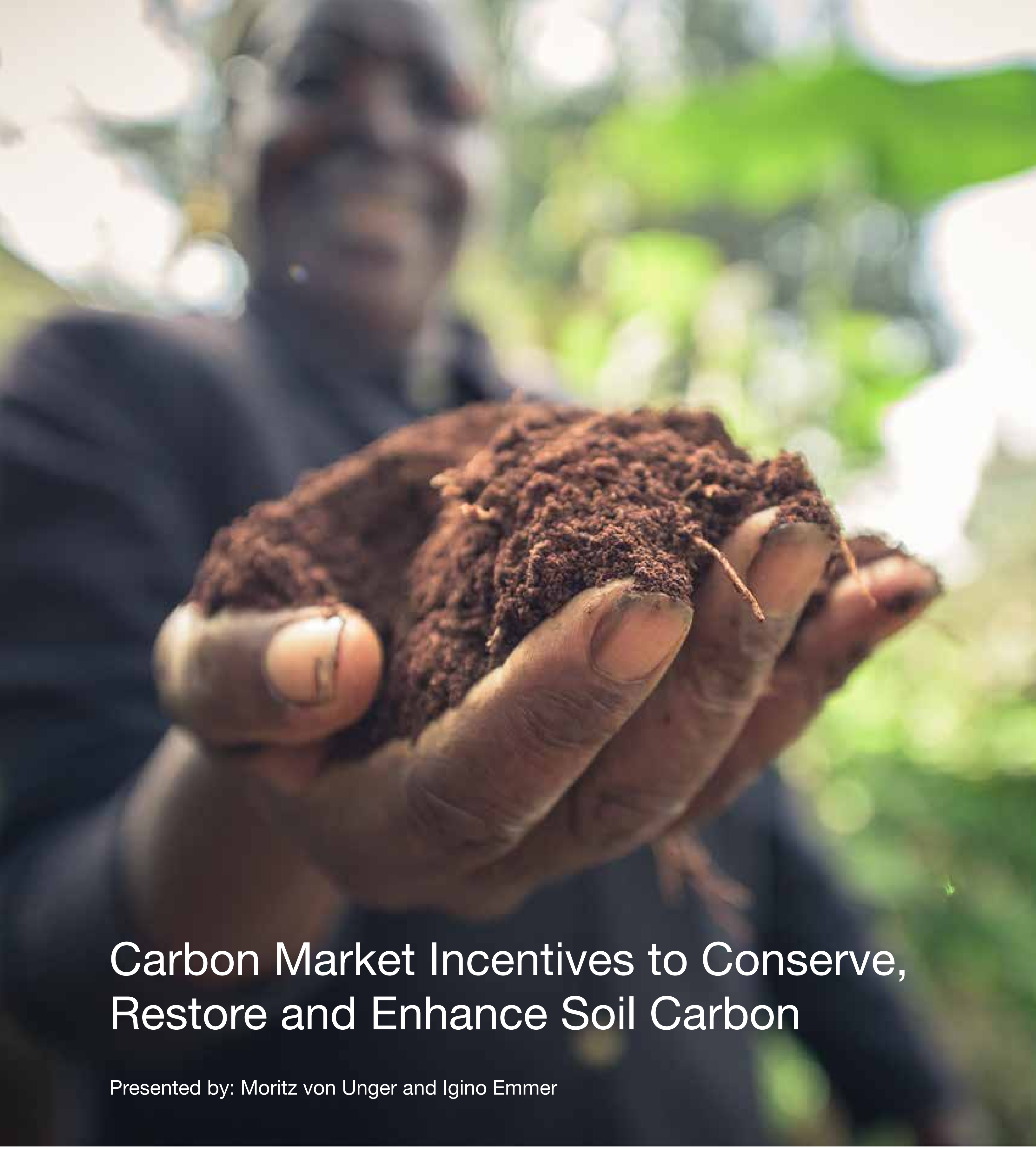

Carbon Market Incentives to Conserve, Restore and Enhance Soil Carbon

Presented by: Moritz von Unger and Igino Emmer

silvestrum CLIMATE ASSOCIATES

The Nature Conservancy

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About Silvestrum

Silvestrum Climate Associates LLC. supports local, national, and international governments, non-governmental organizations (NGOs), as well as private enterprise focused on advancing climate mitigation, adaptation, restoration, resilience, and education for habitats and landscapes.

About The Nature Conservancy

Founded in 1951, the Nature Conservancy is a global conservation organization dedicated to conserving the lands and waters on which all life depends. Guided by science, we create innovative, on-the-ground solutions to our world's toughest challenges so that nature and people can thrive together. We are tackling climate change, conserving lands, waters and oceans at an unprecedented scale, providing food and water sustainably and helping make cities more sustainable. Working in 72 countries, including all 50 United States, we use a collaborative approach that engages local communities, governments, the private sector, and other partners.

This study has been commissioned by The Nature Conservancy (TNC) and is part of TNC's work on soils and climate within the Global Lands Program.

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The Nature Conservancy

Foreword

At The Nature Conservancy, we are convinced that soil is an important foundation for environmental and human well-being. Soils rich in organic carbon are associated with enhanced agricultural productivity, water cycling, biodiversity, and climate change adaptation and mitigation. Due to the sheer size of the soil organic carbon pool – triple that of the atmosphere – increasing soil carbon and protection against loss of soil carbon are important for climate stabilization.

Many of our projects in agricultural landscapes and grasslands strive to provide healthy food and water, increase economic returns for farmers and land managers, and protect biodiversity. Climate financing for soil organic carbon may be an opportunity to bring additional revenue to these efforts. This report was motivated by many of the questions of our conservation leaders, farmers' groups, development actors and corporate sustainability teams. They want to know if there is a credible technical basis for soil carbon sequestration mitigation projects, if the potential is real and significant, and if there are buyers at the end of potentially long and expensive verification processes.

Furthermore, at the Conservancy we are keenly aware of the need for rapid action at large scales from project to jurisdictional and national levels, not only for climate but also for the other benefits of soil health. We are also aware that given the rapid evolution of climate actions, the level of uncertainty surrounding the modalities for climate finance in the future is high. In this evolving context, are new initiatives at project level the right entry point for action at the scale desired?

To answer these and associated questions, this report assesses the state of and prospects for carbon finance for soil carbon projects and its ability to make a meaningful contribution to climate change mitigation. By taking the voluntary market as the lens, it also serves to inform the wider issue of fate and utility of land sector carbon projects within the evolving political framework of the Paris Agreement. While many of the principles will apply to both terrestrial soils and coastal wetlands, the study has focused on the former, for which two decades of experience exist. Carbon interventions in coastal wetlands by contrast – sometimes referred to as "blue carbon" – have only recently been introduced, and it seemed too early to undertake an evaluation of what will hopefully become a "blue carbon" practice.

There are surprisingly few – less than 20 – projects in the world that sequester CO_2 or reduce CO_2 emissions in agriculture registered with one of the international voluntary carbon standards. There are an additional 40-odd compliance market projects in Australia, which has several carbon offset programs. For some of the other greenhouse gases associated with agricultural production, the story is different, but not much.

While soils have largely been absent from carbon markets, despite low cost per tonne of CO_2, there are signs that the future may be different. Initiatives such as the 4 per 1000 and Global Peatlands Initiative have created momentum for policy development on soils. The Paris Agreement has itself started to open the door to soil carbon activities by allowing countries to address mitigation across sectors, and most recently a sharpened perspective on agriculture in general, and soils in particular, emerged from the latest climate talks.

An important conclusion of the report is that most technical barriers to soil carbon projects have been overcome and protocols now exist for all categories covering croplands, grasslands, savannahs and peatlands, for avoided conversion and building soil organic carbon. This progress has been achieved through decades of building technical expertise and standards for land sector carbon markets. TNC and other non-governmental organizations working in the forest sector have been instrumental in this progress. TNC has also developed many agricultural carbon projects within the United States, and is the sponsor of one of the few international soil carbon project initiatives, the Northern Kenya Grassland Project.

Another optimistic finding is that the buyer market is increasingly looking for projects that provide many benefits (mitigation-cum-co-benefits), and thus under current conditions the report concludes that “a soil carbon project without a buyer will be hard to find.” Trends in newer offsetting mechanisms such as in aviation also bode well for the future of the voluntary market. This, alongside the opening of compliance markets, with examples from New Zealand and Australia in the agriculture sector, augers well for carbon finance for soils.

This enthusiasm comes with many caveats. Size and scalability present challenges. Transaction costs for project development continue to be high. In the absence of broader policy-level transformations addressing land tenure, investment climates, planning and zoning, soil carbon projects will not thrive. Public finance and government support are essential to stabilize market activity. And ultimately, it is still not certain that soil carbon will fall into the scope of the new market mechanisms of the Paris Agreement when they become operational.

Soil carbon market projects are still needed as laboratories for engagement with stakeholders, for improving standards, and spreading technology and skills. Rationale for soil project development, however, hinges on strengthening yields, resilience, ecosystem benefits and mitigation, with priorities in that order, i.e. we care about more than climate. From the perspective of The Nature Conservancy, a balance between focusing on individual projects and supporting action at jurisdictional scales and in the public sector is needed. Thus, building soil carbon into cross-cutting intervention formats such as nationally determined contributions is an important way forward, for which projects can provide the technical basis. Soil carbon projects themselves are innovators: for farmers and local communities, as well as investors. They also point the way: towards scale and long-term impact.

Deborah Bossio
Lead Soil Scientist, The Nature Conservancy

Objectives of this Study

This report focuses on carbon finance opportunities for enhancing soil organic carbon stocks across the globe and moving towards low-carbon, sustainable, agriculture practices which deliver both on food security and the global warming trajectory of no more than 1.5°C. More precisely, the study was done to assess the state of and prospects of carbon finance for soil carbon project development and its ability to make a meaningful contribution to climate change mitigation.

In this study, we portray existing methods, standards, and projects in the area of soil carbon development and agricultural soil management. We cover carbon sequestration activities as well as efforts to reduce carbon stock losses (through peatland degradation, in particular), always retaining a narrow focus on (below-ground) carbon in soils. We also touch on several non-CO_2 emissions, in particular methane released from certain land-use practices (e.g. rice paddy fields) and nitrous oxide released through the use of fertilizers. We do not address soil cover interventions and, more concretely, we are leaving forest-related activities – afforestation and reforestation (A/R), forest management, as well as activities to Reduce Emissions from Deforestation and forest Degradation (REDD+) – outside the focus of this study. Obviously, soil carbon interventions share many characteristics with forest carbon interventions, and often we can make reference to the "land-use" sector as a whole. Yet, while forest carbon policies and related activities, including carbon project development, has drawn a lot of attention over the past decade, soil carbon has not or much less so. We also do not cover in any detail carbon stocks in coastal wetlands (often referred to as "blue carbon"). While these provide vast additional potential for reducing emissions and sequestering carbon, we consider the emerging blue carbon methodological approaches[1] (beyond mangrove conservation and restoration, which would simultaneously qualify as A/R or REDD+) as too novel for the kind of "lessons learnt" exercise this study seeks to undertake.[2]

The main purpose of this study is, therefore, to extrapolate the specific situation of soil carbon – its position in climate policymaking, and the specific challenges, as well as the opportunities for intervention – and to explore to what extent carbon project finance tools can help its advancement.

1. Key Messages

Soil carbon projects, registered and duly awarded, are rare. The abstract greenhouse gas (GHG) mitigation potential – some 0.6–1.8 gigatonnes (Gt) of CO_2eq per year may be mitigated through soil sequestration from pastures and grassland (more than 50%) and emission reductions through peatland rewetting and avoided conversion – stands in stark contrast to the minimal number of projects that try to implement, measure and report emission reductions and removals from and into soils, using carbon markets as leverage. There are fewer than 20 projects in the world registered with one of the international voluntary carbon standards that sequester CO_2 or reduce the CO_2 emissions in agricultural plots. For some of the other GHGs associated with agricultural production, the story is different, but not much. While there are a few (about a handful) of rice paddy (methane reduction) projects, more projects are registered for reducing nitrous oxide releases through changes to fertilizer use. Yet, even in this category, annual issuance figures for carbon credits – the backbone of carbon market finance – remain below 50,000. The only sizable project types in the field of agriculture stem from animal manure, the reason being that manure treatment can be used as an energy source.

The management of soils as such has largely been ignored by the carbon markets, even though abatement costs per tonne of CO_2 for a range of intervention formats are relatively low. The mismatch has multiple causes. Firstly, regulated emissions trading schemes ("compliance markets") have ignored the sector, ever since the Kyoto Protocol severely restricted land-use sectors from the world's largest international trading scheme, the Clean Development Mechanism, and when the first compulsory GHG emissions trading scheme involving private parties (installations and traders), the European Union Emissions Trading Scheme, came out against it. Voluntary carbon standards opened their doors, yet their overall market size is small; there is no guaranteed demand of any size to attract ubiquitous supply, and prices are mostly modest (often somewhere between US$4 and US$8).

Secondly, civil society has long been, and still is, at odds over the use of carbon markets to protect ecosystems. A large number of environmental and social non-governmental organizations (NGOs) have been particularly vocal in their rejection of emissions trading instruments, with policymakers taking note. Many organizations (often vehemently) question both the environmental as well as the ethical integrity of emissions, claiming it would legitimize perpetual pollution.

On the technical and implementation side, it has taken many years to build the skills and to design workable formats for the development of such projects. Land-use projects present challenges that are not found in industrial and energy projects. One key challenge concerns size and control. For industrial projects, size is all that matters. The bigger an installation, the better the carbon project opportunity. For land-use projects, size is sometimes hard to establish (think of small-scale farming), and where it is found, it often comes with problems of its own. Effective control over space and time may be hard to ensure – harder in any case than within the walls of a factory. In many countries and regions, land tenure conflicts and tenure uncertainties make projects untenable from the start. Measuring emission fluxes is complex; and the risk of unwanted sequestration reversals and carbon stock losses creates a strange liability for commodity trading. Also, while in some situations the emission reduction output tonnes/hectare is high (true for many peatland projects), in others it is not, forcing projects to become large in size, incurring the trade-offs noted.

Soils have missed out on carbon markets, and yet there are promising signs that the future may be different. The main difference between the early 2000s, when compliance markets decided against soils and other land-use categories, and today, is that robust methodologies exist for almost any project category covering woodlands, croplands, grasslands, savannahs, as well as peatlands. This means that project developers can rely on robust intervention formats, which adequately deal with all sorts of technical challenges, from tracing carbon fluxes to mitigating risks of reversals and stock losses.

It is not only methodological capacities, it is also skills and best practices accumulated over two decades and spread across countries and continents that have changed the odds. While the total project number is still small, many others are underway, and development timeframes are becoming shorter. Internationally active for-profit and not-for-profit organizations today form global networks of knowledge and support to steer climate-smart agriculture action in places as remote as the US and Kenya or the Netherlands and Vietnam.

Voluntary carbon markets have been the facilitators of global concerted action. They are generally small in size, and relevant commercial trajectories – number and size of voluntary market transactions, price per tonne CO_2eq, and other – look more stagnant than upbeat. However, it would be superficial to look at the carbon offsetting markets only in their entirety and to conclude that there is no space for more supply. The buyer market is increasingly selective in its demand profile, looking for what is rare as well as for what strikes many benefits (mitigation-cum-co-benefits). Under current conditions, a soil carbon project without a buyer will be hard to find. Furthermore, there are early indicators that the incoming aviation offsetting mechanism (Carbon Offsetting and Reduction Scheme for International Aviation or “CORSIA”), with an expected demand of 150 to 800 million credits annually over the period 2025 to 2040, will include the land-use sector in its scope, and that buyers seek out particular projects rather than purchase wholesale from anonymous sources, though the list of eligible aggregation levels – projects, programs, or jurisdictional approaches – has not yet been spelled out.

Thus, compliance markets are slowly opening up to the sector. While there is still no system in the world with direct coverage of soil carbon emissions, other types of agricultural emissions – from livestock and fertilizer use – are (slowly) coming into focus for regulators. New Zealand has introduced mandatory GHG reporting for livestock and fertilizer-related emissions. And soil carbon sometimes benefits indirectly from emissions trading: as a source of offset credits (particularly practiced in North America) or through providing centralized funding to encourage carbon project development (as in the case of Australia and California). The more carbon projects to create credits that are put into practice, the harder it will be over time to exonerate the agricultural sector from inclusion in a cap-and-trade environment (or to legitimize a blank inclusion, without exceptions).

