DRAFT for Comments: Synthesis Paper on

Voluntary Carbon Markets for Soil Organic Carbon

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Content

1 Global Frame

Global demand for food production is continuously increasing with a growing global population. At the same time, global food production is challenged by ongoing land degradation and climate change. Nearly 1/4 of the world's landscapes are considered to be degraded, while rising temperatures and changes in precipitation patterns are likely to further increase the risk of land degradation (IPCC, 2019). Without the implementation of measures to protect and restore soils through sustainable land management (SLM), continuous degradation will have serious consequences on soil and its ecosystem services, such as producing food and fiber, supporting nutrient and water cycling, and providing the largest terrestrial carbon sink (Chotte et al., 2019).

SLM generally provides multiple benefits related to soil and agriculture, such as enhancing resilience of agricultural systems, maintaining or enhancing food production, enhancing soil capacity to buffer against degradation processes, improving nutrient cycling, and protecting and sequestering soil organic carbon (SOC) (Gabathuler et al., 2009). With proper management using SLM (Figure 1), carbon sequestration in soils and vegetation can contribute to climate change mitigation through negative and prevented emissions (IPCC, 2014), as well as adaptation by impeding land degrada-

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tion and providing multiple co-benefits for food security and biodiversity (FAO, 2020; IPBES, 2018; Sykes et al., 2019).

During the past five years there has been an increase in the development of an enabling political-instrumental environment that would support the adoption of SLM practices that support SOC protection and sequestration. From a climate change perspective, this is illustrated through the Paris Agreement (United Nations, 2015), the Koronivia Joint Work on Agriculture (UNFCCC, 2018), and the Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate and Land (IPCC, 2019) under the UNFCCC. In terms of land degradation, the UNCCD has set Land Degradation Neutrality (LDN) by 2030 as its

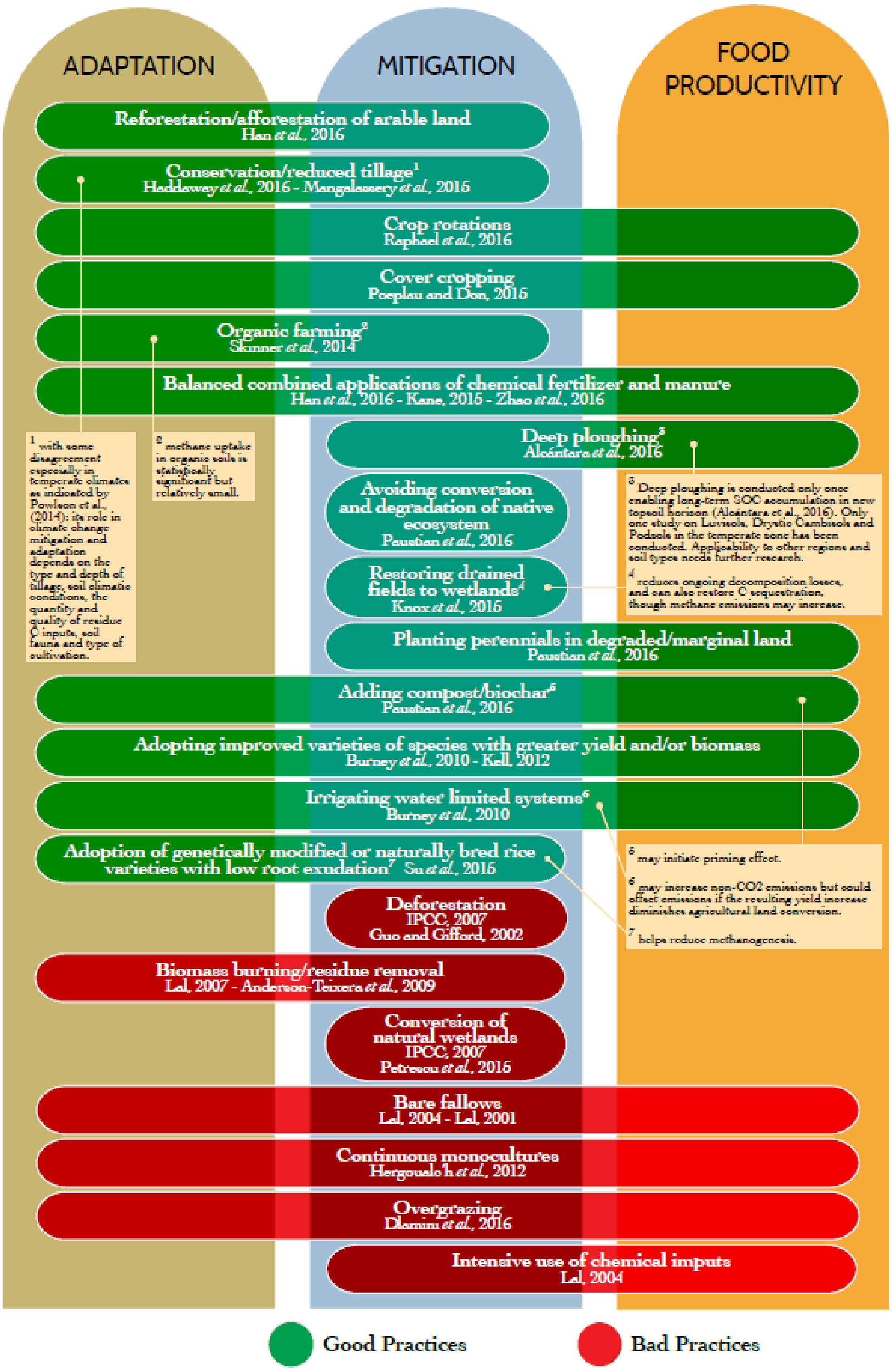


Figure 1. Suggested and dissuaded management strategies for soil carbon sequestration and their impact on food productivity and climate change mitigation and adaptation Source: (FAO, 2017)

main target. LDN is also the goal of Sustainable Development Goal (SDG) 15.3 with its indicator 15.3.1 ("proportion of land that is degraded over total land area") which consists of three sub-indicators and metrics[1] that includes SOC (Orr et al., 2017).

