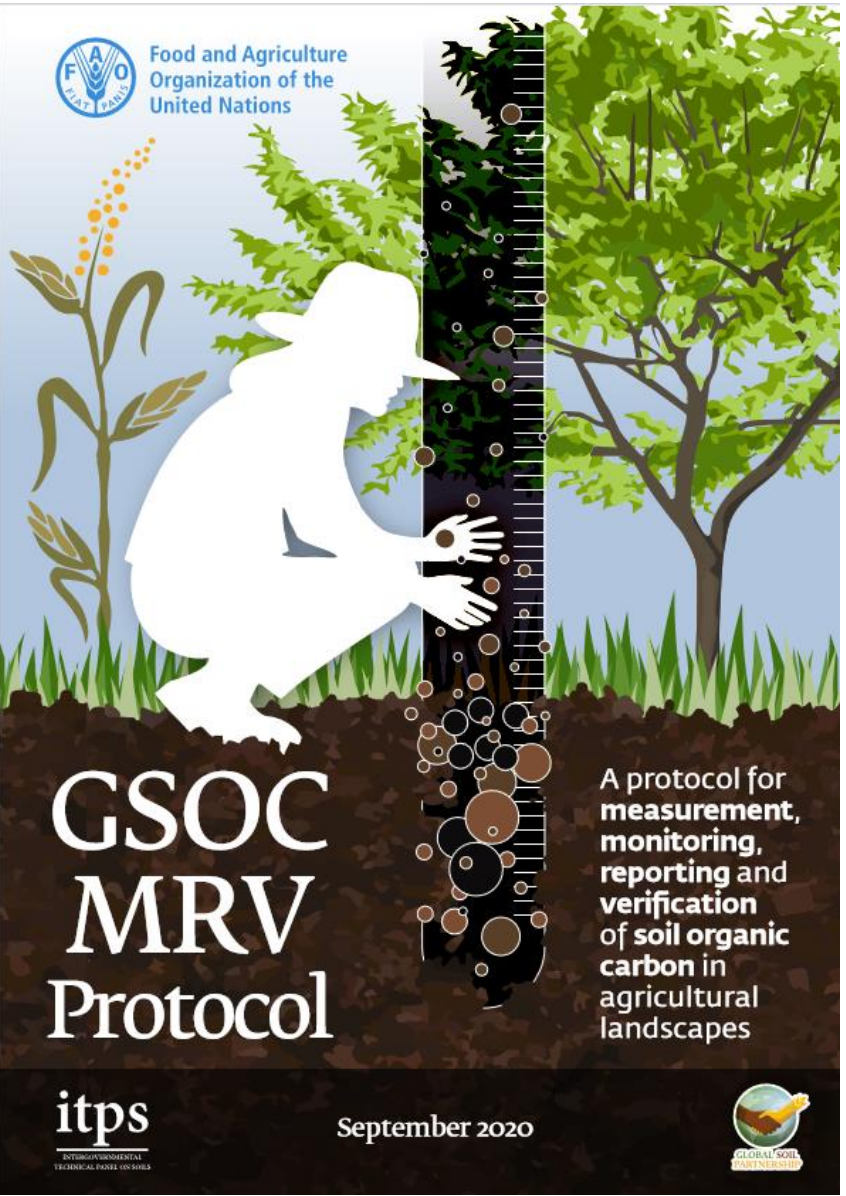
t 0 yr
t+10 yr
t+20 yr etc.

Key: ■ = long term experiment ● = farm

SOC change over time

<https://doi.org/10.1111/gcb.14815>

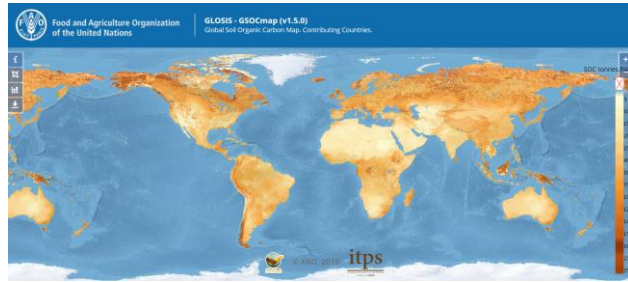
Do we have tools and methods for quantifying soil carbon stocks?



A framework and standard methodologies for the measuring, monitoring, reporting and verifying changes in SOC stocks and GHG emission removals from agricultural projects that adopt Sustainable Soil Management Practices at the farm level.

This protocol is part of a GSP “Carbon Toolkit”

- Global Soil Organic Carbon Map (GSOC map).



- Voluntary Guidelines for Sustainable Soil Management (VGSSM).
- Cookbook on Soil Organic Carbon mapping
- and much more: see the GSP website and its 5 pillars of actions:



- 1- Soil management
- 2- Awareness raising
- 3- Research
- 4- Information & data
- 5- Harmonization

Do we have tools and methods for quantifying soil carbon stocks?