The Paris Agreement itself may turn the page towards soil carbon activities. It encourages countries to focus on sequestration to balance out GHG emissions, if not to reach “net-negative” emissions. It requires countries to aim for addressing mitigation action across sectors, including the land-use sector. It highlights the importance of adaptation and resilience activities and recognizes food security as a priority. Low-carbon – or climate-smart – agriculture delivers on all these cross-cutting objectives.

The land-use sector may ultimately play a prominent role in emissions trading in the context of Nationally Determined Contributions under the Paris Agreement. Article 6 of the Paris Agreement includes several emissions trading instruments, a bilateral trade tool (Article 6.2), a multilateral mechanism (Article 6.4) and a non-market mechanism (Article 6.8). While details of how these mechanisms will work, for which sectors and with which type of intervention format, have still to be agreed upon in a dedicated “rulebook”, the odds are that Kyoto-style restrictions will not be replicated. In practice, countries may use the new trading formats both to enhance climate mitigation ambitions at relatively low costs and to channel climate finance into land-use; in particular, soil-based interventions may have a market advantage for quite some time.

The scenario comes with a number of caveats nonetheless. First and foremost, size and scalability present a challenge. In countries characterized by smallholder farming in particular, steering transformational change towards carbon stock enhancement and sustainable soil farming is a complex operation requiring exceptional outreach and planning skills, financial needs and considerations aside. A single soil carbon project easily involves hundreds, if not thousands of farmers. To gain wide access in the field, to promote deep integration, and to secure continuity in implementation, can be strategically daunting and poses ongoing challenges even for experts. Moving towards upscaled levels of aggregation – programs, jurisdictional and sectoral approaches, and country-wide roll-outs – brings more complexities.

A widespread lack of comprehensive land zoning, non-representative planning decisions, and uncertain land tenure arrangements add to the difficulty of implementing soil carbon policies in partnership with local communities. Against the backdrop of law and tenure, achieving an annual growth rate of 0.4% – the aspirational goal of the 4 per 1000 initiative – which may look straightforward on paper – becomes highly ambitious.

Emissions trading, in this context, offers substantial opportunities, yet it will not bring about change single-handedly and not without concerted action on different levels. Carbon projects make useful laboratories for testing and spreading new technologies and practices and for channeling and leveraging finance. Non-state actors can provide relevant skills, technological and governance infrastructure, advance funding as well as investment to get a project off the ground. In order to leverage a project to trigger full-scale jurisdictional or even national roll-out, on the other hand, a supportive policy environment as well as domestically embedded partners – ideally at both the government and the private level – are essential.

Public climate finance has an important role to play when it comes to creating supportive policy environments, creating institutional platforms for engagements, and promoting domestic champions for change. Carbon projects will be most effective if they second and respond to government-to-government cooperation, building knowledge and adding real-time experience on the ground. Public climate finance has a particular role to play, without which private-sector-driven field interventions will struggle to succeed in triggering transformational change. Building soil carbon projects into cross-cutting intervention formats such as REDD+ and/or Nationally Appropriate Mitigation Actions (NAMAs) seems an adequate way forward. At the same time, the climate mitigation objective should always be put in context.

Climate-smart agriculture is first and foremost about strong yields, second about healthy soils, third about resilience and only fourth about climate mitigation. Soil carbon activities need to be aligned with and respond to this specific list of priorities. Public climate finance can (and should) help place climate-smart agriculture firmly at the interface between food security, resilience, adaptation, as well as climate mitigation.

In the long run, soil carbon projects will not thrive in the absence of broader policy-level transformations addressing strategic plans, zoning, land tenure, investment climate, and more. Conversely, such policy-level transformations are best helped through strong backbone projects, which show strong results in terms of soil protection, output (yields) and climate action. Projects are important workshops (laboratories) for engagement with a wide set of stakeholders, notably farmers and local communities. They point the way by spreading knowledge and practice in the field; they become meaningful showpieces for regulators to seek replication and, ultimately, transformational shift; and they attract national and international investors to identify the kind of impact they wish to achieve.

Much can and should be done on the practical side to improve soil carbon standards and the investment environment for soil carbon projects in the short term. Thirty, 40 or 100-year-permanence requirements make sense for many land-use projects (in particular: A/R and forest management) but they fail to recognize the permanent climate benefit that many short-to-medium-term soil carbon interventions have. This is a lost opportunity. Many farmers will be hostile to committing to a certain land-use for several generations; making a similar commitment for 10, 12.5 or 20 years will seem less daunting.

Land-use-focused carbon standards have adopted a laudable rigor in defining and applying carbon accounting rules to projects, and it is a major achievement that today few question the integrity of their work. This said, in various settings, the rules have become so complex as to act as a disincentive for carbon project development rather than encouragement, without bringing about any clear benefit. Standards must be checked for both their environmental integrity and their fitness to encourage mitigation action. Furthermore, land-use-focused carbon standards must find formats for small-scale and micro interventions. Project design, registration and verification must be a lot cheaper than what is currently on offer through various standards.

Perhaps most importantly, governments should guarantee offtake (e.g. into an existing emissions trading scheme) or help set up centralized funds to create predictable demand and, thus, trigger carbon project development. While there is clearly no abstract shortage of demand for existing soil carbon projects, there is no routine investment path for future project developers, and that hurts. Voluntary carbon projects today rely too much on individual networks to connect developers and buyers. Governments can and should help fill this gap.

Looking Ahead

Soil carbon is on its way to getting recognition commensurate with its potential for the net zero emissions pathway of the Paris Agreement. Carbon projects can spread the much-needed technologies and skills, but governments must stand ready to support them with legal and governance reforms, planning security, and scaling mechanisms. In the long run, governments must also be prepared to remove negative incentives prevalent in many current agricultural subsidy programs. Promoting soil carbon is not just about climate action. It really is about feeding the world and working towards a sustainable future.

Summary tables

Table 1. Ratings of essential attributes of four types of soil carbon project interventions

	Geographic scope	Skills/best practices development	Upscaling of interventions	Additionality	Leakage	Non-permanence	Complexity of validation	Cost of implementation
Peatland restoration		A	B		C	D	E	F
Peatland conservation	G	A			C		E	
Agricultural soil restoration & sequestration		A	B		H	I	E	
Grassland conservation		A	B		J		E	

LEGEND
- No problems
- Additional technical development needed, and/or not available, in all countries or contexts
- Critical without further clarification or risk mitigation
- A persistent problem

A) Expertise exists in places but is not readily available in all countries or contexts. Way to resolve: Promote the establishment of professional service providers (along the model of Energy Service Companies (ESCOs)).
B) Way to resolve: Grouping or programmatic approaches, but multitude of landowners, tenure situations and regulatory uncertainty remain a challenge.
C) Way to resolve: Project design avoiding hydrological connectivity; activity shifting/marketing leakage may be unavoidable.
D) Opportunity to shorten project duration, e.g. 10-15-year cycles instead of >30 years.
E) Way to resolve: Pursuing standardization of procedures, including defaults and simplifications; but procedures are generally a challenge for project developers.
F) High expenses resolved by upscaling.
G) Limited opportunities in industrial countries (the remaining pristine peatlands are protected); high opportunity in developing countries (also in terms of costs).
H) Categorizing interventions that are unlikely to cause leakage (e.g. keeping levels of service intact).
I) Way to resolve: Apply a buffer withholding or other insurance scheme.
J) Activity shifting/marketing leakage may be unavoidable.

Table 2. Ratings for technical, commercial and legal/institutional features		
Technical (including implementation)	**Rating**	**Reference**
Global potential for CC mitigation by soil carbon projects		Chapters 2/7
Availability of feasible project types		Chapter 7
Availability of carbon standards covering soil carbon		Chapter 5
Eligibility of soil carbon project categories		Chapter 5
Availability of GHG accounting procedures		Chapter 5
GHG accounting practicability	1	Chapters 4/5/7
Commercial		
Presence of market for environmental services	2	Chapter 3
Market prices	3	Chapters 3/4/6
Upfront payment needs	4	
Legal/institutional		
Land tenure and safeguards	5	
Carbon rights and safeguards	6	
Operations and governance	7	

LEGEND
- No problems
- Additional technical development needed, and/or not available, in all countries or contexts
- Critical without further clarification or risk mitigation
- A persistent problem

1) See Table 1 (a and e).
2) Markets do exist but provide a niche for projects generating small numbers of emission reductions; they are too small to sell large numbers (millions).
3) Low prices for credits require projects to stack funding sources. A range of projects will be viable at credit prices of US$5–10. Various restoration projects, in industrial countries in particular, however, will incur higher costs.
4) Projects are front-loaded in terms of costs and back-loaded in terms of revenues. There are considerable pre-financing needs in some restoration projects (e.g. peatland restoration), but less so in many sustainable land management projects. Where high investment needs present a problem, proponents should seek equity arrangements or collateralization strategies (including through public co-funding).
5) Multitude of landowners and other tenure holders may present high challenges for implementation. Way to resolve: Work through farmers' associations or local government institutions (in particular those established under customary law) and install robust mechanisms for benefit-sharing and redress.
6) Absence of clear regulatory framework is the rule, rather than the exception. In a range of countries, however, emissions trading precedents exist and can be used to gauge legal risks. New challenges arise from accounting developments within the Paris Agreement. The ideal scenario is a contractual or else legal arrangement with the government. As in 5), strong benefit-sharing, safeguards, and redress mechanisms are essential.
7) Strong program entities are a key asset (see also Table 1 (a)). Close cooperation with governments both at the local and central level will strengthen overall governance and upscaling options.

Table 3. Soil carbon interventions are characterized in terms of opportunities and barriers or challenges	
Barriers	**Opportunities**
Ignored by compliance markets	Current availability of standards and accounting methods (including additionality, leakage, non-permanence)
Incurs considerable transaction costs in terms of project development, as long as level of experience and market perpetration is low	Modest market prices (for most project categories and countries)
Overall credit demand has plateaued (though the effect from the Paris Agreement is not yet clear)	Accumulating best-practices
No support to emissions trading from some influential NGOs	Wide networks advocating soil carbon restoration and conservation are active
Issues with scaling up of projects in the land-use sector (tenure, measure, report and verify (MRV) requirements)	Growth potential of mitigation-cum-co-benefits
Uncertain tenure situations in developing countries	Near-future aviation offsetting mechanism
Multi-stakeholder character of land-use projects	New opportunities in compliance regimes (Paris Agreement but also individual countries)
	Role as laboratory for testing new technologies in the land-use sector

2. Soil Carbon – A Game Changer

Soils play a central role in the world's food security and sustainable development. They feed, fuel and regulate human life at all levels, biologically, physically, culturally and spiritually. Plants require soil to grow, and so agricultural production depends on them. Soils are the foundation for the nutrition of mankind. They also represent one of the biggest biodiversity reservoirs with more than a quarter of the world's flora and fauna living there.[3] This is directly related to human health and well-being. The microorganisms living in soils are the basis for many medications – almost all antibiotics come from soils.[4] Medicine aside, soils provide for a vast spectrum of ecosystem services, including cultural ecosystem services.[5]

Yet soils are under immense stress, both from unsustainable land management and climate change. According to estimates, one third of global soils have been degraded, with 24 Gt of soils lost globally.[6] Climate change increases the variability of temperatures, extreme weather events, and the risks of flooding and drought, in particular. Almost 20% of the Sub-Saharan land area shows declining soil productivity, when corrected for climate effects; for other regions, the range is between 5 and 10%.[7] Assuming business-as-usual, the global amount of arable and productive land per person in 2050 will only be a quarter of the level of 1960. An increase in productivity helps mitigate the effects, but only so much. Fertilizer use has increased 3–4 times (by 233%) between 1970 and 2010, while average grain harvests have only doubled.[8] Overuse of fertilizers, in turn, creates new risks to groundwater and soils.[9]

While the climate impact for soils is massive, so is the climate impact from soils. Land-use change was the dominant source of annual CO_2 emissions until around 1950. Since then, industrial emissions have continued to outpace those of the land sector (agriculture, forestry, and other land-use). However, annual GHG emissions from the land sector are still in the range of almost 25% of anthropogenic GHG emissions (10–12 Gt CO_2eq per year), spread about evenly between agriculture, on the one hand, and deforestation and wetland drainage, on the other.[10] Moreover, because of extra-warming effects from many land-related emissions (which bring co-emissions of methane and nitrous oxide, without those of cooling aerosols associated with industrial emissions), it has recently been argued that even if all non-land-related emissions are switched off in 2015, it is likely that 1.5°C of warming relative to the pre-industrial era will occur by 2100.[11]
Soil carbon (excluding the carbon stored in land-cover) has been reduced through erosion and wetland drainage by 176 Gt compared to the natural, undisturbed state. Peatland drainage alone accounts for about 1.5 Gt CO_2eq (ca. 0.4 Gt of carbon) each year with Indonesia and the EU accounting for almost 60% of the total. If current trends continue, anthropogenic land-based carbon emissions from soil and vegetation will roughly add another 80 Gt of carbon to the atmosphere over the 2010–2050 period.[12]

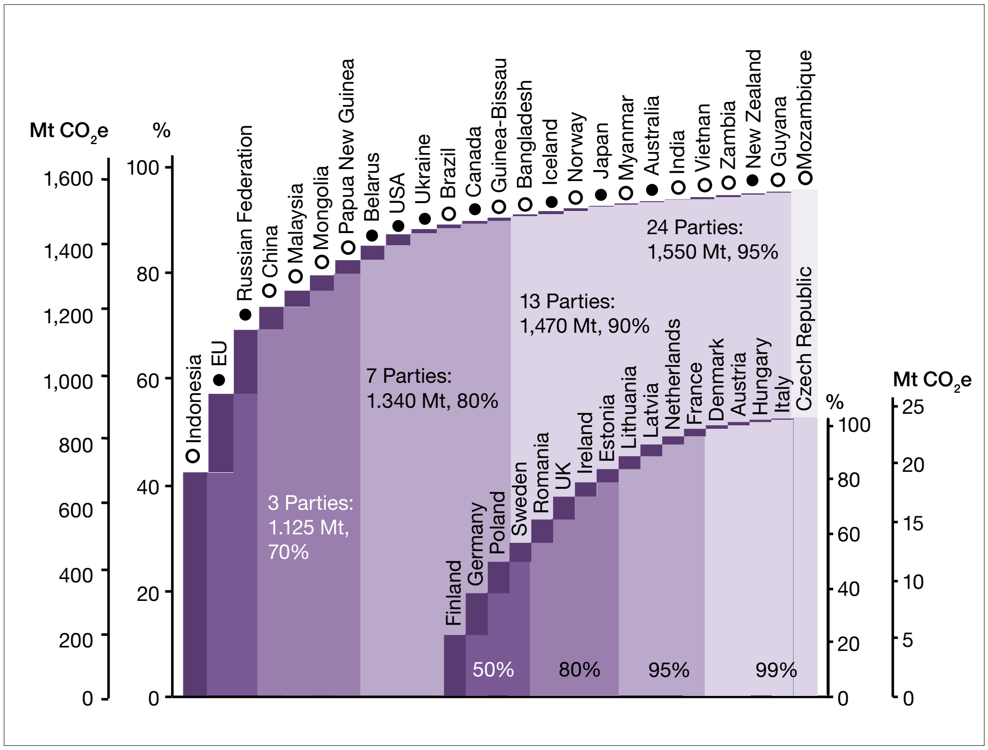

Figure 1: Key countries with emissions from drained organic soils[13]

The graph shows the amount of GHG emissions in a cumulative way in million tonnes CO_2eq per year and as a percentage of the total global emissions from degrading peatlands. Emissions are shown for the countries responsible for 95% of the emissions in descending order. White dots denote developing countries, black dots industrialized countries and Economies in Transition (EIT). Purple shades indicate where the 70, 80, 90 and 95% marks are crossed. The inset depicts the relative contributions of the 16 EU countries that are together responsible for 99% of EU and 17% of global emissions from organic soils.