The 4 per 1000 Initiative, founded alongside the Paris Agreement in 2015, aims to increase SOC sequestration through the implementation of agricultural practices adapted to local environmental, social, and economic conditions. Specifically, the initiative focuses on encouraging the transition towards agriculture that is productive, highly resilient, based on appropriate land and soil management, creating jobs and income, and therefore supporting sustainable development.

The Agriculture, Forestry and Other Land Use (AFOLU) sector is one of the biggest emitters of greenhouse gases (GHG), with unsustainable land uses contributing 10-12 GtCO2e[2] per year (ca. 25% of global emissions). About half of this is due to agriculture, which is also the most vulnerable sector to climate change (IPCC, 2019). Yet, the land sector, holds a large mitigation potential. The global soil carbon mitigation potential from agricultural soil is estimated to be 2-5 GtCO2e per year (Fuss et al., 2018; Smith et al., 2019), with sequestration rates due to management practices in agricultural lands estimated in the range of 0.7-2.9 tCO2e per ha per year (FAO, 2020). A large proportion of this SOC sequestration potential lies in developing countries, with the specific magnitude and rate of SOC sequestration per country depending on land use, management practices, soil characteristics, vegetation, topography, climate, historical carbon loss, and more (FAO, 2020; Fuss et al., 2018; Sanderman et al., 2018; Smith et al., 2020; Wiesmeier et al., 2019; Zomer et al., 2017).

Despite their unique potential to sequester atmospheric carbon, SLM projects have not yet reached their full implementation potential at scale due to several challenges. For SOC projects, for example, upfront investment is often required to transition farms to SLM practices that would mitigate GHG emissions while simultaneously providing a host of other environmental and social benefits (Unger and Emmer, 2018; VERRA, 2020). SOC protecting or sequestering activities, policies and targets related to agriculture were included in 28 first Nationally Determined Contributions (NDCs) submitted to the Paris Agreement (Wiese-Rozanova et al., 2020). However, for many of these countries, implementing these activities towards the set targets would require financial resources beyond the current means of the national governments. A potential way to increase finance for SOC sequestration activities is to connect them to additional sources of finance through the sale of carbon credits in carbon markets (VERRA, 2020).

The following sections provide a synopsis of the discourse around the integration of SLM, soils, and SOC into carbon markets. The crucial aspects for such integration are highlighted. An overview of standards and methodologies for SOC project certification are presented, along with key considerations for SOC project development. A case stud is presented in which SLM, soils and SOC have been integrated into the carbon market. Additional references are provided where relevant for more in-depth reading.

More information

For more information on the global importance of SLM and SOC in terms of food security, climate change and voluntary carbon markets, refer to Bossio et al. (2020) and Unger and Emmer (2018).

2 Role of SOC in Voluntary Carbon Markets

Past

Historically, land use, land-use change and forestry (LULUCF) and agricultural emissions were largely excluded from compliance markets (Box 1). Unlike the compliance markets, the voluntary carbon market (VCM) was open to the LULUCF and Agriculture sectors (Hamilton et al., 2007).

Present

Based on preliminary results from the State of Voluntary Carbon Markets 2020 report, the volume of VCM offsets for the AFOLU sector (LULUCF and Agriculture sectors combined)[3] has dropped by 28% (from 50.7 tCO2e in 2018 to 36.7 tCO2e in 2019), compared to a 78% surge in the Renewable Energy sector volume

[1] The three sub-indicators (and associated metrics) for SDG indicator 15.3.1 are: land cover (land cover change), land productivity (land productivity dynamics), and carbon stocks (soil organic carbon stocks)

[2] 1 GtCO2e = 1 000 000 000 tCO2e (metric tons carbon dioxide equivalent)

[3] The term Agriculture, Forestry and Other Land Use (AFOLU) is used in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines which describes the anthropogenic GHG emissions from two distinct sectors: Agriculture and LULUCF (Land Use, Land Use Change and Forestry), which were previously treated separately (Smith P. et al., 2014).

(from 23.8 tCO2e in 2018 to 42.3 tCO2e in 2019). Despite the reduction in VCM offset volume, the average offset prices associated with Nature Based Solutions (NBS) and Natural Climate Solutions (NCS)[4] under AFOLU have increased by about 30% compared to a 16% decrease in offset prices for Renewable Energy. Despite the lower volume of AFOLU VCM offsets, the 2019 market value of AFOLU offsets (average USD 4.3 per tCO2e) was more than three times that of Renewable Energy (average USD 1.4 per tCO2eq) (Donofrio et al., 2020).

Box 1. A brief history of carbon markets

Since the adoption of the Kyoto Protocol in 1997, large sources of GHG emissions from the land use, land-use change and forestry (LULUCF) sector have been excluded from carbon compliance markets. The Kyoto Protocol limited the accountability of emission reductions from the LULUCF sector in the Clean Development Mechanism (CDM), to afforestation and reforestation and methane emissions from agriculture (Larson et al., 2011; Unger and Emmer, 2018).

Launched in 2005, the European Union Emissions Trading System (EU ETS) trading of CDM offsets signaled the birth of compliance markets (Donofrio et al., 2020) and was also the first compulsory scheme to include private parties. In designing the EU ETS, the EU decided against the integration of agricultural emissions, which became a blueprint for ETS designs worldwide (Unger and Emmer, 2018). The substantial land-use restrictions was supported by a broad alliance of NGOs, which questioned the environmental and ethical integrity of trading systems, claiming it would legitimize ongoing pollution (Unger and Emmer, 2018). The main concerns of the parties leading to this decision was the permanence risk of land-based emission reductions and high costs for monitoring systems and protocols to track GHG fluxes.