At project level different tools and guidance are available to support users

Selection of appropriate calculators for landscape-scale greenhouse gas assessment for agriculture and forestry

Environmental Science & Letters
 Received 13 January 2013
 Accepted for publication 18 February 2013
 Published 7 March 2013
 Online at stacks.iop.org/1751-8752/10/015029

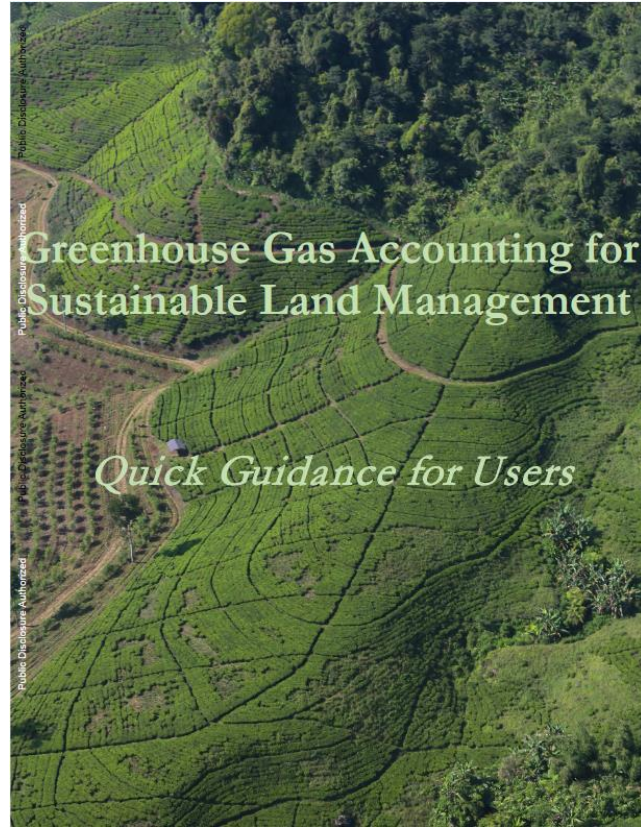
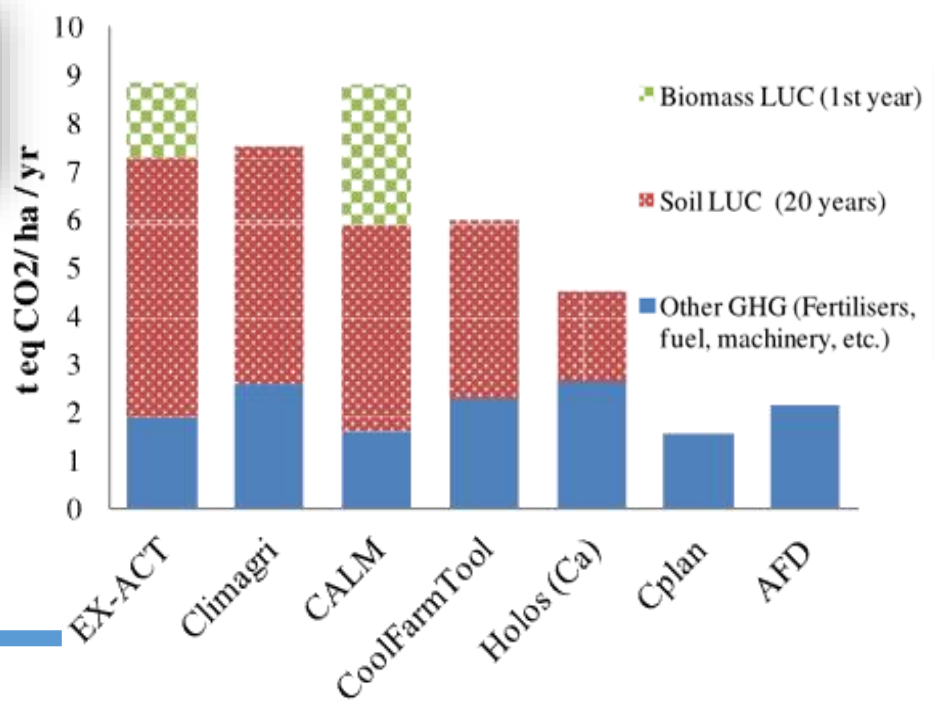
Abstract
 This letter is intended to help potential users select the most appropriate calculator for a landscape-scale greenhouse gas (GHG) assessment of activities for agriculture and forestry. Eighteen calculators were assessed. These calculators were designed for different aims and to be used in different geographical areas and they use slightly different accounting methodologies. The classification proposed is based on the main aim of the assessment, raising awareness, reporting, project evaluation or product assessment. When the aims have been clearly formulated, the most suitable calculator can be selected from the comparison tables, taking account of the geographical area and the scope of the calculation as well as the time and skills required for the calculation. The main issues for interpreting GHG assessments are discussed, highlighting the difficulty of comparing the results obtained from different calculators, mainly owing to differences in scope, calculation methods and reporting units. A major problem is the poor accounting for land use change; the calculators are usually able to account satisfactorily for other emission sources. One of the main challenges at landscape-scale level is to produce a realistic assessment of the various production systems as the uncertainty levels are very high. The results should always give some indication of the link between GHG emissions and the productivity of the area, although no single indicator is able to encompass all the services produced by agriculture and forestry (e.g. food, goods, landscape value and recreation).