In order to achieve the objective of the Paris Agreement – holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels (Article 2 Paris Agreement) – soil and other land-related emissions must not only be halted, they need to be reversed. In order to see global CO_2 emissions peak around 2020, reach net-zero between 2040 and 2050 and achieve net-negative emissions in the second half of the century, net sequestration from soil and biomass needs to reach 5–15 Gt CO_2eq per year after 2050.[14]

The pathway requires that nations across the globe tap into the full mitigation potential offered by the land sectors. While the total mitigation potential of agriculture and forestry (including coastal wetlands), constrained by food and fiber security as well as biodiversity conservation, is estimated at about 24 Gt CO_2eq per year, about half of that amount is considered to be achievable by cost-effective means, assuming a carbon price of up to US$100 per tonne.[15] The global technical mitigation potential of all agriculture sectors, excluding fossil fuel offsets from biomass, is estimated to be 5.5–6 Gt CO_2eq per year by 2030. About 89% of this potential can be achieved by soil carbon sequestration through cropland management, pasture management, restoration of organic soils and degraded lands, bioenergy and water management. Some 0.6–1.8 Gt CO_2eq per year may be mitigated through soil sequestration from pastures and grassland (more than 50%) and emission reductions through peatland rewetting and avoided conversion.[16] Much of the abatement potential can be achieved at costs much lower than US$100 per tonne. In fact, an abatement figure of 1.55 Gt CO_2eq across agricultural sectors appears possible at costs at or below US$20 per tonne.[17]

"Climate-Smart Agriculture" aims at delivering on the sector's potential. Policies and practices which aim at reducing GHG emissions from the agricultural sector and at increasing the carbon stock, while at the same time enhancing sustainability, productivity and resilience of soils and other resources, have collectively been coined as "climate-smart agriculture", and the bulk of literature, methodological guidance and experience reports has been growing rapidly.[18]

The 4 per 1000 initiative, developed within the ambit of the negotiations of the Paris Agreement in 2015, focuses on the land sector's sequestration potential. The 4 per 1000 initiative suggests that an annual growth rate of 0.4% in the soil carbon stocks would not only zero out the GHG emissions from the land sector, but all net annual carbon increase in the atmosphere associated with human activities (around 4.3 Gt per year).[19] [20] The top one meter of soils is said to stock 1500 Gt of carbon[21]. An annual increase of 0.4% of this amount (6 Gt of carbon) would halt the annual increase in CO_2 in the atmosphere.

While the numbers are theoretical and hardly account for feasibility considerations,[22] the 4 per 1000 concept signals an important paradigm shift, namely that without the climate change mitigation contribution from soils and agriculture, the global warming targets cannot be achieved. Both the concepts of climate-smart agriculture and 4 per 1000 acknowledge that enhancing the health and carbon content of soils in parts of the world where soils have been degraded will increase yields, resilience of pastures and agricultural lands and reduce poverty.

3. Soil Carbon Finance – A Niche Market

Despite its potential, dedicated climate finance to address mitigation options in soils, or within the agricultural sector at large, remains minimal. Out of the US$139 billion that developing countries make available from public sources per year, only US$3 billion goes into mitigation interventions in the land-use sector.[23] Given the concentration of REDD+ funding,[24] the agriculture sector receives not much more than US$2 billion per year for mitigation purposes.[25] On the side of carbon project development, the World Bank's US$90 million-strong BioCarbon Fund has been active for over a decade, supporting 20 projects in the area of habitat restoration and carbon enhancement (albeit with a focus on afforestation and reforestation).[26]

Low-carbon development funding available to the agricultural sector in industrial countries is not comprehensively traced. A variety of support schemes exist. However, programs directly focusing on climate mitigation are not the rule. In the US and the EU, for instance, certain farming subsidies are linked to conservation or greening interventions.[27] Furthermore, there are various financial incentive schemes to encourage certain forms of organic farming. In the EU, the most important support scheme is the European Agricultural Fund for Rural Development (EAFRD), worth €100 billion for the period 2014 to 2020 (and linked to another €61 billion funding provided from member states).[28] Under the EAFRD, Member States are required to base their rural development programs on at least four out of six common EU priorities. These include "restoring, preserving and improving ecosystems related to agriculture and forestry" and "promoting resource efficiency and supporting the shift towards a low-carbon and climate-resilient economy in the agricultural, food and forestry sectors". At least 30% of funding must be dedicated to "measures related to the environment". This may include climate-smart agriculture. Nonetheless, there is no specific focus on mitigation techniques or outcomes, while dedicated support schemes that reduce soil carbon emissions or encourage soil carbon sequestration and measure, report and verify (MRV) results in the way climate finance interventions are used to, are sporadic at best.

Both in developed and developing countries, the agriculture sector is notably absent from any compulsory carbon pricing schemes. Pricing carbon emissions – explicitly through carbon taxes or emissions (or "carbon") trading, or implicitly through regulation – means that people are faced with the full social cost of their actions, which in turn will lead individuals and businesses to switch away from high-carbon goods, services and production cycles, and to invest in low-carbon alternatives.[29] In recent years, emissions trading, in particular, has been proliferating across the globe.[30] An emissions trading scheme (ETS) – also referred to as a cap-and-trade system – in the first instance, caps the total level of GHG emissions and obliges emitters covered by the scheme to surrender each year an amount of pollution permits (sometimes called allowances) equivalent to the year's emissions; at the second stage, the scheme allows those industries with low emissions to sell their extra allowances to larger emitters.[31] By creating supply and demand for emissions allowances, an ETS establishes a market price for GHG emissions. The cap helps ensure that the required emission reductions will take place to keep the emitters (in aggregate) within their pre-allocated carbon budget. Not a single ETS caps agricultural emissions.

The European Union, when designing its flagship ETS in the early 2000s, decided against the integration of agricultural emissions; that decision became a blueprint for ETS design worldwide. When designing the world's largest scheme, covering some 11,000 installations and almost 2 Gt CO_2eq annually,[32] EU policymakers decided against the inclusion of land-use-based emissions arguing that the "reversible nature of [land use, land-use change and forestry] activities" would add too much of a risk in terms of targets and liabilities.[33] In addition, the argument went, complex monitoring systems and protocols to trace GHG fluxes from land at the farm-holding level would need to be developed at high costs, and the high variability of credits and debits between years would undermine the functioning of the carbon market as a whole.[34]

New Zealand's ETS perhaps comes closest to the inclusion of agricultural emissions, limited, however, to nitrous oxide gases and methane (referred to as "biological emissions"), not soil carbon emissions. Notably, given the predominance of agriculture in New Zealand's economy, these emissions represent around half (47%) of the country's total.[35] Meat and dairy processors as well as livestock exporters must report the on-farm "biological emissions" associated with the production of the milk and meat they process to the Environmental Protection Authority. For nitrous oxide – which is generated through the use of fertilizers on the farms – the reporting obligation is with the fertilizer manufacturers and fertilizer importers, respectively. However, farmers and producers are not currently required to surrender ETS units for the biological emissions produced by agricultural activities. The New Zealand government has stated that surrender obligations would not begin unless "there are economically viable and practical technologies available to reduce emissions" and the country's trading partners "make more progress on tackling their emissions in general".[36]

Sometimes, low-carbon agricultural practices benefit indirectly from carbon pricing tools. The sector, then, is in competition with many others, and dedicated funding windows, where they exist, are modest. California makes an appropriation, from the emissions trading auction proceeds, towards "sustainable agricultural practices that promote the transitions to clean technology, water efficiency, and improved air quality".[37] In 2017, the state has committed about US$34 million to fund projects that "[protect] agricultural land from development and [reduce] harmful greenhouse gas emissions".[38] Twenty-five agricultural conservation easements and two strategy and outcome grants were given out, impacting organizations in 19 counties.[39] Under a separate initiative, California's Healthy Soils Initiative, limited additional funding (US$3.75 million) is provided for growers and ranchers targeting conservation management practices that sequester carbon, reduce emissions and improve agricultural soils (practical methodologies for quantification are provided by the state government).[40] Other schemes make similar appropriations. Appropriations for climate-smart agriculture are absent, nonetheless, from the world's largest scheme, the EU ETS.[41]

An arguably more focused and predictable funding path is provided under several schemes through ETS offsetting provisions, creating a market of its own for abatement activities in the agricultural sector. Emissions trading schemes in North America are particularly open to offsetting mechanisms targeting, among others, agricultural practices. Elsewhere, rather than linking project credits directly with an ETS, countries have set up dedicated funds that purchase credits on behalf of the government (see section 5.2.6 below).

Under most schemes, the project numbers remain small. However, offsetting protocols for the agricultural sector – which are mostly derived from voluntary carbon standards – offer practical tools and benchmarks for measuring emission reduction and sequestration activities at the farm-holding level. As such, they may offer the clearest route yet for the integration of the sector at large in emissions trading schemes.

4. Climate Policy and Climate Finance

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992 and entered into force in 1994, holds a holistic view of GHG emissions (sources) and removals (sinks). It sets out the obligation for its Parties to promote and develop technologies, practices and processes to control and reduce emissions “in all relevant sectors”, including agriculture and forestry (Article 4.1 (c)), as well as to promote “sustainable management”, conservation and enhancement of sinks and reservoirs of all GHGs (Article 4.1 (d)).

The Kyoto Protocol, however, was designed to largely exclude important sources of emissions from land use, land-use change and forestry (LULUCF) and to discard sequestration opportunities in soils altogether. On the path of negotiating the Kyoto Protocol – the first international framework to formulate and apply concrete GHG emission targets for a range of countries – the Berlin Mandate of 1995 required that Parties set quantified limitation and reduction objectives for both emissions and sink, stressing that the Protocol should cover “all greenhouse gases, their emissions by sources and removals by sinks and all relevant sectors”. [42] However, in the aftermath of the Berlin Mandate decision, Parties grew increasingly sceptical about the prospects for including land-use-related emissions.[43] When the Protocol’s text was finally consolidated, the question was delegated to a future decision by the treaty’s decision-making body (Article 3.4 of the Kyoto Protocol). This body ultimately decided that carbon stock reporting and accounting for revegetation, cropland management, grazing land management, and (since 2013) wetland drainage and rewetting, was optional to Parties only.[44] Only three countries made use of any of the options.[45] Carbon stock management – outside forestry – was for all practical purposes irrelevant.

The other important milestone, with regards to the Kyoto Protocol, was the restriction of activities eligible under the Clean Development Mechanism (CDM), which yet again led to the exclusion of soil-related emissions. The CDM is one of three flexible mechanisms created under the Kyoto Protocol to allow for emissions trading among Parties with an emissions target (developed countries) as well as between countries with a target and those without (developing countries). The CDM has been designed for the latter. It sets incentives for the development of projects in developing countries to reduce GHG emissions or remove CO_2eq. from the atmosphere by issuing credits – so called Certified Emission Reductions (CERs) and by allowing countries with an emissions target to purchase these credits and use them to offset their own emissions.[46] More than 8400 projects have been developed so far, with a total credit issuance rate of some 1.8 billion CERs.[47] Several countries, among them the US, Canada and Brazil, lobbied hard for the inclusion of land-use-related projects in the list of eligible CDM activities, when the CDM technical guidelines were negotiated between 1997 and 2001.[48] Their position was backed up by considerations that the agricultural sector was dominant in many developing countries and that banning the sector from the CDM would risk forgoing important mitigation options as well as opportunities for sustainable development in the world’s poorest countries.[49] This notwithstanding, a majority of countries had methodological concerns concerning the accountability of most land-use-based emissions, emission reductions and removals, as well as concerning the question of permanence (see below section 5.1.9).

When the technical guidelines were finally adopted at the Conference of the Parties (COP) of Marrakesh, LULUCF emissions were mostly left out of the scope of the CDM. The mechanism, the guidelines read, “is limited to afforestation and reforestation”.[50] Moreover, a specific credit category was created for afforestation and reforestation (“A/R”): temporary Certified Emission Reductions (tCERs and long-term CERs), which had the disadvantage that they expired after several years and that they had to be continuously replaced by new temporary credits in order to achieve compliance effects. This special credit category proved the biggest market challenge for A/R projects under the CDM.[51]

It is important to note that the substantial land-use restrictions – on scope and credit longevity – were supported by a broad alliance of NGOs. Civil society has long been at odds over attempts to use emissions trading for the protection of ecosystems. There is a wide variety of non-state actors active in the climate mitigation process.[52] There are environmental groups, research institutions, international organizations, business associations, indigenous peoples’ organizations and many more, who hold a formal observer status or are accredited by the UNFCCC. Sometimes the interests among non-state actors are aligned, often they are not. Yet, there are few topics that have proved as divisive as the role of land-use emissions for carbon markets, not just among different segments of civil society, but among environmental groups themselves. [53] On the one hand, there is the pro-market faction, centered around economic think thanks and US-headquartered[54] environment organizations (though they include important NGOs from developing countries and the EU). They consider carbon markets a useful tool for investment that, if structured right, can help natural resource management and habitat protection. On the other hand, there is a faction wary of markets, made up of many EU-headquartered environmental organizations and international grassroot movements.[55] They (often vehemently) question both the environmental as well as the ethical integrity of emissions trading on the basis of nature-based interventions, and it is sometimes difficult to differentiate between the two fields. The debate has barely moved since the days of the Marrakesh negotiations, as can be seen in the current discussions on land-use-based offsets for the aviation industry.[56] Whatever the merits, the criticisms had a decisive influence on policymaking before and during the Marrakesh conference.

While CO_2 emissions from soils and carbon sequestration gains were broadly excluded from the CDM scope, non-carbon-stock agriculture, by contrast, remained eligible under the CDM. The CDM has developed over time a set of methodologies, including for manure treatment (GHG destruction),[57] fertilizer use (GHG avoidance),[58] methane emissions from water management (GHG avoidance),[59] sugarcane waste (GHG avoidance),[60] use of nitrogen-use efficient seeds (GHG avoidance),[61] and livestock fodder (GHG avoidance)[62]. The portfolio of agricultural CDM projects is substantial, though highly concentrated, namely on methane avoidance from manure and domestic manure (some 300 projects), palm oil waste and composting (each with about 50 projects) and biomass energy from agricultural waste (almost 500 projects). There are no other project types, except for one methane reduction project from rice irrigation.[63] Total credit numbers – at about 50,000 CERs – are comparably small.

The Kyoto Protocol's smaller project-based mechanism – Joint Implementation (JI), available to projects in industrialized countries and Economies in Transition (EIT) – by contrast had no similar restrictions to non-carbon-stock agriculture, but agricultural projects were rare nonetheless. Still, the mechanism saw a project on no-till technologies to avoid CO_2 emissions (Ukraine)[65] as well as another project involving fertilizer use (Hungary).[66] These projects were comparatively large in size with 500,000 emission reduction units (ERUs) and 200,000 ERUs expected, respectively. The projects were never replicated.

Around 2011/2012, the Kyoto mechanisms dramatically lost momentum, when price levels – already weakened compared with the period 2007–2010 – imploded to less than US$1 and soon after to a low US$ cent value (see figure 2). While the reasons for the near-complete devaluation are manifold – notably supply had shot upwards since 2010, struggling to find demand in a weaker-than-normal global economy that was slow to move out of a great recession; EU regulators had virtually closed the offtake window from the EU ETS – the effects could not be mistaken. Projects could no longer be financed from the CDM and the JI. The Kyoto markets had, for all practical purposes, disappeared.