A clear shift towards NCS in VCMs was observed in 2017, with NCS reducing emissions by financing improved management of forests, farms, and natural ecosystems. Forestry projects have long dominated in the VCM NCS domain, with Reducing Emissions from Deforestation and forest Degradation (REDD) and REDD+ projects often being the top project types in terms of volume (Donofrio et al., 2019). Biosequestration projects that capture and store carbon in plants and agricultural soils (i.e. SOC) form a subcategory of NCS (Donofrio et al., 2019; VERRA, 2020). However, as of September 2018, Unger and Emmer (2018) reported that globally, fewer than 20 projects that sequester CO_2 or reduce CO_2 emissions in agricultural plots were registered with international voluntary carbon standards, with market prices remaining modest between USD4 and USD8 per tCO2e. Hence, the VCM market figures for AFOLU largely do not include SOC projects.

Donofrio et al. (2019) explained that the increased volume in Forestry and Land Use appeared to be driven by buyer enthusiasm for NCS (see Box 2 for more information). Learning from the forestry example, an increase in demand for SOC projects in VCMs may well be stimulated by the continuous and increased publication of scientific evidence, awareness raising campaigns and continuous development or improvement of methodologies to harness the potential of SOC as NCS.

Donofrio et al. (2019) also cautioned that, when comparing the surge in volume for Forestry and Land Use projects relative to other project types, increases in volume also appeared to be drive by the expansion of relevant domestic policy into relevant activities. These findings highlight the importance of domestic enabling environments and policies to support participation in VCMs through different project types.

Future

Under the Paris Agreement, Article 6 provides the option for countries to reduce their GHG emissions using international carbon markets. Specifically, Article 6.2 allows countries to set up bilateral and voluntary agreements to trade or transfer carbon credits between countries (Farand, 2019; Kizzier et al., 2019; Re, 2019). In addition, Article 6.2 puts high emphasis on the promotion of sustainable development, ensuring environmental integrity and transparency, and the need for robust accounting to avoid double counting (United Nations, 2015). Article 6.4 established a central UN mechanism to oversee the trade of credits from emissions reductions. This mechanism is open to both public and private entities, with the goal to mobilize private sector participation in climate change mitigation (BMU, 2020; Kizzier et al., 2019; Re, 2019).

[4] Within voluntary carbon markets, NCS drives demand for several project types, most of which are forest-related (i.e. afforestation, reforestation, revegetation, improved forest management, Reducing Emissions from Deforestation and forest Degradation (REDD), and REDD+). Non-forest projects types are Agricultural Land Management (ALM), Avoided Conversion of Grasslands and Shrublands (ACoGS), and Wetlands Restoration and Conservation (WRC).

During the UNFCCC COP24 in Katowice, Poland an almost complete set of rules and guidelines for the implementation of the Paris Agreement was adopted. However, parties were not able to agree on implementation rules and an accounting system for Article 6, referred to in climate jargon as the "Article 6 rules". One major point of contention is the issue of developing accounting rules for emission reductions under Article 6.2 that are robust enough to: 1) avoid double counting (emission reductions counted more than once) and 2) ensure that the environmental integrity of the Paris Agreement is upheld by ensuring additionality[5] and increased NDC ambition and progression. A second unresolved question under Article 6.4 revolves around the potential transition of Kyoto Protocol mechanisms into the Article 6.4 mechanism. This includes how credits generated under the Clean Development Mechanism should be dealt with and whether countries would be able to use these credits under the Paris Agreement (BMU, 2020; Farand, 2019; Re, 2019).

Box 2. Scientific evidence and awareness raising influenced VCM buyer demand for forest projects (Adapted from (Donofrio et al., 2019)*)*

NCS projects were an integral part of VCMs since their inception in the late 1980s, but showed a surge in related project numbers in 2017 and 2018. In 2018, market actors indicated that their purchasing decisions were influenced by awareness-raising campaigns around NCS organized by NGOs and United Nations agencies, as well as media outlets increasing their coverage of Nature Based Solutions, especially tree planting.

The awareness campaigns and media coverage were largely based two major sources of information. The first was the widely cited research published in the Proceedings of the National Academy of Sciences in 2017 which showed that the climate mitigation potential of NCS had been vastly underestimated. The second was the 2018 IPCC Special Report on Global Warming of 1.5 °C (SR15) which identified carbon sinks, especially from NCS, as critical to meeting the Paris Agreement's target to keep global warming below 1.5 °C.

The second five-year cycle of NDC submission to the Paris Agreement has started in 2020. Countries whose first NDC time frame ended in 2025 or 2030 were therefore requested to submit new or updated NDCs (Fransen et al., 2019). As the potential of SOC is increasingly recognized for its role in the goal for zero net GHG emissions, international interest also increases to reflect this potential through SLM and SOC in NDCs (Wiese-Rozanova et al., 2020).

Carbon projects are an important pathway for spreading the technologies and skills required to implement SLM practices for SOC protection and sequestration, but carbon projects require support from governments through legal and governance reforms, planning security and scaling mechanisms (Unger and Emmer, 2018). Numerous methodologies and monitoring systems exist for almost every type of agricultural land management project, which allows project developers to deal with various technical challenges, such as tracing GHG fluxes or mitigating risks of carbon losses (Unger and Emmer, 2018). (methodologies related to SOC projects are discussed in Section 2.2).

In the following sections an overview of the standards and methodologies available for soil carbon project certification is provided.

More information

For more information on SOC and VCMs, refer to Unger and Emmer (2018).

For information on the role of SOC in NCS, refer to Bossio et al. (2020).

For trends in VCMs since 2006, refer to Donofrio et al. (2019, sec. The EM Time Capsule) for a brief overview and the State of Voluntary Carbon Markets series for details per annum.

For comprehensive information on carbon project development, refer to Unger and Emmer (2018).

3 Key considerations for SOC projects

A comprehensive guide on SOC projects, their key features, methodologies and standards was developed by Unger and Emmer (2018) and is recommended for further reading. The publication includes case studies and provides valuable information on the feasibility of SOC projects in practice at the macro (implementation) and project (on the ground) level.

The following sections highlight selected key aspects for SOC projects in developing countries.