Keywords: landscape, carbon calculators, greenhouse gases, GHG emissions, AFEXLU, mitigation

Online supplementary data available from stacks.iop.org/1751-8752/10/015029/mmedia

1. Introduction
 Climate change and its consequences are recognized as one of the major environmental challenges for this century. The Intergovernmental Panel on Climate Change (IPCC) identified

<https://iopscience.iop.org/article/10.1088/1748-9326/8/1/015029>



EX-Ante Carbon-balance Tool | EX-ACT

Mainstreaming greenhouse gas accounting into agricultural investments and policies

FAO eLearning ACADEMY

Estimating GHG Emissions and Carbon Sequestration in Agriculture, Forestry and Other Land Use with EX-ACT

JUNE 2019 5 h

<http://www.fao.org/in-action/epic/ex-act-tool/overview/en/>


Most are based on IPCC guidelines and default values, but results change according to the completeness and scope of the tools.

<https://openknowledge.worldbank.org/handle/10986/31063>


Do we have tools and methods for quantifying soil carbon stocks?


At national level (targeting NDC enhancement)

N.EX.T.

 **NDC EXpert Tool**
FAO tool to target GHG emissions reductions commitments in the NDCs

 **Internationally approved methodologies**
Based on IPCC standards (2006, 2013 Wetlands supplement and 2019 Refinement) developed for AFOLU and aligning with the Enhanced Transparency Framework

 **Estimates national climate mitigation commitments**
Provides annual GHG emissions reduction and mitigation potential of implemented and planned policies

 **Helps**
Governments and companies improve their strategies, pointing them toward net zero GHG emissions in the AFOLU sector.

FOREST LAND												
DEFORESTATION												
Description	Land uses		Mineral soil		Period		Deforested area (ha)			G		
	F/P	Initial land use	Final land use	Main cropland	IPCC/VRB Type	Ref. year	Target year	Ref. value	Target value	Reference	Target	Potential
So-1	F	Tropical moist deciduous forest	Annual cropland	Cassava	IPCC HAC - Soils	2022	2030	10,000	1,000	6,475,237	6,475,24	-5,827,713
So-2	F	Subtropical humid forest	Perennial agroforestry	Alley cropping	IPCC LAC - Soils	2028	2040	2,000	0			
So-3	F	Please select	Flooded rice	Please select	IPCC Please select			0	0			
So-4	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-5	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-6	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-7	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-8	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-9	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-10	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-11	F/Forest	Plantation			IPCC Please select			0	0			
* Depicts of change's implementation												
Total mitigation potential (tCO2-e)												


AFFORESTATION/REFORESTATION												
Description	Land uses		Mineral soil		Period		Reforested area (ha)			Results (over period analysis)		
	F/P	Initial land use	Main cropland	Final land use	F/P IPCC/VRB Type	Ref. year	Target year	Ref. value	Target value	Reference	Target	Potential
So-1	F	Flooded rice	Please select	Tropical moist deciduous forest	IPCC HAC - Soils	2020	2040	300,000	200,000			
So-2	F	Please select	Please select	Please select	IPCC Please select			0	0			
So-3	F	Please select	Please select	Please select	IPCC Please select			0	0			


Simplified

Country-tailored

Climate, soil, agro-ecological zones, crops, livestock, etc



 Food and Agriculture Organization of the United Nations

 **OVERVIEW COUNTRY** Viet Nam

Start entering the country name and select it from the dropdown list

UN Regional Classification | South-eastern Asia

Overall reference year | 2020

Overall target year | 2050

Main methodologies | IPCC 2006 & IPCC 2013

Global Warming Potential (100 years horizon) | AR5 without climate-carbon feedback

Main IPCC soils | LAC - Soils
HAC - Soils
Wetland - Soils

Allow to analyze climate commitments of **different implementation periods & different agro-ecological zones**

Include **direct and indirect GHG emissions**

Track and monitor **GHG emissions reductions**

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