Table 4: Projects associated with agriculture in the CDM, without A/R (registered projects) [64]

Sector	Number of Projects	Focus in Geographic Distribution	Amount of Credits
Methane avoidance · Manure · Domestic manure · Palm oil waste · Composting	373	· Brazil · Mexico · China	16,470
Alternative waste treatment · Palm oil waste · Rice husk · Mustard crop · Poultry litter	416	· Malaysia (palm oil) · India (rice husk cogeneration, mustard crop, poultry litter)	32,761
Irrigation	1	India	0

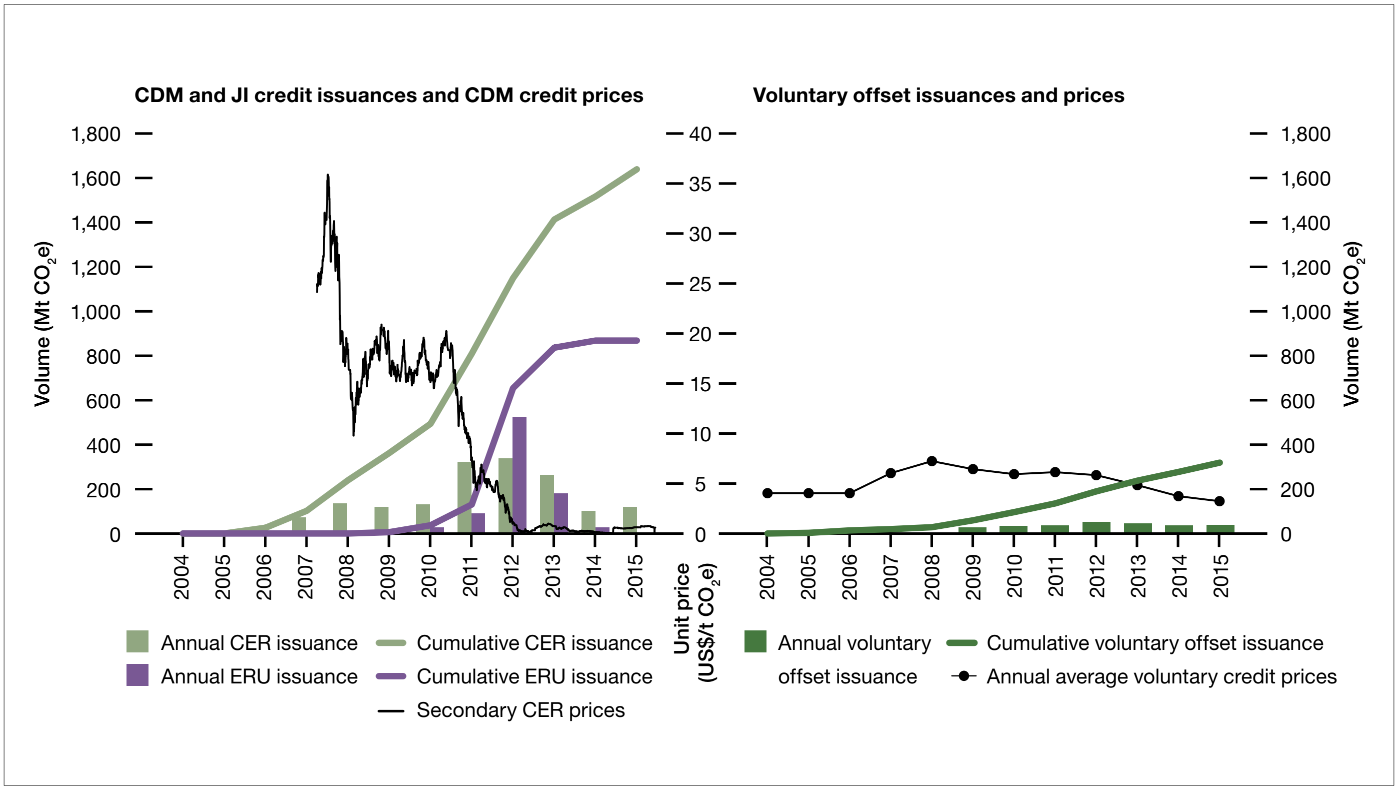

Figure 2: Various carbon credit amounts and prices (per category)[67]

At the same time, the development of the post-Kyoto framework had been delayed, ever since international negotiations suffered a material setback at the Copenhagen summit in 2009. This meant not only that country targets and ambitions for the years after 2012 (when the relevant "commitment period" under the Kyoto Protocol ended) were missing, but that no one came to the rescue of the CDM and JI markets, while ideas on new market mechanisms – discussed at every COP since Copenhagen – failed to meet with agreement among Parties to the Convention. [68] The momentum for project development moved to the non-regulated sphere, the so-called voluntary carbon markets. Here, average prices had decreased somewhat over the past years, but overall remained healthy. Besides, stating average prices in voluntary markets also hides substantial spreads for different project types (see section 5).

Countries did not remain entirely idle, however. Discussions within the UNFCCC negotiations framework took off, and new policy tools – in particular so-called Nationally Appropriate Mitigation Actions or "NAMAs" – were drawn up and piloted by a growing number of countries. Parties agreed for the first time (in 2011, at the Durban COP) to have the Convention's main technical advisory body, the Subsidiary Body for Scientific and Technological Advice (SBSTA) to "consider" agriculture within the "general framework for cooperative sectoral approaches".[69] In parallel, the NAMA concept rapidly spread to economic sectors and segments, which hitherto had seen few, if any, transformative dynamics. Soils and agriculture have been among them. Despite the lack of a clear international definition of a NAMA, the general consensus indicates that a NAMA is a voluntary intervention by a developing country government that leads to a reduction in GHG emissions, transcends the narrow project scope by tailoring national or local policies, and often aims at leveraging and scaling up broader low-carbon transformations within a specific country.[70] Given the decentralized nature of NAMA development, there are no definite registries or NAMA appraisal structures.[71] According to international policy observers, however, globally about 260 NAMAs are currently under development and/or implementation; some 25 of these NAMAs are designed in the agricultural sectors.[72] An overview of ongoing NAMA initiatives is provided in Table 5.

Table 5: NAMA initiatives		
Country	Sector	Highlights
Brazil[73]	Livestock	Interventions along the entire supply chain
Chile[74]	Cropland, pastureland	Improvement and enhancement of soil organic carbon (non-disruptive tillage, recycling of organic residues, anti-erosion measures, integrated production systems)
Colombia[75]	Crop farming	Improved cropland management, soil sequestration, fertilizer use, solid waste and water treatment
Colombia[76]	Livestock	Sustainable pastureland management, ecosystem restoration, manure management
Costa Rica[77]	Coffee	Fertilizer, water, soil and vegetation (intensified shading), waste treatment, energy production
Costa Rica	Livestock	Hedges/pasture sections, rational grazing (soil sequestration), fertilization, energy efficiency (processing)
Cuba[78]	Pig farms	Treatment of pig wastewater
Dominican Republic	Pig farms	Treatment of pig wastewater
Dominican Republic[79]	Coffee	Fertilizer, wastewater use, biomass instead of timber for energy, agroforestry
Honduras[80]	Livestock	Livestock farming
Mexico[81]	Pasture	Improved grazing land management, improved carbon stocks
Moldova[82]	Livestock	Feed switch for cattle (to domestically harvested grapes)
Moldova[83]	Crop farming	No-till and mini-till technologies and distribution
Mongolia[84]	Biochar	Biochar use (emission reductions), soil enhancement through biochar application (sequestration), fertilizers, energy efficiency
Pakistan[85]	Livestock and croplands	Manure management, biogas production, bio-fertilizer production and application
Rwanda	Tea and coffee	Processing-focused
Rwanda[86]	Cattle and crops	Manure composting, lime fertilizers, erosion prevention
Thailand[87]	Rice	Land levelling, alternative wetting and drying (emission reductions)
Uganda	Livestock	Feed change to reduce methane emissions
Uganda[88]	Rice	Switch from paddy to high-yielding upland rice farming and supply chain changes
Uganda	Processing of diverse agro-products	Wastewater treatment
Uruguay	Agricultural waste	Waste to energy
Uzbekistan[89]	Agroforestry	Fruit tree planting and pasture management in mountain belt areas to sequester carbon and prevent soil erosion
Vietnam[90]	Livestock	Pig manure to biogas
Zambia	Crop farming and livestock	Fertilizer, conservation agriculture, manure management
Zimbabwe[91]	Dairy and pig farming	Manure to biogas

By the time the Paris Agreement was adopted, some 95% of Parties had included the agricultural sector in their action plans – for mitigation and adaptation – submitted in preparation for the Climate Change Conference, the so-called Intended Nationally Determined Contributions (INDCs). The horizontally organized ("bottom-up") INDC process – though judged insufficient, as of yet, to stay within the global warming thresholds of 2°C or 1.5°C – has proved a successful policymaking strategy, and the Paris Agreement has enshrined the process – now referred to as "Nationally Determined Contributions" (NDCs) as one of its constructive, perpetual pillars. Almost all NDCs reference agriculture either in the mitigation section or in the adaptation section or (most often) in both sections.[92] Several developing and developed countries have highlighted the specific role of "sustainable soil and land management technologies" (Bhutan)[93], the goal to "improve carbon storage of soil" (China)[94] and to "increase… soil fertility" (Uzbekistan)[95]. Brazil plans to "[restore] an additional 15 million hectares of degraded pasturelands" by 2030 and to "[enhance] 5 million hectares of integrated cropland-livestock-forestry systems".[96] Japan put dedicated removal targets in place both for forests as well as for "cropland management, grazing land management and revegetation" (91 million tonnes (Mt) CO_2eq).[97] Uruguay has formulated concrete mitigation and sequestration targets across its soil organic carbon stocks (grasslands, peatlands, croplands).[98]

The Paris Agreement includes the recognition of "the importance of the conservation and enhancement, as appropriate, of sinks and reservoirs of greenhouse gases referred to in the convention" (preamble) and notably in Article 5. This article is usually referenced for its importance in the context of forest conversion (REDD+). However, it is notably wider in scope and aimed at any type of terrestrial ecosystem. Even more importantly, Article 4 of the Paris Agreement stresses the key functional importance of carbon sinks by instructing Parties to undertake rapid GHG reductions so as to achieve, in the mid-to-long-term, "a balance between anthropogenic emissions by sources and removals by sinks"; and the transparency framework established under Article 13 has a comprehensive view on "anthropogenic emissions by sources and removals by sinks" (Article 7 (a)). Most recently, a newly sharpened perspective on agriculture, in general, and on soils, in particular, emerged from the latest COP – "COP 23" hosted by Fiji at the seat of the UNFCCC secretariat in Bonn, Germany – when Parties made the joint request to both its technical advisory body (SBSTA) and its advisory body on implementation (Subsidiary Body for Implementation, SBI) to address "issues related to agriculture" and invited Parties to exchange views on, inter alia, "improved soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems, including water management".[99]

While important details are not yet in place – chiefly concerning accounting principles for land-based emissions and financial incentive mechanisms – land and agriculture are clearly recognized as the "new frontier". Future negotiations may not be without challenges, however. Given the relevance of the agricultural sector for climate change and its economic importance for many developing countries, one might wonder why there has not been more action and dedication in climate negotiations. The Paris Agreement recognized the importance of the land sector but makes no explicit reference to "agriculture". Perhaps the strongest concerns against regulating the sector within the Paris framework today come from developing country Parties which do not want to see their food security and smallholder agricultural systems curtailed by mitigation obligations.[100] Nonetheless, sectoral coverage may not just mean incurring obligations but also tapping into opportunities, and the latest negotiations at COP 23 showed that climate negotiators firmly embrace the sector for future action.

The agricultural sector is perhaps well placed to lead the way for emissions trading mechanisms under Article 6 of the Paris Agreement. Developed countries may use the new trading formats both to enhance climate mitigation ambition at relatively low costs, and to channel climate finance into land-use; in particular, soil-based interventions may have a market advantage for quite some time. The scenario comes with certain caveats nonetheless. The permitted scope of intervention formats has not yet been defined, at least for the purpose of Article 6.4, which as the centralized instrument is expected to be more restrictive than the bilateral one. The accounting tandem between output transfers under Article 6, on the one hand, and climate finance consideration, on the other, has some plausibility, but rules are still not in place. Finally, while the vast majority of countries have expressed their support for actions to improve sustainable agriculture in their NDCs, only a minority of countries have made specific provisions for specific targets in the agricultural sector or for soil carbon emissions. In fact, a number of developing country governments have expressed concerns that the use of agricultural soils should be subject to any mitigation targets at all. This may complicate the trading environment, as there is a growing consensus that transfers should go hand-in-hand with ambitious baselines, moving beyond what is considered to be "mere offsetting". This could translate into an expectation that a sector must be "capped" before it is ready for Article 6 transfers. The NDC framing aside, ongoing pressure from civil society against forest-based emissions trading[101] increases the (unintended) risk that the land-sector as a whole will be left out from the Article 6 mechanisms, at least for some time.

Climate finance, meanwhile, is slowly making the sector a priority. All Parties agree that without access to finance, farmers cannot make investments in their soils and their farming process to transition to a resilient-farming, low-carbon infrastructure. The Green Climate Fund (GCF) has notably established a specific funding window for "cross-cutting" themes, most of which are linked to land-use and/or agriculture (though clear methodologies for balancing mitigation and adaptation outputs are still missing.)[102] A number of funding proposals target smart agriculture interventions, including those with strong soil carbon components.[103] Elsewhere, a range of initiatives have been taken to leverage private sector finance by collateralizing risks and improving the enabling environment, and to make climate-smart agriculture available to impact investment and capital markets at large.[104] Dedicated impact investment funds focus increasingly on landscapes and soil resources.[105] The International Finance Corporation, the private sector arm of the World Bank, in its Green Bond Program, supports investments in climate-smart agribusiness, with a total of about a US$100 million-worth of climate loans committed so far.[106] Payment-for-Ecosystem-Service (PES) mechanisms focusing on domestic commercial finance to support soil conservation are being piloted.[107] At the government-to-government level, first debt swaps for climate action have been pioneered (following a blueprint designed by The Nature Conservancy in the Seychelles).[108]

5. Soil Carbon Projects – Key Features, Methodologies and Standards

5.1 Key Technical Aspects of Carbon Project Development

5.1.1 Project Development Cycle

A soil carbon project is, first and foremost, not much different from any other carbon project. The carbon project development cycle includes various typical stages, which may be expanded, skipped or accelerated depending on needs and circumstances. There are several ways of depicting the project cycle, i.e. focusing on the requirements of carbon standards (see figure 3) or focusing on project activities. In the latter case, a full cycle includes a capacity stage in which participants learn relevant aspects of soil carbon projects, followed by a pre-feasibility stage and a feasibility stage which is concluded by a documentation stage. Then there is a pre-implementation stage followed by a life cycle stage. Here too, stages may be skipped, combined or accelerated. Comprehensive guidance documents and manuals for carbon project development, in general, and project development in the area of land use, have been widely published over recent years.[109] In the following, we will limit ourselves to recapitulating major project stages, while highlighting specific features of soil carbon projects.

5.1.2 Potential Project Activities and Technologies

Soil carbon interventions account for GHGs in two ways: carbon sequestration (taking up CO_2 from the atmosphere) and conservation (avoiding the release of GHGs into the atmosphere). That means a carbon project can sequester carbon by creating carbon sinks in the form of growing vegetation or by enhancing carbon storage in soils, or it can protect land against degradation.

A list of intervention types is provided overleaf.