3.1 Standards and methodologies for SOC project certification

SOC projects can account for GHGs by enhancing SOC sequestration in soils, or by protecting soils from degradation to avoid the release of stored SOC into the

[5] For more on additionality, refer to Section 3.5

atmosphere. A clear distinction is usually made between avoided conversion and carbon sequestration. Following a similar distinction, several internationally active voluntary standards have developed specific methodologies and project formats for the AFOLU sector (Unger and Emmer, 2018). The main standards are the Verified Carbon Standard (VCS) (managed by Verra), the American Carbon Registry (ACR), the Climate Action Reserve (CAR), Plan Vivo, and Gold Standard. Project categories under these standards generally fall under:

- Agricultural land management
- Restoring wetland ecosystems
- Avoided conversion of grasslands and shrubland)
- Peatland rewetting or restoration

Under these categories, numerous methodologies have been developed over the past two decades to calculate mitigation benefits and issue carbon credits in a wide range of AFOLU project activities. Specific eligible project activities are defined in the respective methodologies, covering croplands, grasslands, savannahs, peatlands and coastal wetlands. Carbon accounting methodologies include both biomass and SOC as major carbon pools and sources of GHG emissions and are specified for each project type and methodology. Although still relativity small in project numbers (Unger and Emmer, 2018), there is sufficient experience with SOC projects to support the development of mitigation plans with confidence at larger scales (Bossio et al., 2020; Unger and Emmer, 2018).

Box 3. Methodologies available for SOC projects. Updated from (Unger and Emmer, 2018). Methodologies published in 2020 are indicated by the stipulation of the publication date.

Verified Carbon Standard (VCS)

Avoided Conversion of Grasslands and Shrublands (ACoGS)

- Methodology for Avoided Ecosystem Conversion VM0009

Agricultural Land Management (ALM)

- Adoption of Sustainable Agricultural Land Management (SALM) VM0017
- Soil Carbon Quantification Methodology VM0021
- Sustainable Grassland Management VM0026
- Sustainable Grassland Through Adjustment of Fire and Grazing VM0032
- Methodology for Improved Agricultural Land Management VM0042 (Approved 19 October 2020)

Peatland restoration and conservation (Restoration of Wetland Ecosystems (RWE), and Conservation of Intact Wetlands (CIW))

- Rewetting of Drained Tropical Peatlands VM0027
- Rewetting of Drained Temperate Peatlands VM0036

American Carbon Registry (ACR)

- Avoided Conversion of Grasslands and Shrublands to Crop Production
- Compost Additions to Grazed Grasslands

Climate Action Reserve (CAR)

- Grassland Project Protocol
- Soil Enrichment Protocol (Published 30 September 2020)

Plan Vivo

- Plan Vivo Climate Benefit Quantification Methodology - Small-Holder Agriculture Monitoring and Baseline Assessment (SHAMBA) methodology

If a suitable approach is not available, projects can develop or adapt their own approaches and submit to Plan Vivo Foundation for approval

Gold Standard

- Soil Organic Carbon Framework Methodology (Released 28 February 2020)
- Soil Organic Carbon Activity Module (Released 28 February 2020) (To be applied in conjunction with the Soil Organic Carbon Framework Methodology)

Food and Agriculture Organization (FAO)

- GSOC MRV Protocol (Published 17 September 2020)

A **positive indicator** of increased interest in SOC projects in VCMs is the publication of four new methodologies for agricultural land management and SOC in 2020 (Box 3) and the development of one new standard which is still underway (Box 4). Three of the new methodologies were published under standards by VCS, CAR and Gold Standard (its first methodology applicable to SOC projects). The fourth new methodology was published by the Food and Agriculture Organization (FAO) of the United Nations as part of the Global Soil Partnership (GSP) initiative RECSOIL – Recarbonization of Global Soils. RECSOIL provides a set of tools to offset GHG emissions to decarbonize the economy based on the implementation of SOC-centered sustainable soil (land) management practices on a large scale. A summary of the methodologies available for SOC projects under the five main standards and FAO is provided in Box 3.

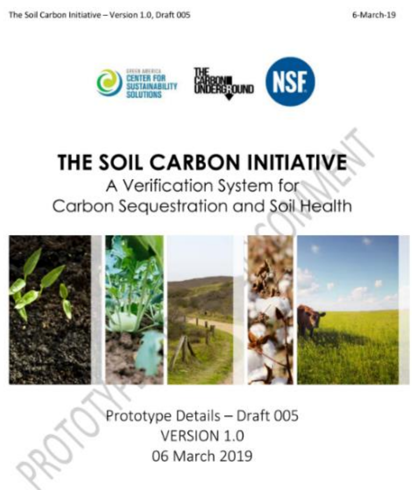
Numerous domestic standards and associated methodologies exist which apply to specific countries (i.e. Australia, Canada, and many others). As a result, these standards are not currently relevant for application in developing countries (Unger and Emmer, 2018) and hence not discussed in this paper.

3.2 Climate finance

An important distinction must be made between climate and carbon finance. Climate finance refers to the local, national, or transnational funds required to address climate change mitigation and adaptation (Gupta, 2016). Essentially, climate finance refers to the funds used for SOC project development and implementation. Carbon finance is the income generated by projects through the sale of carbon credits earned in carbon markets (Gupta, 2016) (discussed in Section 2.4).

Historically, climate finance and policy options for SOC have been considered low, but the viability of climate financing for soil appears to be improving (Bossio et al., 2020), although still as a niche market (Unger and Emmer, 2018). Given the key role of SLM in climate change mitigation and adaptation, there may be opportunities for increasing the role of climate finance in supporting the achievement of the NDCs through SLM. The main sources of climate finance investments in SLM are the Global Environment Facility (GEF), Adaptation Fund, and the Green Climate Fund (GCF). The GCF now targets land use and agriculture under a "cross cutting" project theme (Unger and Emmer, 2018).

Box 4. New Soil Carbon Initiative standard under development



The Soil Carbon Initiative (SCI) has designed an outcome-based, scientific verifiable agricultural standard with input from over 150 stakeholders to improve soil health and build soil carbon by encouraging a shift to regenerative agricultural practices. The Version 1.0 methodology was out for comment until 5 May 2020 (The Soil Carbon Initiative, 2019). The standard was designed to help farmers and supply chains to measure improvements in soil health and soil carbon sequestration to address the change in climate. The SCI measures soil health and soil carbon without dictating which management practices should be applied. The points-based standard is applied in three stages through enrolment, demonstration of commitment (annual evidence of plans and activities), and outcomes-based testing of performance areas (within a year of enrolment and every three years thereafter. Farmers can earn SCI verification by enrolling agricultural systems that are already at a high level of soil health, or by demonstrating improvements in performance areas during the next testing cycle (every three years). Farmers are required to continue demonstrating improvement until a high level of soil health performance is reached relative to their region.

The standard tests four performance areas of:

1. SOC
2. Soil water dynamics (water infiltration or water holding capacity)
3. Aggregate stability
4. Microbial biomass.

Each performance area is suggested to include in field, in-lab, and proxy tests which are flexible and may incorporate test that farmers are already doing. Acquiring "SCI-Verified" status requires lab tests for performance areas as much as possible based on review of results by certified SCI "Verifiers".

Although the ultimate aim is to drive SOC sequestration in soil, SCI does not require producers to measure changes in SOC stocks to be SCI verified, due to the long time (5+ years) required to demonstrate such improvements. Instead, SCI offers significant points for using a validated program to demonstrate improvements in SOC stocks.

In terms of carbon project development, the World Bank's BioCarbon Fund has supported 20 projects related to habitat restoration and carbon enhancement, but most of these projects focused on afforestation and reforestation (Unger and Emmer, 2018). According to Bossio et al. (2020, p. 2) "there are a range of fresh private-sector initiatives on SOC that promise sufficient funding and transformational change, and impact investors focusing on landscapes, soil resources and payments for ecosystem services schemes".

More information

For more information on financing instruments, challenges and opportunities related to soil remediation, as well as forest and landscape restoration, refer to Liagre et al. (2015) and Perera et al. (2018).

3.3 Carbon finance and carbon markets

Carbon standards create "carbon credits" as tradable units issued into registries where credits can be traced (Unger and Emmer, 2018). Different standards use different units for carbon credits, such as:

- VCS: Verified Carbon Units (VCUs)
- ACR: Emission Reduction Tonnes (ERTs)
- CAR: Climate Reserve Tonnes (CRTs)

In all cases, one carbon credit (i.e. 1 VCU, 1 ERT or 1 CRT) represents an actual reduction or sequestration gain achieved of 1 metric ton CO_2 (tCO_2) or 1 metric ton CO_2 equivalent (tCO2e) (1 carbon credit = 1 tCO2 or 1 tCO2e).

Once issued into registries, credits can be traded (sold and purchased) between account holders in what is referred to as "emissions trading"[6]. Once a credit has been used for offsetting or compliance purposes, it is cancelled or "retired" in the registry (Unger and Emmer, 2018).

Average prices for voluntary offsets through voluntary carbon standards often fall in the range of USD4-USD8 (Unger and Emmer, 2018). This average range falls well below average prices achieved in compliance markets, and lower still than the World Bank range of USD40-USD80 per metric ton estimated to be necessary to achieve the goals of the Paris Agreement (Donofrio et al., 2019).

In the 2020 State of Voluntary Carbon Markets assessment, market participants "saw a maintained trend in favour of nature-based solutions, and demand for offsets associated with AFOLU appears strong in 2020" (Donofrio et al., 2020, p. 8).

More information

For a detailed analysis of trends in carbon pricing, refer to the World Bank's State and Trends of Carbon Pricing 2020 report.

3.4 Demand for carbon credits (buyers)

The majority of carbon credit demand comes from corporate entities, led by socially and environmentally responsible corporate decision-making (Unger and Emmer, 2018). Over the next 5-7 years, the corporate based voluntary market to offset footprints is going to dominate in terms of the overall demand that will be created

An influx of new buyers in the VCMs was observed in 2018, with demand during that year being broad-based and mostly driven by new market entrants. New buyers ranged from small businesses to major corporations, with many first-time buyers located in countries that were not historically big sources of demand (Donofrio et al., 2019). Donofrio et al. (2020) cautioned that new buyers in the VCMs have tended to focus on price rather than co-benefits, such as contributions to the SDGs. Historically, co-benefits have been a key selling point for AFOLU projects which increasingly audit to the SDGs.

Buyers are increasingly selective in their demand profile, looking for what is rare and what would yield co-benefits in addition to mitigation. Co-benefits in terms of biodiversity and community-benefits have been noted to be particularly important (Unger and Emmer, 2018). Despite buyers preferring projects that demonstrate benefits beyond emission reductions, their willingness to pay a premium for those benefits appears limited (Donofrio et al., 2019).

Unger and Emmer (2018) highlighted that for SOC projects, public funding has been and will probably continue to be instrumental.

3.5 Ensuring environmental integrity of SOC projects

The environmental integrity[7] of carbon credits has to be shown and maintained to provide buyers with the

[6] Emissions trading refers to the issuance of and trade with traceable, commodified units (Unger and Emmer, 2018)

[7] „While there is currently no globally accepted definition for environmental integrity, it is usually an umbrella term referring to the key considerations relating

confidence that the credits accurately represent genuine and real emission reductions. To ensure such environmental integrity, carbon crediting mechanisms follow best practice principles that set key requirements for projects to meet in order to receive carbon credits (World Bank, 2020). Two principles are of particular importance – permanence and additionality.

Permanence

Permanence in terms of carbon markets refers to the longevity of a carbon pool, whereby carbon credits should represent permanent emission reductions and removals. Under most carbon standards, increases in SOC stock or avoided SOC loss as a result of a project activity must be maintained for a long period (usually at least for 100 years), and its reversal (i.e. by reverting to unsustainable management practices) must be avoided. Permanence is important when emission reductions or removals are used as offsets – if the underlying carbon stock disappears, the offset will also be affected (Unger and Emmer, 2018).