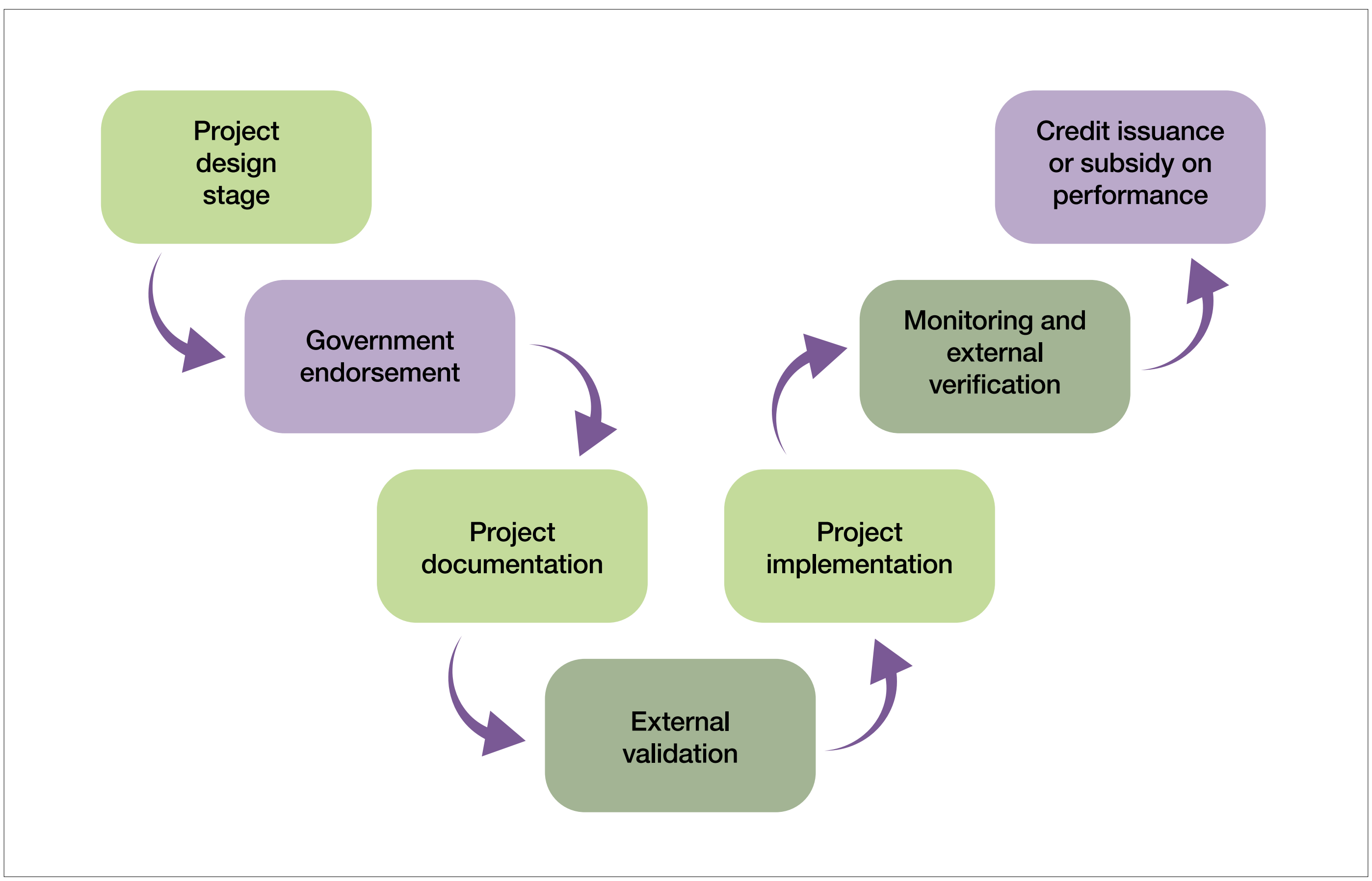

Figure 3: Carbon Project Development Cycle

Activities and Technologies in Soil Carbon Projects

Various sources categorize intervention types in different ways. At a general level, a distinction is being made between avoided conversion and carbon sequestration. In the literature, assessments of the mitigation potential, in summary, list the following:

- Avoided conversion of grasslands, savannahs and peatland which involve protection of ecosystems against conversion to cropland or grazing land.
- Cropland and pasture management
- Peatland rewetting or restoration

Cropland and pasture management can be broken down into addition of organic manures, compost or mulch, cover cropping, use of perennials or deeper-rooted cultivars, conservation tillage, agroforestry, enhanced crop rotation and rotational grazing.

Voluntary carbon standards define project categories at a similar general level and leave it to compliant GHG accounting methodologies to define which are eligible intervention types. Project activity categories include:

- Agricultural Land Management (VCS and ACR)
- Restoring Wetland Ecosystems (VCS and ACR)
- Avoided Conversion of Grasslands and Shrublands (VCS, ACR and CAR)
- Conservation of Intact Wetlands (VCS and ACR)

Hybrid schemes (see right) follow these categories, albeit sometimes with different descriptions.

5.1.3 Carbon Accounting Methodologies

A variety of carbon accounting methodologies for agriculture, forestry and other land-use (AFOLU) project activities exist which include both the biomass and the soil organic carbon as major carbon pools and sources of greenhouse gas emissions.

Methodologies for avoided conversion of grasslands as well as cropland and pasture carbon enhancement use carbon stock changes in soils as the prominent proxy, making them relatively insensitive to the intervention type leading to carbon enhancement. Peatland methodologies have dedicated accounting protocols due to the importance of hydrology.

Current methodologies relevant for soil carbon projects are listed below. Most methodologies present a list of applicability conditions, allowing for a relatively quick assessment of the suitability of the methodology for the particular circumstances. Section 5.2 provides a more detailed description of the standards.

Methodologies Available for Soil Carbon Projects

Verified Carbon Standard (VCS)

Avoided Conversion of Grasslands and Shrublands (ACoGS)

- Methodology for Avoided Ecosystem Conversion VM0009[110]

Agricultural Land Management (ALM)

- Adoption of Sustainable Agricultural Land Management (SALM) VM0017[111]
- Soil Carbon Quantification Methodology VM0021[112]
- Sustainable Grassland Management (VM0026)[113]
- Sustainable Grassland Through Adjustment of Fire and Grazing (VM0032)[114]

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

- Rewetting of Drained Tropical Peatlands (VM0027)[115]
- Rewetting of Drained Temperate Peatlands (VM0036)[116]

American Carbon Registry (ACR)

- Avoided Conversion of Grasslands and Shrublands to Crop Production (ACoGS)[117]
- Compost Additions to Grazed Grasslands[118]
- Restoration of Pocosin Wetlands[119]

Climate Action Reserve (CAR)

- Grassland Project Protocol[120]

Plan Vivo

Accepts existing methodologies from other standards or project-specific methodological approaches.[121]

- Rehabilitation and sustainable management of degraded pastures[122]
- Plan Vivo Climate Benefit Quantification Methodology – Carbon sequestration through improved grassland and natural resources management in extensively managed grasslands[123]

HYBRID SCHEMES

Alberta Carbon Offset System

- Quantification Protocol for Conservation Cropping[124]

Australia Emissions Reduction Fund (ERF)

- Sequestering Carbon in Soils in Grazing Systems[125]
- Estimating Sequestration of Carbon in Soil using Default Values[126]

5.1.4 Project Boundary

Under AFOLU carbon project guidelines, project proponents must clearly define the boundaries of a project to facilitate measurement, monitoring, accounting and verification of the project's emission reductions or GHG removals. The project boundary not only involves the geographic boundary, but also the temporal boundary (often referred to as the crediting period, but see also the note on permanence, below), the carbon pools involved (e.g. biomass, soil organic carbon) and the GHGs accounted for (CO_2, CH_4 and N_2O).

Project Boundaries for Soil Carbon Projects

Geographic

At project verification (i.e. based on the ex-post assessment of the project's monitoring results), the geographic project boundary must encompass the area to be under control or to become under the control of the project participants. In a managerial sense, setting defined project boundaries also serves as a reality check for developers assessing what area – or what area size – can be reasonably managed and controlled. A common difficulty for project developers is that area targets (a certain number of hectares, for instance), often in response to donor expectations, are set unrealistically high. A likely consequence is that substantial project resources are invested in "area searches", that a project includes area pools of first, second and third-ranked sites rather than a clearly identified, best-suited core site, and that the demarcation of project boundaries is intentionally omitted (or postponed).

Carbon Pools

As with other AFOLU projects, soil carbon projects should consider five carbon pools: above-ground biomass, below-ground biomass, deadwood, litter, and most importantly soil carbon. Pools can be omitted if their exclusion leads to conservative estimates of the number of carbon credits generated.

Eligible Gases

Projects must account for any significant sources and sinks of CO_2, CH_4 and N_2O that are reasonably attributed to project activities. GHG accounting methodologies provide varying procedures for these gases, in conformance with the applicability conditions of these methodologies. While soil organic matter building can increase emission of CH_4 and N_2O, based on de minimis principles and the availability of default values, methodologies often include simplifications to the accounting, thus lessening the burden of project developers. In soil carbon projects, the most relevant gas is CO_2 and carbon stock change serves as a proxy for its sequestration or avoided emissions.

5.1.5 Leakage

Closely related to the existence of boundaries in project-scale activities is leakage. Leakage refers to a situation where an activity within the project boundary triggers an emission on lands outside of the project boundary. Two common forms are activity-shifting leakage and market-leakage. Activity-shifting leakage occurs when activities inside the project boundary (e.g. land conversion) relocate outside of the boundary. Market leakage occurs when project activities affect an established market for goods (e.g. farmed products) and causes the substitution or replacement of those goods elsewhere.

Leakage and Soil Carbon Projects

The phenomenon of leakage, related accounting guidelines, and mitigation strategies have been widely researched in the context of REDD+. The relevant results are adaptable to certain soil carbon interventions – e.g. peatland conservation and restoration – but not necessarily to others. For instance, cropland and pasture management activities are unlikely to involve activities that may be displaced to other lands as they will continue at a similar level of service or production. Only in the case of a significant decline in production (even if temporary) should leakage be assessed.

5.1.6 Project Proponent(s)

To varying extents, carbon standards require the identification of one or more "project proponents". While the CDM is less pronounced on the issue and sees "project participation" first and foremost as a procedural carbon cycle function, other standards, such as the VCS, come with firm requirements on substance for the project proponent and targets the identification of the "individual or organization that has overall control and responsibility for the project, or an individual or organization that together with others, each of which [being] also a project proponent, has overall control or responsibility for the project".[127]

The relatively high threshold for project proponents is of particular relevance in land-use-related projects, where different actors and organizations may compete for overall control and responsibility. The underlying rationale is twofold. Firstly, clear project ownership structures help facilitate project development and implementation. Where it proves impossible to allocate control to one actor/organization or collectively to several actors/organizations, project management as a whole almost certainly is at risk from the start. Secondly, the project proponent is the natural right-holder for the carbon asset. In case there is a mismatch between the official proponent and the true holder of project control, the generic claim to the carbon asset may become contentious.

On the other hand, proponents and other stakeholders (including the carbon buyer, in cases where a project is meant to generate credits) are at liberty to create governance and corporate structures that are best suited for the particular operational, legal and financial needs.

Project Proponents in Soil Carbon Projects

Soil carbon projects usually focus on farmland and depend on close engagement with farmers. Where plots are large – combining several hundred or thousands of hectares – organizational responsibilities are concentrated, and the identification of project proponents is similar to any other carbon project. When plots are small, as is often the case both in developed and developing countries, establishing centralized responsibility and control is a challenge. Specific formats for decision-making and representation need to be put in place, and pre-existing institutional structures – such as farmers' associations and/or (in many developing countries) customary law bodies – may help with building a robust governance framework. The project proponent(s) will have to show comprehensive authorization to register and develop the project in the name of and on behalf of all participating farmers.

5.1.7 Baseline Quantification

The baseline for any carbon management project is often described as the "business-as-usual" case or the amount of GHGs that would be emitted if the project was not enacted. This is illustrated in the simple figure below.

Baselines may represent three different general trends in carbon stock, viz. a decline, stocks remaining at a (more or less) constant level, or an increase. In conservation, baseline carbon stocks are set to decline (figure 4a). The intervention avoids this level of decline, either by keeping carbon stocks constant, or by just letting stocks decline at a considerably lower rate. In both these cases there is a net positive result, indicated by the green shades. In restoration (figure 4b), carbon stocks may be at a low level, as a result of one or more degradation events, or stocks may continue to decline. In the latter case, the project not only increases carbon stocks but also prevents further loss occurring – this may be referred to as the "stop-loss" component of the restoration activity. Finally, certain cases (not depicted in figure 4) may have a baseline in which carbon stocks increase, e.g. when vegetation or soil, or both, are developing. A project may be designed to accelerate these processes, e.g. in enrichment planting as part of sustainable forest management.

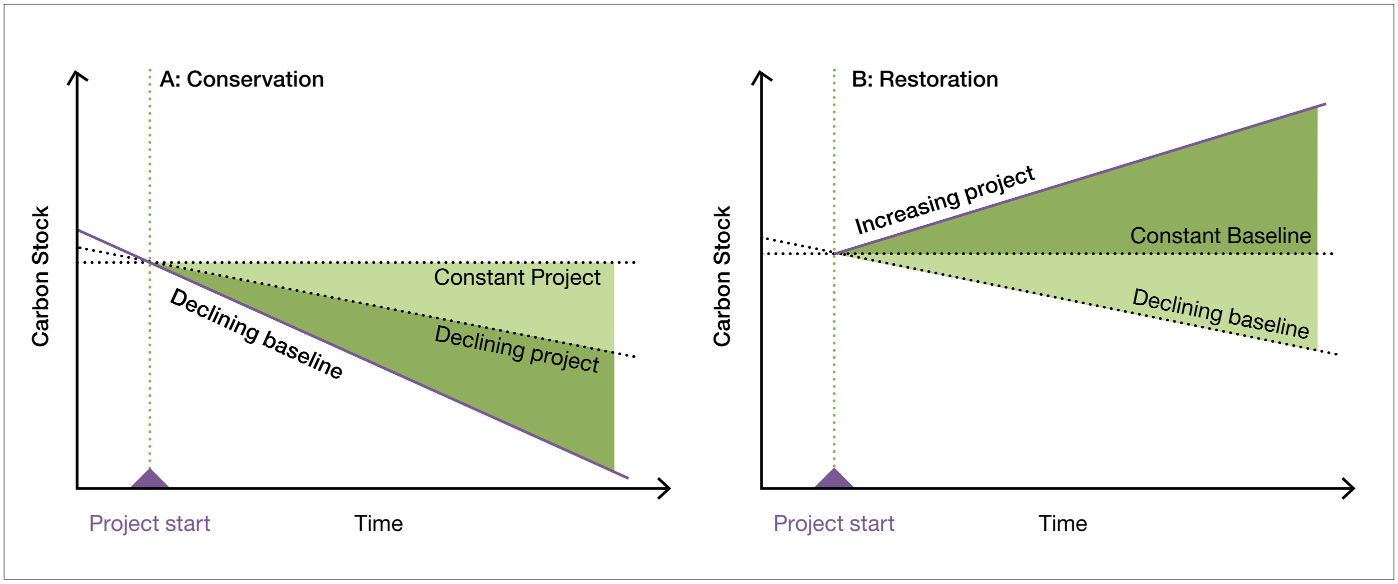

Figure 4: Hypothetical scenarios for net project benefits (green shades) of carbon conservation and restoration projects, based on the difference between the baseline and the project scenario.

In soil carbon projects, baseline soil carbon stocks can go in any direction over time, but usually the baseline is a scenario of degradation. This degradation is either halted or reversed by the project intervention (restoration) or avoided (conservation).

Not only biological, geological and other natural constraints shape a specific project activity but also socio-economic conditions. The detailed description of both current and expected land-use forms and the drivers of land disturbance and degradation, as well as a comprehensive mapping of stakeholders (local communities, governments, economic actors, others), is usually an early and necessary part of a carbon project identification. The failure to fully account for activities, drivers of disturbance and stakeholders jeopardizes the accurate baseline description – i.e. the accounting framework for carbon crediting – and it prevents an informed technical assessment of whether a project activity can be performed and controlled. Approaches to baseline assessments abound in current GHG accounting methodologies. For example, the way REDD+ methodologies structure procedures for the behavior of degradation agents can be copied for soil carbon application.

5.1.8 Additionality

Additionality represents the fact that the project and its emission reduction would not have happened without the intervention of the carbon market, 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. In essence, these procedures seek answers to the following questions: Was GHG emissions mitigation part of the rationale for project design and implementation? Did the presence of carbon markets provide an incentive to project implementation? The burden of proof is on the project developer and often this burden is onerous.

The VCS allows for demonstrating the additionality of a class of project activities in a methodology to ease the burden of proof. The rationale for this standardized approach is to encourage project activities that are infrequently implemented when compared with their maximum adoption potential, and to streamline project development and the assessment process for individual projects. This option requires the methodology to demonstrate that the activity penetration rate is less than 5% of the maximum adoption rate. This has so far been achieved for tidal wetlands. Given the immense potential for soil carbon projects and the very small number of actual projects, this option might well be feasible for soil carbon projects.

5.1.9 Permanence

In this context, permanence refers to the longevity of a carbon pool. It plays no role in agricultural projects which reduce GHG emissions outside changes to soil carbon stocks (e.g. fertilizer use, manure treatment, etc.).

Under most carbon standards, an increased carbon stock or avoided loss of carbon stock as a result of a project activity must be maintained for a long period (usually at least for 100 years), and its reversal 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.