Where projects carry a risk of reversibility, at minimum, adequate safeguards need to be in place to ensure that the risk is minimized and that, should any reversal occur, a mechanism is in place that guarantees the reductions or removals shall be replaced or compensated (World Bank, 2020).

"Current project standards offset the risk of non-permanence by issuing only temporary credits, or by installing a fixed (e.g. Gold Standard) or variable (e.g. VCS) buffer withholding. For example, in VCS language, the "non-permanence risk analysis only needs to be applied to GHG removals or avoided emissions through carbon sinks. Project activities generating emissions reductions of N_2O, CH_4 or fossil-derived CO_2 are not subject to buffer withholding, since these GHG benefits cannot be reversed". Non-permanence risk is seen to consist of three risk factors: internal, external, and natural risks, for which rating can be obtained. Under the VCS, the total risk rating shall not exceed a value of 60% or the project risk is deemed unacceptably high and thus the project not eligible. Note that each percent withholding means a deduction on the return on investment, although the standard has created opportunities to reduce the withholding over time" (Unger and Emmer, 2018, p. 25).

Additionality

Additionality is a fundamental criterion for any offset project. Additionality refers to the fact that the project and its emission reduction would not have happened if the project had not been carried out (World Bank, 2020). Additionality is shown based on an analysis of barriers to implementation of the project activity.

Carbon standards provide procedures and rules for testing the additionality of a proposed project which forms part of the baseline and project development steps. These procedures aim to determine whether GHG emissions mitigation was part of the rationale for project design and implementation, and whether the presence of carbon markets provided a clear incentive to project implementation. (Unger and Emmer, 2018).

At the project design level, projects for agricultural carbon finance are required to provide and explicit explanation for land degradation and the subsequent potential for carbon sequestration or emission reducitons as a means to show the additionality of proposed project activities. In order to reach such additionality, relevant management practices need to be implemented at sufficiently "additional" volumes to the baseline. To achive this, the scale of adoption of SLM practices, for example, needs to be substantially higher than the baseline context and the proposed business as usual scenario. Effectively showing additionality during project desing may therefore result in high resources costs to robustly document the baseline scenario and convincingly show that the project activities will result in improvements that can be verified (Cavanagh et al., 2020).

3.6 Ex-ante versus ex-post finance

In principle, carbon finance is based on an "ex-post" or results-based financing (RBF) modality, meaning that an emission reduction has to be achieved, reported and verified before it can be issued and transferred. This is generally also the norm for voluntary standards currently active in the AFOLU sectors (e.g. Verra, Plan Vivo, and American Carbon Registry), but an increasing number of exceptions are emerging whereby standards issue "ex-ante" credits (e.g. Gold Standard) (DEHSt, 2018). The sale of ex-ante credits enables the covering of project establishment costs using carbon finance (Malin et al., 2013).

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to the validity and the social-environmental impacts of generating, transacting and accounting for the use of the carbon credit." (World Bank, 2020, p. 49)

3.7 Benefits for farmers

The ultimate benefit derived by farmers from carbon finance projects may depend on a number of factors. In the case of the KACP (Vi Agroforestry, 2012), for example, analysts have raised concerns regarding the low returns from emission reductions sales to farmers and the high transaction costs of the implementing agency and sub-contracted firms (Cavanagh et al., 2020). Based on a random sample of 16 KACP farmers' groups representing 279 households, it was estimated that in the KACP the average carbon revenue received per farmer translated into an average of USD 0.33 per household per year from 2009-2016 which are considered unlikely to provide sufficient incentive for the adoption of SALM practices (Cavanagh et al., 2020).

The co-benefits of SOC projects are not only important for buyers, but also for farmers as direct beneficiaries. Depending on the specific project activities implemented, such co-benefits may include enhanced farmer income through increased soil productivity, improved household food security and nutrition (FAO, 2019), and increased crop yields. In the KACP, increased maize yields resulting from SALM practices was reported up to 90% in five years which improved the income of households (Vi Agroforestry, 2019).

4 Key actors in voluntaty carbon markets for SOC

The full range of actors in VCMs is too vast to list in this paper. Here, a preliminary list of key actors in terms of standards and methodologies, as well as climate finance is provided.

Category	Organization	Description
Providers of standards and methodologies	Verra (VCS)	VCS, managed by Verra, is the world's largest voluntary standard in terms of the number of projects and credits and offers methodologies across the full range of AFOLU, with a number of methodologies related to soil management, as well as peatland and wetland restoration and conservation.
	American Carbon Registry (ACR)	The American Carbon Registry (ACR) started off as a US domestic VCS, but has since extended its scope to all countries, providing for several soil-based methodologies.
	Climate Action Reserve (CAR)	The Climate Action Reserve (CAR), a voluntary initiative created in 2001 as the California Climate Action Registry, has developed two methodological approaches ("protocols") on soil carbon. The CAR published a new Soil Enrichment Protocol in September 2020.
	Plan Vivo	Plan Vivo is the only standard that exclusively restricts projects to the AFOLU sector.
	Gold Standard	In 2020, Gold Standard introduced its first methodology targeting SOC through its Gold Standard Soil Organic Carbon Framework Methodology. The methodology presents requirements to quantify changes in GHG emissions and SOC stocks resulting from the adoption of improved agricultural practices which may include both avoided emissions and SOC sequestration.
	FAO/Global Soil Partnership (GSP)	Launched the RECSOIL – Recarbonization of Global Soils initiative as a set of tools to offset GHG emissions to decarbonize the economy based on the implementation of SOC-centered sustainable soil (land) management practices on a large scale.
Climate finance	World Bank BioCarbon Fund	The World Bank BioCarbon Fund has been active for over a decade. The Fund supported the Kenya Agriculture Carbon Project (KACP) which was the first soil and agricultural carbon project in Africa through which the carbon revenues resulted in direct additional income for farmers as a reward for environmental services.
	Global Environment Facility (GEF)	GEF funds are available to developing countries and countries with economies in transition to meet the objectives of the international environmental conventions and agreements.
	Adaptation Fund	The Adaptation Fund (AF) was established to finance concrete adaptation projects and programmes in developing countries that are particularly vulnerable to the adverse effects of climate change. It was established under the Kyoto Protocol of the UN Framework Convention on Climate Change, and since 2010 has committed funds for localized climate adaptation and resilience activities.
	Green Climate Fund (GCF)	The GCF targets land use and agriculture under a "cross cutting" project theme
	Livelihoods Carbon Fund	With a first Carbon Fund launched in 2011, the Livelihoods investment funds are supported by private companies committed to generating impact while offsetting their carbon footprint or transforming their supply chains.
	South Pole Climate Impact Funds	South Pole works with clients across the private, public and non-profit sector on structuring and managing climate impact funds that deliver social and environmental benefits. Climate impact funds bring together companies, governments and philanthropies to finance climate action at scale. By pooling investments, investors co-finance projects and companies that generate a quantifiable, positive climate impact.

5 Case studies

Monitoring and carbon accounting: Kenya Agriculture Carbon Project (KACP)

The KACP (Vi Agroforestry, 2020, 2019) is a climate compensation project located in western Kenya which promotes sustainable agricultural land management (SALM) practices for implementation on smallholder farms (average size of <1 ha) to improve livelihoods and generate GHG removals through soil and tree carbon sequestration. The 20-year project (2009-2030) set a total emission reduction target of 1,980,088 tCO_2e by 2030 using the Verified Carbon Standard (VCS) carbon offset standard. The project formed the basis for the development of a new carbon methodology, VCS methodology Vm0017 (VCS, 2011), based on an approach of accounting for carbon sequestration in the soil from the adoption of SALM practices (Wekesa and Jönsson, 2014).

The project was implemented by Vi Agroforestry, in partnership with the World Bank's BioCarbon Fund and UNIQUE forestry and land use, involving 29,497 smallholder farmers participating through 1,730 farmer groups, covering 21,966 ha of land under SALM. SALM practices included:

- Mulching and composting for nutrient management
- Soil and water conservation such as retention ditches
- Crop rotation and intercropping
- Agroforestry
- Tillage and residue management
- Land restoration and rehabilitation through natural regeneration
- Integrated Livestock Management
- Integrated Pest Management
- Sustainable energy (i.e. biogas and efficient stoves)

The KACP was the first soil and agricultural carbon project in Africa through which the carbon revenues resulted in direct additional income for farmers as a reward for environmental services. The SALM practices sequestered an estimated average of 1.68 tCO_2e/ha/year, resulting in a total of 184,447 tCO2e sequestered and verified of which 24,788 tCO2e was sold to the BioCarbon Fund for the period of 2010 to 2015. These carbon revenues were shared between farmers (60%) and to cover costs for the administrative work and advisory services (40%). In addition, SALM practices increased maize yields by 90% in all agro-ecological zones in five years and improved the income of households from increased crop yields and the sale of carbon credits.

The KACP project crediting periods runs from July 2009 to June 2030 for a total of 20 years based on a number of monitoring periods. The first three monitoring periods occurred as follows:

- 1st monitoring period: 1 Jul 2009 to 31 Mar 2012
- 2nd monitoring period: 1 Apr 2012 to Mar 2015
- 3rd monitoring period: 1 Apr 2015 to Mar 2017

The monitoring system started by establishing the baseline through Permanent Farm Monitoring (PFM) using the Activity Baseline Monitoring Survey (ABMS). The baseline survey was conducted in 2009 using a sample of 100 farmers from Kisumu and 100 from Kitale based on maize production. The necessary surveys were conducted by a field-officer to ensure high levels of precision in measurements and georeferencing of assessment locations. Progressive PFM surveys were conducted every year from 2010 to 2014 with data collect seasonally and entered annually into the database.

Subsequent monitoring is based on Farmer Group Monitoring (FGM) as a tool to monitor project implementation annually, providing the basis for Vi Agroforestry to identify farmers or farmer group-specific training needs. The system provides a sustainable farm self-learning and planning tool for farmers. Through a FGM sub-system, farmers record their data at individual farm level (self-monitoring and evaluation), building group capacity to monitor implementation by all the group's members. The individual data collected is aggregated at group level involving an intensive recording and verification process involving farmers, contracted farmer groups, project field coordinators and a project M&E officer (Figure 2).