Current project standards offset the risk of non-permanence by issuing only temporary credits (CDM, see above), 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".[128] 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.

Permanence and Soil Carbon Projects

One-hundred-year permanence requirements represent one of the key challenges for soil carbon project development. Many farmers will be willing to commit a specific plot for 10 or 20 years, while making fiduciary arrangements for 100 years is out of the question for them.

While continuity is highly desirable, the 100-year requirement is well-intentioned, but still excessive. Originally designed for afforestation and reforestation projects, the requirement adds little value to interventions that halt degradation in the first place: stopping soil erosion or draining organic soils, for instance. An intervention window of any number of years, in these cases, leaves a permanent impact for the climate, even if degradation activities resume after the intervention.

This aside, soil carbon projects are perhaps more about behavioral change than any other carbon project category. Inducing farmers to change practices for a limited number of years may very likely yield long-term results, especially where no additional opportunity costs are incurred.

The Australian Carbon Farming Initiative lets farmers choose between a 100-year permanence and 25-year permanence promise. The latter gives rise to credit deductions and an increase in the buffer-debit. However, it gives farmers the chance to test a project, without committing their plots for a lifetime. The policy should be replicated by other standards.

5.2 Standards

5.2.1 General

Several funding schemes have raised the development of standards and accounting protocols for these types of interventions, but most prominently in the voluntary market. Several internationally active voluntary standards have been developing specific methodologies and project format for the AFOLU sector for a number of years, among them the Verified Carbon Standard (or VCS, managed by Verra), the American Carbon Registry (ACR), the Climate Action Reserve (CAR), and Plan Vivo. Other global standards – notably the Gold Standard – have so far not introduced methodologies or project activities targeting specifically the conservation, restoration or enhancement (including sequestration) of soils. However, as the Gold Standard has turned to address mitigation options in the agricultural sector, peatlands may soon come into view. Among its latest methodology developments is one on agricultural supply chains. Should this methodology ultimately include agricultural production from organic soils, this would present the standard's first focus on peatland interventions. Alongside the larger international standards, there are also smaller ones that cater for a domestic market. The UK Woodland Standard, for instance, which started as a domestic scheme to provide incentives for afforestation and reforestation, has started examining the inclusion of the UK Peatland Standard as a new project type. The German MoorFutures Standard specializes in peatland restoration activities in Northern Germany.

While the main project activities have been realized in voluntary markets, it is noteworthy that several forestry projects developed under the CDM – despite the mechanism's limitations –[129] had important soil regeneration and sequestration components. Projects included soil regeneration of degraded and soil-focused agroforestry measures, even though in both projects only above-ground biomass was quantified for carbon credit generation.[130] Nevertheless, the Moldova Soil Conservation Project, which makes use of the methodology AM0002 ("Restoration of degraded lands through afforestation/reforestation"), does account for the changes in the soil carbon pool affected by the A/R measure.[131] The BioCarbon Fund sponsored both the project and the development of the methodology.

5.2.2 Verified Carbon Standard

The world's biggest voluntary standard in terms of number of projects and credits – the Verified Carbon Standard – offers methodologies across the full AFOLU range. On the side of soil management, one finds methodologies on Avoided Ecosystem Conversion (VM0009), Adoption of Sustainable Agricultural Land Management (VM0017), Soil Carbon Quantification Methodology (VM0021), Quantifying N_2O Emission Reductions in Agricultural Crops Through Nitrogen Fertilizer Rate Reduction (VM0022), Sustainable Grassland Management (VM0026) and Sustainable Grassland Through Adjustment of Fire and Grazing (VM0032).[132]

Furthermore, the VCS provides for a dedicated wetlands standard with bespoke methodologies on, inter alia, Avoided Conversion of Peat Swamp Forests (VM0004), Rewetting of Drained Tropical Peatlands (VM0027), and (since 2017) Rewetting of Drained Temperate Peatlands (VM0036).

Projects have been forthcoming, if still at a small scale. The first soil carbon project earning carbon credits under the VCS was the *Kenya Agricultural Carbon Project (KACP)*. Widely regarded as a landmark project for soil carbon sequestration, the project involves 60,000 farmers on 45,000 hectares (ha) by helping them to adopt climate-smart agricultural practices. The project is working under the 2011 approved cropland focused *Sustainable Agricultural Land Management (SALM) Carbon Accounting Methodology* (VM0017); it earned its first credits in 2016 and has produced 10,790 VCUs since then. The same methodology is used by the Zambian project *COMACO Landscape Management Project*, registered in 2016 (which includes a REDD+ component).

Another two projects working under the SALM carbon accounting methodology have been established in India. The corresponding *Agricultural Land Management Projects* in Telangana and the Beed district, aim to improve the soil carbon status through the Integrated Watershed Development Program (IWDP). In Telangana, project activity has started with a three-year roll out in March 2017 covering 3305 ha. Estimated annual average GHG reductions and removals account for 16,662 t CO_2eq.

The project in the Beed District covers 3300 ha. As in Telangana, it is promoting holistic watershed development and an integration of carbon sequestration practices. It is estimated to annually reduce 20,768 t CO_2eq.

Aiming at grazing land, the *Northern Grasslands Project* (Kenya), sponsored by The Nature Conservancy, implements a shift from continuous, unrestricted grazing to planned rotational grazing across more than 1 million ha of northern Kenya rangelands. It is working under the *VCS ALM – Sustainable Grassland Management through Adjustment of Fire and Grazing Methodology*. Currently under validation, it expects to reduce around 1.8 Mt CO_2eq every year.

The *Agricultural Soil Carbon Through Improved Grassland Management in New Zealand* aims to verify that soil carbon has been sequestered from the atmosphere into soil as a result of appropriate farming practices and soil management tools. It is also based upon the VCS-approved VM0017 methodology approach and its estimated annual emission reductions are 5970 t CO_2eq.

The *Katingan Peatland Restoration and Conservation Standard* has been registered in Indonesia, promising more than 7 Mt CO_2eq.[133] In Belarus, a restoration initiative currently seeks validation under the newly adopted methodology VM0036.

5.2.3 American Carbon Registry

The American Carbon Registry (ACR) started off as a US domestic VCS, but has since extended its scope to all countries. It provides for several soil-based methodologies: for wetland restoration (each time linked to a certain geography – Pocosin Wetlands, delta wetlands in California and Mississippi; peat swamps (Avoided Planned Land Use Conversion in Peat Swamp Forests, not yet formally approved); avoided conversion of grasslands and shrublands; and biotic sequestration (as part of grazing land and livestock management); as well as concerning other agricultural practices, namely animal manure (methane recovery), fertilizer (reduced use), composting, and rice management systems.[134]

At the time of writing, the vast majority of ACR agricultural projects involved animal manure (generating close to 700,000 emission reductions). Only four non-manure projects had reached the stage of issued credits: a project on avoided land conversion in North Dakota; a project on fertilizer reduction in corn farming (Michigan); and two rice management projects (Arkansas and California). They gave rise to a total of about 40,000 emission reductions. Two more rice projects were recently registered (Iowa and Missouri). Furthermore, the Climate Trust is currently developing a grassland conservation project for registration with the ACR in Oregon.

5.2.4 Climate Action Reserve

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 Grassland Protocol[135] provides guidance to account for GHG emission reductions associated with projects that avoid the loss of soil carbon due to conversion of grassland to cropland.[136]

The protocol was approved in January 2017, and, as of early 2018, seven Avoided Grassland Conversion (AGC) offset projects – three of which were developed by The Nature Conservancy under ID CARC0002 – have been listed with the Climate Action Reserve.[137] The other soil-related protocol is the Rice Cultivation Project Protocol approved in 2013. The ARB adopted the Rice Cultivation Projects Compliance Offset Protocol in July 2015.[138] This Protocol is associated with the implementation of rice cultivation practice changes that result in a decrease in methane emissions into the atmosphere.[139] No rice cultivation project has been registered with the CAR yet.

5.2.5 Plan Vivo

Plan Vivo is the smallest among the international standards. However, it is the only standard exclusively restricted to AFOLU projects.[140] It currently hosts 19 projects.[141] Most of these are forestry-related (A/R and REDD+), but four recent projects are dedicated to soil carbon: two on rehabilitation of degraded pastures covering 619 and 1822 ha, respectively (both located in Burkina Faso), one on highland ecosystem restoration covering 541 ha (Ethiopia), and another on pasture conservation covering 77,000 ha (Mongolia).

Plan Vivo is generally open for proposals on new project categories and accepts existing methodologies from other standards or project-specific methodological approaches. The methodologies used in the soil carbon projects were ECCM Protocol (Edinburgh Centre for Carbon Management): Estimating tree growth (above and below-ground biomass of regrown/replanted trees), in the case of Burkino Faso,[142] a project-specific methodology in the case of Ethiopia,[143] and the Plan Vivo Climate Benefit Quantification Methodology – Carbon sequestration through improved grassland and natural resources management in extensively managed grasslands.

All four projects have recently been registered only. Credits have not yet been issued for the Ethiopian project; for the projects in Burkina Faso, 619 and 1822 credits were issued, respectively; for the project in Mongolia, 2015 credits were issued.

We understand that works are underway to combine several areas in and around an extensive peat swamp in West Kalimantan, Indonesia, in a carbon project developed under Plan Vivo.[144]

5.2.6 Hybrid Schemes

Of growing importance are those schemes where governments reach out to and encourage voluntary project development through either public funds or offsetting protocols under compliance markets. Examples of these hybrid (public–private) schemes are the Emissions Reduction Fund, created by the Australian government providing public funding to voluntary projects, Japan's bilateral/multilateral Joint Crediting Mechanism, and California's ETS, which uses voluntary standards as agents for the development of compliance offsets. These schemes, along with other national and international practices, are further explained in table 6.

Table 6: Emissions trading schemes around the world. Inclusion of agriculture projects as offsets			
Country or State	**Scheme**	**Offsets**	**Offsets Agriculture (soil sequestration methodologies highlighted)**
Alberta (Canada)	Climate Change and Emissions Management Act (CCEMA) of 2007	Alberta Emissions Offset Registry (Verified Emissions Reductions or Removals) – Only domestic offsets are eligible – Accounting protocol: In-house	Approved quantification protocols for agriculture:[145] • Agricultural Nitrous Oxide Emission Reductions • Anaerobic Decomposition of Agricultural Materials • Conservation Cropping • Emissions Reductions from Dairy Cattle • Reduced Age at Harvest of Beef Cattle • Reducing Greenhouse Gas Emissions from Fed Cattle
Australia	Emissions Reduction Fund (ERF) and Carbon Farming Initiative[146]	Not an emissions trading scheme per se – Only domestic offsets are eligible – Accounting protocol: In-house	The ERF / CFI offers two methodologies for soil carbon sequestration: • Sequestering Carbon in Soils in Grazing Systems Methodology (covering, among others, conversion of cropland to permanent pasture, rejuvenating pastures, or changing grazing patterns) • The methodology on Sequestration of Carbon in Soil (management practices are sustainable intensification, stubble retention and the conversion into pasture) • 34 projects registered since 2011 (all using the Sequestering Carbon in Soils in Grazing Systems Methodology)
Brazil	Brazil Emission Reductions Market under development		
California (USA)	ARB Emissions Trading Program – Linked to Quebec's cap-and-trade scheme since 2014 and to Ontario's as of 2018	Registry Offset Credits (ROCs) – US offsets as well as offsets generated under the linked schemes (Quebec and Ontario) – International credits an option under the legislative framework; requires further delegated acts, however – Accounting protocol: In-house, with external providers: Climate Action Reserve, American Carbon Registry and Verified Carbon Standard	There are no general restrictions, but offset protocols need to be proposed, examined and properly vetted before their adoption The Compliance Offset Protocol for Rice Cultivation Projects[147] is so far the only Protocol under the cap-and-trade program with a direct link to soil carbon management activities
Canada	Federal Carbon Pricing Backstop (under development)[148] – The measure will have the effect of a subsidiary regime coming into place for regions and territories that have not installed a robust carbon pricing instrument on their own – The scheme is a combination of a carbon tax (for fossil fuels) and an emissions trading component for industrial facilities emitting above certain thresholds	– Canadian offsets are eligible as well as offsets generated under the linked schemes (Quebec and Ontario) International credits an option under the legislative framework; requires further delegated acts, however – Accounting protocol: In-house, with external providers: Climate Action Reserve, American Carbon Registry and Verified Carbon Standard	Not yet defined
European Union	LULUCF Regulation[149] (about to be formally adopted)	The mandatory scope is in essence forest land and agricultural land, and land for which the use has changed from or to these uses	• EU Member States must guarantee zero-net emissions (No-Debit-Rule) • Soil sequestration on agricultural and forest lands must be accounted for • Limited offsetting under the "Effort Sharing Decision" framework – the cap-and-trade scheme between EU Member States covering all sectors outside the EU ETS and LULUCF

Table 6: Emissions trading schemes around the world. Inclusion of agriculture projects as offsets (cont'd)

Country or State	Scheme	Offsets	Offsets Agriculture (soil sequestration methodologies highlighted)
Japan	J-Credit Scheme (to end by 2021)	– Only domestic offsets are eligible – Accounting protocol: In-house	Agriculture:[150] • Abatement of N_2O emissions from pig and broiler excreta disposal by utilizing low-protein feed • Conversion of disposal management system for livestock excreta • Mitigation of N_2O emissions from tea land soil applying chemical fertilizers containing nitrification inhibitor
Japan	Joint Crediting Mechanism (JCM),[151] established in 2013	Only offsets – Only international offsets from developing partner countries are eligible – Accounting protocol: In-house (CDM methodologies are principally acceptable, but specific use must be approved for each country)	• The majority of JCM's 112 projects (spread across 17 partner countries) so far are energy and industry-related • However, in 2015, Japan launched the JCM REDD+ Model Project (providing an additional US$6.7 million), which supports projects in Laos and Indonesia[152] • The program also provides funding for energy-from-agricultural-waste interventions (Laos, Vietnam) and a solar-powered irrigation project in India[153]
Kazakhstan		Foreseen from a variety of sectors, including agriculture	
New Zealand	New Zealand Emissions Trading Scheme (NZ ETS)[154]	Domestic offsetting from forestry activities only	No offsetting provisions in place or planned[155] Note, however, certain agricultural practices must report their emissions under the NZ ETS
Quebec (Canada)	Quebec's cap-and-trade program (SPEDE) – Linked to California's cap-and-trade scheme since 2014 and to Ontario's as of 2018	Offset credits must represent actual, verified, additional, permanent and enforceable emission reductions. Covered entities can use offsets only to fulfil up to of 8% of their compliance obligation[156] – Only domestic offsets are eligible – Accounting protocol: In-house	First agricultural protocol:[157] • Covered manure storage facilities – CH_4 destruction • New protocols to be finalized soon
Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont (USA)	**Regional Greenhouse Gas Initiative (RGGI)**	Offset projects within five prescribed project categories are eligible for the award of CO_2 offset allowances:[158] – Only domestic offsets are eligible – Accounting protocol: In-house	• Avoided methane emissions from agricultural manure management operation
South Africa	**Carbon Tax Bill (not yet adopted)**	Regulation on Carbon Offsets (not yet adopted) – Only domestic offsets are eligible – Accounting protocol: CDM, VCS and others contemplated	Eligible offset projects under the tax include in the AFOLU sector: • Restoration of sub-tropical thicket, forests and woodlands • **Restoration and management of grassland** • Small-scale afforestation • Biomass energy • Anaerobic biogas digesters • **Reduced tillage**[159]
South Korea		Offset projects allowed – Only domestic offsets are eligible – Accounting protocol: CDM	As per CDM

6. Carbon Credits and Markets

As a rule, a carbon standard creates tradable units issued into, and traced by, registries. The units are usually standard specific: "Verified Carbon Units" or "VCUs" in the case of the VCS; Emission Reduction Tonnes or "ERTs" in the case of the ACR; "Climate Reserve Tonnes" or "CRTs" in the case of CAR; "Registry Offset Credits" or "ROCs", where offset credits are issued for the Californian market; and so on. Each time, the underlying metric is that one (1) unit represents an actual reduction or sequestration gain achieved of 1 tonne CO_2 or 1 tonne CO_2equivalent (referring to the conversion ratio, measured in the global warming potential, for other greenhouse gases). Some standards also allow for the attachment of specific labels indicating additional qualifiers such as specific sustainability features (e.g. the "CCB Label", attached to a VCU).[160]

Units and labels are given a unique serial number and are issued into electronic registries such as *Markit*[161] and *APX*.[162] Registries assume a fundamental role for any credit-issuing carbon standard. They trace projects and credit issuances as well as all events of "emissions trading", i.e. the sale and purchase of credits between account-holders. Importantly, they also allow for the cancelation (or "retirement") of credits, indicating that a credit has been "used" for offsetting or compliance purposes. While emissions trading – the issuance of and trade with traceable, commodified units – remains the rule, the Gold Standard has recently announced[163] that it will offer market participants the issuance of non-tradable and non-offset-compatible emission reduction *statements* in lieu of *credits*. This is to reduce the risk of double counting (see box 1).