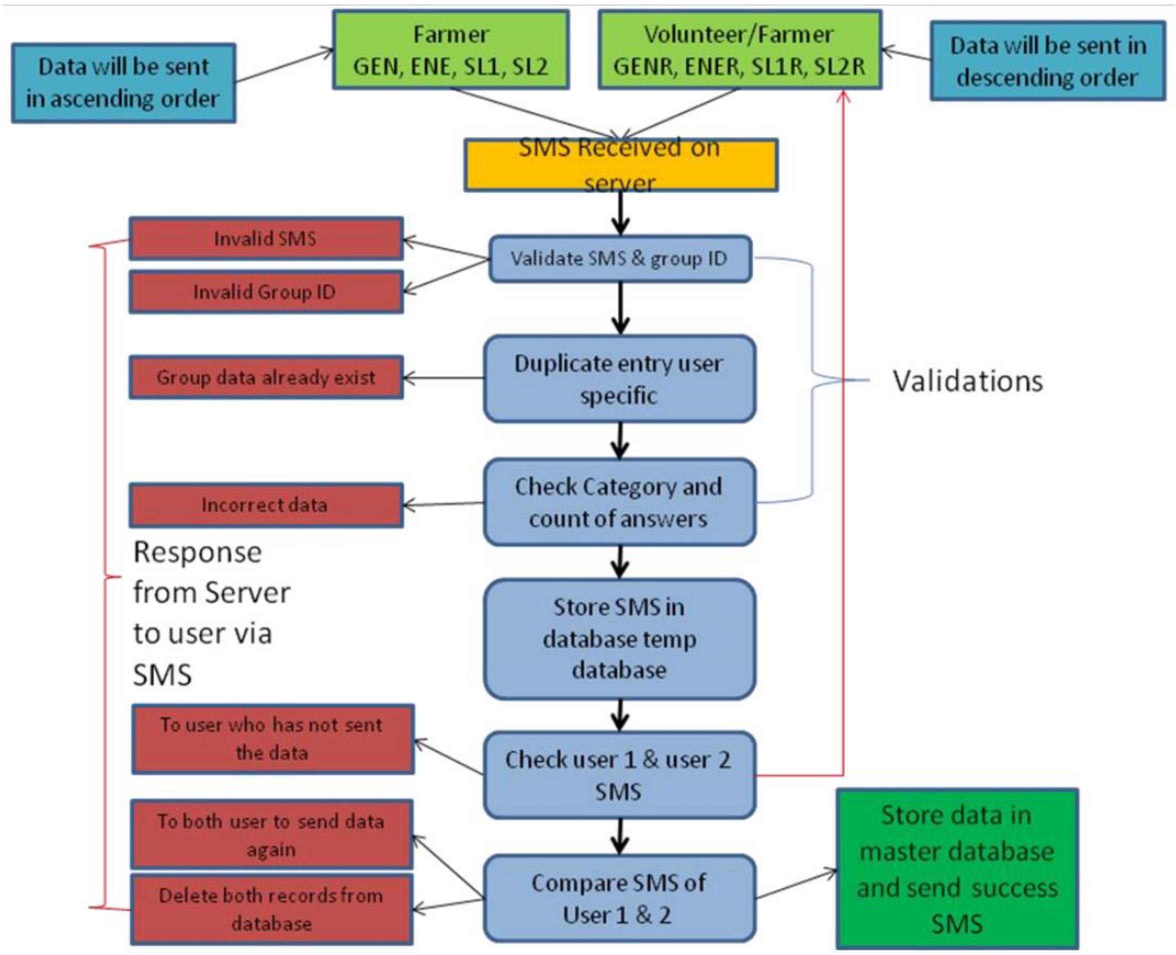

Figure 2. Data transmission and quality control procedures in the KACP (Source: Presentation by Nalianya, M. (Vi Agroforestry) during an East Africa Soil Carbon Workshop, 17-18 April 2018, Nairobi, Kenya (Nyawira and Sommer, 2018).

Flexibility is key – from Kenya around the globe and back to Rwanda

10 years of soil carbon monitoring *UNIQUE forestry and land-use*

(Text provided by UNIQUE forestry and land use)

The Sustainable Agricultural Land Management (SALM) methodology was the first VCS authorized methodology for monitoring GHG benefits. The methodology can be applied for a broad range of SALM practices and was particularly developed for smallholder agricultural production systems that are quite diverse. Practices and yields are monitored, and together with online available information on soils and climate, the impact on soil organic carbon (SOC) stock changes are estimated using the RothC model, which was previously parameterized in Kenya.

- Standard:
  Under the Verra standard, the leading standard in the voluntary carbon market
- Methodology:
  UNIQUE forestry and land use developed the SALM Methodology VM0017 Adoption of Sustainable Agricultural Land management. The methodology was approved in 2011 and financed by the World Bank in the context of the Kenya Agricultural Carbon Project. The project implementer is the Kenyan NGO Vi Agroforestry: https://verra.org/wp-content/uploads/2018/03/VM0017-SALM-Methodolgy-v1.0.pdf
- Soil carbon monitoring approach:
  The SALM methodology is monitoring farm practices and modeling soil organic carbon stock changes based on farm activity data collected by the farmer. Compared to direct SOC measurements this system provides direct farm management relevant information e.g. on input and practice related yields. The error reflects the uncertainty of the activity monitoring and of the model. Direct measurements have errors related to the soil analytics and face the challenge of measuring a small change against a large SOC stock. Hence, it takes

5-10 years to be able to trace a significant change. Furthermore, SOC varies tremendously within a farm. Therefore, it remains unclear what monitoring approach is better, but certainly direct measurements only have co-benefits for precision farming at industrial scale.

The SALM methodology was developed using the RothC carbon model, but other models can be used as well. The SOC stock changes consider crop residues and manure inputs in the soil. The increase or decrease in SOC stocks is the result of the decomposition of the added organic materials. The version of the RothC model is an automatized web application synchronized with a set-of digital tools that allow projects to collect the required data in an App and enable the analysis and reporting in a customized dashboard.

- Digital Solutions

  Digital solutions are currently revolutionizing commercial agriculture, particularly precision farming and robot technology. The digital divide between commercial farms and small-scale farmer is growing but there are digital technologies that are also improving the access to and information sharing between small-scale farmer and the value chain partner. Data collection tools (excel sheets, SMS based or customized APPs) have been developed for carbon monitoring and a Web-Dashboard for analyzing data and reporting and verification exists (www.digital.unique-landuse.de).

6 List of abbreviations

ACR	American Carbon Registry
AFOLU	Agriculture, Forestry and Other Land Use
CAR	Climate Action Reserve
CCAFS	Climate Change, Agriculture and Food Security
CRT	Climate Reserve Tonne
ERT	Emission Reduction Tonne
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gas
GSP	Global Soil Partnership
IPCC	Intergovernmental Panel on Climate Change
KACP	Kenya Agricultural Carbon Project
LDN	Land Degradation Neutrality
LULUCF	Land use, land-use change and forestry
MRV	Measurement, reporting and verification
NBS	Nature Based Solutions
NCS	Natural Climate Solutions
NDC	Nationally Determined Contribution
SALM	Sustainable agricultural land management
SCI	Soil Carbon Initiative
SDG	Sustainable Development Goal
SLM	Sustainable land management
SOC	Soil organic carbon
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary carbon market
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit

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