Box 1:
Risk of Double Counting for Soil Carbon Projects

Double counting means that the same activity or effect to reduce or remove GHG emissions is accounted for twice (or multiple times), e.g. credited under two different standards or monetized at two different levels, the voluntary standard level and the host country level, for instance. As this goes against both logic and environmental integrity, carbon standards across the globe strive to avoid it. When the Kyoto Protocol defined accounting targets for industrialized countries, both the Gold Standard and the VCS established double-counting rules to make sure that an activity implemented in a country with a Kyoto target would not create credits at two levels: for the project implementer (as VERs or VCUs) as well as for the government of the host state (in the form of Kyoto-styled Assigned Amount Units (AAUs) freed up by the activity).

In most parts of the world, however, the issue was of little relevance given that the countries had not adopted a reduction target or an emissions trading scheme. This has recently changed. With the Paris Agreement intended to lead to a regulated world in which each country accounts for all its GHG emissions across sectors and sets itself reduction targets ("cap"), the space for voluntary carbon standards needs to be redefined. Ultimately, to avoid double counting at multiple levels, voluntary crediting will only be acceptable on the condition that the host country makes a commensurate deduction to its cap, so that the voluntary mitigation benefit does not weaken the country's overall target. Alternatively, the Gold Standard proposed to forego crediting in exchange for a recognition – a "statement" – that a certain project has been implemented from voluntary sources. Whether this alternative resolves the underlying risk – namely that government ambitions are diluted if a deduction to the country accounting framework is not made – remains somewhat unclear.

It should be noted, in any case, that for the sector under review in this paper – soil carbon – most countries are a long way from formulating reduction and/or sequestration targets. Inclusion in the national country commitments – the NDCs – will hardly happen before 2025 and 2030, and even then, firm accounting may not be the rule for some time to come. The experience from REDD+ (which has been dealing with projects "nested" into a larger jurisdictional or national REDD+ target for a number of years) would also suggest that projects are recognized and consistently valued for their frontrunner qualities and that the national or jurisdictional programs are generally likely to comprehensively *react* to them, including in terms of double counting.[164]

Altogether, while the risk of double counting should be assessed for any project in its particular country context as early as possible, we judge the hampering impact for soil carbon projects in the short and mid-term to be small. In fact, the status as a mostly un-"capped" sector may bring it to the forefront of voluntary emissions trading in the near future, as the risk of double counting is low and in turn the accounting value for credit purchasers – whether private or public – is high. Conversely, trading in the framework of Article 6 of the Paris Agreement may be less likely, while soil carbon emissions are not comprehensively accounted for in the host country.

Across standards, most credit demand is corporate, led by socially and environmentally responsible corporate decision-making.[165] **For soil carbon projects, however, public funding has proved, and probably continues to prove, instrumental.** While global demand has slowed since 2011 and many suppliers are over-stocked with unsold credits,[166] corporate attention has moved in two directions. First, corporations across the globe have adopted more holistic climate mitigation policies, committing to reducing their carbon footprint in production, sourcing and distribution, without necessarily relying on offsetting.[167] Second, corporate offset buyers make more refined choices concerning, not necessarily the standard, but the type and origin of credits. A study from 2016[168] found that buyers are increasingly interested in credits that "fit" with the organization's mission (e.g. in terms of sector and also, for small buyers, in terms of location) and that "co-benefits", in particular in the areas of biodiversity and community-benefits, are of great importance. Similarly, domestic survey assessments in industrialized countries concluded that demand is different according to the project and the project location – with domestic projects generating by far the highest demand.[169]

An issue to watch in coming years will certainly be the way in which the aviation industry will position itself in the market. The International Civil Aviation Organization (ICAO), a UN specialized agency, agreed in principle to implement a global "market-based measure" (MBM) in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO_2 emissions from international civil aviation (i.e. civil aviation flights that depart from one country and arrive in a different country) above the 2020 levels, taking into account special circumstances and respective capabilities. A pilot phase will run from 2021 through 2023, followed by a voluntary Phase 1 (2024–2026) and a mandatory, all-country scheme in Phase 2 (as of 2027).[170] Almost 90% of international aviation traffic is expected to participate in the pilot phase from 2021.[171] Demand for offset credits is estimated to be between 140 and 170 million t CO_2eq in 2025 and to reach annual figures of between 600 and 800 million t CO_2eq by 2040.[172]

While the precise rules have yet to be established, airlines have started to pilot project offsets, with some clearly favoring land-use related credits. Some airlines will be able to rely on a decade of voluntary offset sourcing. Yet, the size of the future market will be decidedly larger. Delta Airlines, for instance, recently announced investments in four new offsetting projects, all of them in the forestry sector, located in the following countries: Brazil, Democratic Republic of the Congo, Guatemala, and Zimbabwe.[173]

In line with the trend of project-conscious sourcing, prices vary considerably, not just between standards, but also between activity sectors and even projects and credit amounts within the same standard. Large-volume transactions usually set a lower price per tonne, small-volume transactions a higher price.[174] Older vintages – "vintage" stands for the year in which the emission reduction of removal activity took place – carry a lower price than newer vintages. For the forestry and land-use sector, in 2016, Hamrick and Galant[175] report a transaction volume of about 13 Mt CO_2eq, with an average price of US$5.1 per tonne. REDD+ credits traded in average at US$4.2, A/R credits at US$8.1, credits sourced from improved forest management at US$9.5, and credits from grassland and rangeland management at US$6.9.

When one looks at the different standards, VCS and Gold Standard prices are below those in some smaller standards, which is probably explained by the depreciative effect of larger credit volumes. A German standard dedicated to peatland restoration, MoorFutures,[176] realizes prices up to €67 per tonne (US$76, at time of writing).

Prices aside, non-liquidity of credits and the risk of not finding a buyer by the end of the year remain major challenges for the market as a whole. The Australian Carbon Farming Initiative is the only standard among those closely assessed which comes with a form of offtake-guarantee. It is linked to the government-funded Emissions Reduction Fund ("ERF"), whose public mission is to help achieve Australia's emission reduction target for 5% below 2000 levels by 2020, and 26–28% below 2005 levels by 2030.[177] To fulfil this role, is has been given AUS$2.55 billion (US$1.86 billion, at time of writing).

ERF project participants have an opportunity to sell their emissions reductions as verified under the CFI to the government through competitive reverse auctions organized by a dedicated public authority, the Clean Energy Regulator. The Regulator enters into contracts with successful bidders, which guarantee payment in return for delivery of emissions reductions.[178] The mechanism does not per se set a price floor, but the magnitude of secure demand provides for planning security in practice. The last auction in December 2017 provided an offset project developer with an average price per tonne of abatement of AUS$13.08 (US$9.56, at time of writing).

While development costs – as a share of transaction proceeds – have been decidedly higher across land-use sectors compared with industrial and energy-related sectors, soil carbon projects may still be developed at moderate tonne-prices. In a portfolio review of the BioCarbon Fund, the World Bank found the price of development to exceed US$1 per t CO_2eq validated in land-use projects, which compares with development prices as low as 10 US cents for some industrial projects.[179] Nevertheless, the BioCarbon Fund managed to cap the transaction price per tonne CO_2eq for its portfolio projects (which include several soil carbon projects) at below US$5.[180]

7. Soil Carbon Projects in Practice

Developing a soil carbon project is a complex undertaking shaped, in the first place, by incidents, policies and measures outside the control of the project developer. The level and extent to which these exogenous factors weigh on the project should be carefully established prior to project engagement. When the impact is negative, public or philanthropic, assistance targeting enabling environments or offering no-loss subsidies to run a pilot may be needed for the project to proceed.

At the project level proper, business acumen as well as considerable technical, legal, financial and social skills will need to be available to ensure design, implementation and diligent follow-up.

7.1 Feasibility of Implementation (Macro Level)

The overall feasibility of soil carbon projects depends on a combination of factors, such as a country's a) political commitment to emission reductions; b) ability to implement measures i.e. pertaining to resources, institutional capacity, and governance; and c) ability to mobilize adequate finance,[181] mitigation potential in a country or region, cost of implementation, and competition on the carbon market.

While the mitigation potential for avoiding land-use change (including forestry) and the enhancement of carbon sinks is estimated to be in the order of 1.4–6.8 and 6.64–16.14 Gt CO_2eq per year, respectively, the following estimates are provided for the individual intervention types.[182] These must be seen as work in progress, since subsequent assessments have gained precisions.[183]

Table 7: Mitigation potential per soil-carbon-related intervention type (from Roe et al 2017)

Intervention Type	Mitigation Potential [Gt CO_2eq per year]
Avoided peatland conversion	0.5
Avoided conversion of grassland	0.0002–0.002
Soil carbon enhancement in agriculture	2.57
Organic amendment/biochar	2.57
Cropland management	0.3–1.5
Pasture management	0.31–0.43

Based on proxies for factors a – c, mitigation potential per country or region,[184] the following rough stratification emerges (see table 8). Ideally, data on the cost of implementation should be entered into the mix, but unfortunately this information is hardly available at this stage.

Table 8: Relating enabling environment for soil carbon projects with mitigation potential					
Country or region	Enabling environment*			Mitigation potential#	
	Political-will score	Governance score	Finance score	Mitigation potential t C/ha/yr	Mitigation potential Gt C/yr
North America	6	5	4	0.60 to 1.22	0.17 to 0.35
Europe	6	5	4	0.55 to 1.14	0.11 to 0.23
Australia	6	5	4	0.57 to 1.16	0.04 to 0.08
Russia	6	2	3	0.60 to 1.23	0.05 to 0.11
Brazil	6	3	3	0.53 to 1.08	0.06 to 0.13
S America	1 to 4	2 to 3	2 to 3	0.53 to 1.08	0.06 to 0.13
China	2	2	3	0.54 to 1.12	0.07 to 0.14
SE Asia	0 to 4	2 to 4	2 to 3	0.53 to 1.10	0.05 to 0.09
WCE Africa	0 to 4	1 to 2	1 to 2	0.58 to 1.19	0.06 to 0.12
Ethiopia	5	2	1	0.58 to 1.19	0.06 to 0.12
India	1	3	2	0.62 to 1.28	0.11 to 0.21
LEGEND: Low; Medium: low end; Medium: high end; High					
* See Roe et al 2017, also for definitions; # Zomer et al 2016					

At the project scale, the most relevant score would be the one for governance (which here also covers institutional capacity), while the set of factors characterizing the enabling environment as a whole would be more relevant for national or regional programs. The low scores for the enabling environment in certain African regions present a challenge to project developers, who might be attracted to the continent because of the opportunities in terms of mitigation potential. While a proper feasibility assessment and due diligence is warranted in any project-scale initiative independent of its scores, in countries and regions with a fallible environment a higher risk of failure must be accepted. In this respect this is no different to other classes of land-based carbon projects, such as reforestation and forest conservation.

7.2 Feasibility on the Ground (Project Level)

Considerable expertise and technical knowledge has been built up over the years which can serve soil carbon initiatives. However, while many land-based carbon projects reached completion and have often proved perfectly resilient long after the intervention took place, many other initiatives have never moved beyond the design or test phase, or they became stranded at some point during implementation. The reasons are numerous and not always related to the (certainly worrying) decrease in carbon prices that has been seen in recent years. Sometimes, project proponents found out (too late) that certain requirements of carbon standards were not met. Sometimes necessary seed financing was not in place. Sometimes land access and control could not be secured (and maintained). Sometimes the political context was not favorable, and sometimes a project suffered from a lack of "ownership" on the side of the project developers.

In many cases, the development of a dedicated carbon project served as a secondary goal and only received minimal attention when the project was too far along in the design and implementation process to make necessary amendments. Unfortunately, factors that lead to the failure or deferral of carbon projects are not usually shared with the public or other project developers and therefore newcomers will often not benefit from lessons learnt.

What most of the failed or troubled projects have in common is that the proponents did not make the right prioritizations from the start. Land-use and coastal-use-related projects touch upon a multitude of sensitive issues, including methodology and monitoring, amongst many others. A comprehensive analysis combining technical, financial and legal issues, and preparing the intervention in practical terms should precede the concrete planning and implementation phase of any project. A feasibility and prioritization assessment will minimize and mitigate the risks and will, if well designed, serve as a robust script for the implementation of the project.

Therefore, based on previous experience in carbon project development, the following are important early considerations:

- Assume ownership of the project
- Choose and demarcate the site(s) carefully
- Choose the standard and the project delivery cycle
- Access the market early
- Link the project to other (climate) finance options
- Check the costs and prepare for economies of scale.

Despite best intentions, not every obstacle can be removed, and not all projects will be able to generate credits for carbon finance. Applying the carbon standard and methodological rulebooks is one thing; securing the success of a project is quite another. It requires careful site selection, robust project design, an early eye to marketing and co-finance options, diligent risk assessment – in a broader sense than the one the VCS applies in its AFOLU Non-Permanence-Tool – and professional and cost-efficient implementation with a commitment to long-term maintenance.

Anyone contemplating the development of a carbon project should begin with a feasibility assessment that addresses these issues and delivers a professional expert opinion on whether a carbon finance scenario exists, what the projected returns are, what the roadmap is for key decisions and milestones, and what the relevant risks are. The authors have seen a great many "projects" that have been going on for months and sometimes years, if mostly on paper, with the firm intention to add a "carbon component" to it "in due course", failing to see that an early carbon project feasibility assessment would have avoided a number of poor design decisions and added consistency and robustness to project implementation as a whole.

Much of a carbon feasibility assessment relates to general aspects of the project activities – including technical, social, legal, and financial details – and that "having the carbon feasibility covered" really means that the project developers have a good understanding of the project risks and opportunities as a whole. Expert counsel may be needed for a number of carbon-specific elements, but it will not replace holistic project planning at the operator level.

In certain cases, it is recommended to cut the feasibility assessment in phases: a pre-feasibility phase and a detailed-assessment phase. When the core parameters of a potential project are not yet identified or when a project faces structural challenges – e.g., it is the first project of this kind in a particular country – then it makes sense to first engage in a pre-feasibility examination, which looks, in an indicative way, at project locations and scenarios, pre-checks available methodologies and the availability of core data needed and assesses general legal and regulatory issues. Note that a pre-feasibility assessment may use any available default or educated guess if at that point in time nothing else that meets the standard or methodological requirement is available. At this stage, the methodology may be used for general guidance on GHG accounting.

A feasibility assessment to determine a potential blue carbon project's suitability and anticipated GHG benefit must include, at a minimum:

- Social and technical feasibility, including an assessment of opportunities and risks of community engagement, restoration best practices, anticipated GHG benefits, available methodologies, land suitability, project boundary, additionality, and permanence.
- Financial feasibility, including an estimate of income and expenses, stakeholders, financial flows over lifetime of project, and best practices for structuring carbon finance.
- Legal and institutional feasibility, including carbon and land rights, taxation issues, relevant regulatory requirements, and transactional structures.

8. Case Studies

Soil carbon projects are firmly rooted in the local and national context in which they are developed. That means each project experience is unique and no intervention is much like another. Soils are different, for one thing, along with the crops grown and the techniques of cultivation. Farmland is organized in very different ways. Some countries have large and highly concentrated farms with industrialized technology and management systems. Others are marked by smallholder farming and lower technology settings. Land tenure regimes are different, and so are farm workers' arrangements, national subsidies, regulatory standards, fertilizer-use practices, and so on. The first lesson from climate-smart agriculture practices is that there is no ready-to-use blueprint for intervention.

Even so, a number of common traits stand out, and many soil carbon projects share various patterns. We have led a number of interviews with soil carbon project developers and investors, and in this chapter, we are presenting project posters for three soil carbon interventions: a sustainable cropland project in Kenya ("*Kenya Agricultural Carbon Project*" or "*KACP*"), a peatland protection project in Indonesia ("*Katingan Peatland Restoration and Conservation Project*" or "*Katingan*"), and a pasture cropping example in Australia (the "*Leonard Springs Carbon Project*" or "*Leonard Springs*"). All three projects, though distinct in scope and geography, have certain aspects and indicators in common which are representative of soil carbon projects at large.

The first common aspect is accidental, though relevant to understanding the overall challenge soil carbon projects face today. Soil carbon projects are still novel and mostly untested, which means that their preparation has often gone hand-in-hand with methodology development and first-of-a-kind intervention design. This has taken time and effort, with commensurate financial implications. Both the *Katingan* project in Indonesia and the *KACP* project have been in development since 2008, with a range of different donors (private and public) and a phalanx of international and domestic project partners. The *Leonard Springs* project in Australia is different in that it is a lot more recent. However, it is embedded in the Carbon Farming Initiative – itself a pioneering concept both in terms of methodological as well as institutional and financial design – which goes back to 2011.

Kenya Agricultural Carbon Project (VCS Project 1225)[185]	
Project Type	Agricultural Land Management (ALM). Improved Cropland Management (ICM).
Location	Kitale and Kisumu, Western Kenya (45,000 ha)
Project Proponent	Vi Agroforestry Programme
Other Project Participant(s)	Project development support: UNIQUE Forestry and Land Use Technical advisors: JOANEUM RESEARCH
Starting Date **Ending Date**	July 1st, 2009 June 30th, 2030
Crediting Period	20 years
Project Description	The project promotes and implements a package of Sustainable Agricultural Land Management (SALM) practices within smallholder farming systems and generates GHG removals through soil and tree carbon sequestration.
Standards & Methodology	**VCS Standard** VM0017
Credits Expected	Total estimated: 1,980,088 ERs Average annual estimated: 99,004 ERs
Credits Issued	From April 1st, 2012 to March 31st, 2015: **143,906 VCUs** (157,731 ERs)
Investor(s)	World Bank Bio-Carbon Fund
FINANCING & PROCEEDS	
Development	Projected costs: (adapted from World Bank Carbon Finance Unit, 2008)[186] - Total project costs: US$1,460,000 - Preparation costs: US$50,000 - Establishment costs: US$50,000 - Operating costs for phase 1 (year 1–3): US$1,026,000 - Operating costs for phase 2 (year 4–6): US$162,000 - Others (carbon validation): US$172,000 The implementation of the project was initially funded by Sweden's development agency SIDA from 2008 to 2011 and, since 2012 by the Swedish foundation Vi Agroforestry. The Bio-Carbon Fund (World Bank) has funded the SALM methodology development. Main upfront investments involved designing the project and starting the carbon project cycle. Prefunding of activities of farm collectives and farmers' associations were not needed.
Price Per Credit	Below US$5.
Benefit-Sharing	Carbon revenue distribution: 60% will be distributed to formally contracted farmer groups, 35% will be used by the project entity for advisory services to farmers and 5% will be used by the project entity for communication and marketing of excess emission reductions to buyers other than the Bio-Carbon Fund.[187]
CHALLENGES & OPPORTUNITIES	
Legal	Uncertain land tenure titles have proved challenging for the implementation of the project, in particular the composition of the benefit-sharing arrangement.
Outreach	Strong community engagement has been key to the success of the project. The carbon project concept was not widely known prior to engagement, and the business case for carbon generation as such received limited attention, if any. The project team focused on raising attention to higher crop yields from sustainable cropland management (cover crops, crop rotation, mulching, improved fallows, compost management, green manure, agroforestry, organic fertilizer and residue management), lower fertilizer costs, and successful restoration of degraded soils. The project uses participatory planning, learning and monitoring extension tools to involve all target farmers in the project activities. All farmers targeted are involved directly. The farmer organization is democratically strengthened through capacity-building and can become an independent member-based farmer organization. The project embraces the idea that farmers are not only beneficiaries of the project but partners. Ownership of the project by community has been ensured by: - Stakeholder awareness-raising as an entry point in the village and complementary extension services to engage in partnerships - Sensitization and trust-building of farmer groups - Recruitment of registered farmer groups including contracting - Strategic planning, training and advisory services for farmers on non-farm-specific SALM practices on a group level - Supporting crop processing, marketing and bulk input purchasing activities to strengthen groups and add value to the crops produced.
Technical	The technical implementation, monitoring and verification presented **no major challenges**. For **monitoring purposes**, the project relies on a combination of "permanent farm monitoring" implemented by field officers of the project proponent on sample farms and "farmer group monitoring", i.e. a farmer self-assessment system within each of the registered farmer groups. There are only **limited leakage risks**: - This project aims at increasing the organic inputs from plants and manure to the agricultural land. The project intervention is focusing on the whole farm as the basic unit where biomass is produced to provide organic inputs to the crop fields as well as to provide feedstock to livestock. Consequently, biomass and organic material is only shifted within a single farm system. - The one potential source of leakage is an increase in the use of fuel wood and/or fossil fuels from non-renewable sources for cooking and heating purposes due to the decrease in the use of manure and/or residuals as an energy source. - Leakage due to the increase in the use of fuel wood from non-renewable sources for cooking and heating purposes may be a significant source of leakage if manure or other agricultural residuals used for cooking and heating are transferred to the fields as part of the project. In the project, the traditional cooking method is cooking on open fires or three-stone fires. Vi Agroforestry, through its whole-farm approach, is promoting the shift from the traditional three-stone stove to an improved and wood-saving stove. It is expected that the firewood consumption per farm is reduced by half through this intervention. Further, as part of the project, firewood trees (e.g. Markhamia lutea) are planted to ensure a sustainable source of energy.
Scale-up Options	The potential for wider penetration and scale-up across Kenya is considered high, but for practical purposes will require implementation in partnership with the government (public-private partnership).

Secondly, in most soil carbon projects, the number of stakeholders and farmers involved is large and the level of aggregation is advanced. *KACP* involves 60,000 farmers; *Katingan* spreads across 34 villages, home to approximately 43,000 people. *Leonard Springs* is smaller in number, but it still integrates hundreds of farmers, and most other soil carbon projects under development in the world are similar. The numbers are evidence of the enormous size of soil carbon operations, their impact on livelihoods, and the success for scale and replicability. At the same time, these projects are not operational without a professional entity on the ground who is locally entrenched and capable of running the project, interacting with hundreds or thousands of stakeholders, and working through the carbon cycle. The necessary profile these program entities need to meet is certainly not trivial. They need to be experienced project managers with strong business acumen; have a strong background in agriculture and – in many development countries, in particular – livelihood improvement; have carbon expertize; and know how to read and prepare for policy development. Where energy projects and even occasionally forestry projects can rely on efficient task sharing, with operations on the ground being different from carbon operations, soil carbon projects will usually require highly integrated operators.

Katingan Peatland Restoration and Conservation Project (VCS Project 1477)[188]	
Project Type	Category: Agriculture, Forestry, Other Land Use (AFOLU) Activity Group: Combination of REDD+WRC and ARR+WRC; specifically, as Avoiding Planned Deforestation (APD) and Reforestation (ARR), in combination with Conservation of Undrained and Partially Drained Peatland (CUPP) and Rewetting of Drained Peatland (RDP) activities
Location	Central Kalimantan, Indonesia (150,000 ha)
Project Proponent	PT. Rimba Makmur Utama (PT. RMU)
Other Project Participant(s)	Project Development Support: Yayasan Puter Indonesia & Wetland International Investor and Technical Advisors: Permian Global
Starting Date **Ending Date**	November 1st, 2010 October 31st, 2070
Crediting Period	60 years
Project Description	The Katingan Project protects and restores 149,800 hectare of peatland ecosystems, to offer local communities sustainable sources of income, and to tackle global climate change. The project lies within the districts of Katingan and Kotawaringin Timur in Central Kalimantan Province, and covers one of the largest remaining intact peat swamp forests in Indonesia.
Standards & Methodology	VCS Standard VM0007
Credits Expected	Total estimated: 447,110,780 ERs Average annual: 7,451,846 ERs
Credits Issued	From November 1st, 2010 to October 31st, 2015: **12,748,612 VCUs**
FINANCING & PROCEEDS	
Development	Comprehensive documentation is not publicly available. Development costs include contributions to the methodology, REDD+ licensing (estimated at US$1.8 million for the first couple of years, payable upfront),[189] a range of community outreach activities, feasibility studies, including on potential bilateral trade deals involving the government, substantial hydrological assessments, and more. Overall yearly costs for the project have been estimated to exceed US$5 million.[190] A number of international donors, including the Global Environment Facility and the Clinton Foundation, supported the program during the first years. We estimate the costs for project documentation and carbon cycle preparation (without implementation and methodology costs) to be in the range of US$300,000.
Price per credit	Commercial data is protected. The price per credit will be influenced by the overall development and marketing arrangement the project proponent has with Permian Global, the investor. We estimate that the transaction value is in the range of US$5 per credit.
Benefit-Sharing	Local villages are integrated via community agreements; the project requires a workforce for irrigation management, fire control, patrolling, monitoring and more. The project gives rise to new forms of income related to sustainable harvest of timber and non-timber products, agroforestry, ecotourism and sustainable fisheries.
CHALLENGES & OPPORTUNITIES	
Legal	Legal work centered on two levels: (1) demarcation of land on the ground and involvement of communities through contractual tools; and (2) licensing and carbon proceeds agreement with government entities. The work on both levels has tied up extensive resources (especially concerning government approvals at different administrative levels), but the result is deemed by project representatives a clear and predictable legal framework. Project representatives do not see the development of country targets under the Paris Agreement as a major risk. The regulatory situation is deemed clear for the foreseeable future.
Outreach	Local partner and sub-grantee NGO Yayasan Puter laid the groundwork for community development plans by initiating community participatory mapping in 25 local villages. These maps were the basis for collective decision-making, benefits-sharing, and capacity-building of local institutions, and they ultimately led to community agreements.
Technical	The technical implementation, monitoring and verification presented no major challenges. The number of qualified validators/verifiers was limited, and it was difficult to know who to hire even though the idea was not to go for the easiest or cheapest, but for quality. Methodologies have little room for deviations, but projects can very often fine tune procedures. Flexibilities can be allowed through the use of (justified) “adjustments” when submitting the monitorings report. This may make the validation/verification process more expensive, though still cheaper than creating a new methodology or amending an existing one under the current regime. Leakage accounting represents a big burden on projects. A jurisdiction should provide the data needed for a proper analysis.
Scale-up Options	Though a centralized country in theory, the regulatory conditions in each of Indonesia’s jurisdictions are quite distinct, and replication is not easily feasible. However, both the technical and the business model have proved resilient, and overall developments in Indonesia may suggest that peatland efforts are scalable. Reportedly, in 2017 – i.e. in the second year of its dedicated strategy – Indonesia managed to rewet an astonishing 2000 km^2 of peatlands.[191]

Thirdly, from the perspective of farmers and local communities, the priority is on yields and soils and their resilience, and not necessarily on carbon. While carbon proceeds as a recurrent income are not only welcome, but essential for the implementation of the project, the motivation among stakeholders is primarily on supporting the health of soils and preventing or reversing soil degradation. This has implications for both the business model and the outreach strategy. Farms need to be convinced to join a soil carbon project, and local communities near undegraded peatlands need to be interested in long-term conservation. The motivation is specific (local), not general (climate change mitigation). At the policy (government) level, the motivation is usually multi-layered – contributing to climate change mitigation has become an international policy priority – but for governments, too, aspects of food security and health will outweigh climate change targets. From the perspective of project development, it is important to build a comprehensive strategy that delivers on (in this order of prioritization) yields, soils, then resilience, and finally mitigation gains.

Fourth and lastly, carbon project development goes only so far, i.e. there are limits to what can be considered still manageable levels of project aggregation and to bottom-

up efforts. Governments have an important role to play if scale and replication are the ultimate goals. The *Leonard Springs* project makes a strong case for governments directly engaging with voluntary project development through credit auctions. The *Katingan* example has been a national blueprint for enhanced government action. In 2017, the national government has mobilized rewetting efforts for 2000 km^2 of drained peatlands, a vast area.[192] *KACP* has been developed against the backdrop of a high-priority National Climate-Smart Agriculture Strategy.[193] In all cases, projects and national policy development have been working hand-in-hand.

Leonard Springs Carbon Project (Project ERF111213)[194]	
Project Type	Agriculture
Location	Victoria, Australia
Project Proponent	Corporate Carbon Solutions Pty Ltd
Other Project Participant(s)	Individual landholders
Starting Date **Ending Date**	March 2017 March 2052
Crediting Period	25 years
Project Description	This project increases carbon in soil in the grazing system by rejuvenating pastures using a novel Australian invention, "Soilkee", which facilitates pasture cropping.[195] "Pasture cropping systems" is a generic term for the integration of cropping with pasture and livestock farming systems through the planting of a wide variety of crops into established pastures. Advantages include resting perennials, increasing nutrient supply, improving soil health and weed control. Furthermore, the addition of legumes to established pastures increases soil nitrogen levels (nitrogen fixation) and improves carbon sequestration.
Standards & Methodology	Carbon Credits (Carbon Farming Initiative) (Sequestering Carbon in Soils in Grazing Systems) Methodology Determination 2014
Credits Expected	375,000 t CO_2e
Credits Issued	None to date
FINANCING & PROCEEDS	
Development	Corporate Carbon acts as a large-scale aggregator preparing project documentation, working with farmers to adopt specific soil carbon management actions, ensuring proper monitoring, and representing farmers towards the Carbon Farming Initiative (CFI), the standard-setter, and the Emissions Reduction Fund (ERF), the carbon purchaser. Corporate Carbon covers its own development costs and is compensated for it through a share in carbon proceeds. Carbon project development costs are significant, given the technical complexity of the methodology. However, the advantage of operating aggregated soil carbon projects is the replicability of project activities and the double dividend of improved agricultural productivity and carbon credits.
Price per credit	Around AUS$12 (US$9.30, at time of writing)
Benefit-Sharing	Credits are issued on the basis of measured increases in soil organic carbon that are taken every 2–3 years. In order to manage differing results between farmers, participating landholders are registered as standalone projects, allowing improved implementation flexibility and project autonomy. Payments made are results-based, i.e. a farmer qualifies only when there is a measured increase in soil carbon. However, under the Corporate Carbon aggregation model, there is no penalty to farmers for not meeting sequestration targets.
CHALLENGES & OPPORTUNITIES	
Legal	Project is contracted at all levels, namely (1) between farmers and project proponent, as well as (2) between the project proponent and the ERF, which guarantees offtake for 10 years. Corporate Carbon bears the risk for carbon credit deliveries to the ERF, which is managed on a portfolio basis through other ERF projects.
Outreach	A key requirement for the project proponent is farmer engagement. Corporate Carbon has a goal of signing up an additional 200 projects with farmers over the next two years. A key component of the outreach is built around the Soilkee system. Demonstrations of Soilkee in practice are regularly given at farmer field days. The Soilkee approach begins with a mechanical improvement of rainfall infiltration, and oversowing a mixture of plants into the pasture. The additional growth from plants such as oats, peas, tillage radish, vetch, rye grasses, chicory, clovers, wheat, plantain, hemp millet and canola provides high-quality stock feed, in addition to nitrogen fixing and biologically-based rainfall infiltration (additional root pathways). The increased plant growth drives a build-up in soil organic matter, and benefits microbial activity. The cumulative effect is an increase in soil organic carbon and improved agricultural quality. One of the challenges for farmer recruitment and retention is the interface between on-farm activity and meeting the participation requirements set out under the soil carbon method, which is itself a regulatory instrument. The methodology also sets out the detailed practices for soil sampling and measurement, which are set far in excess of current agronomic standards. However, this is presented as a value add to farmers who have never engaged in a systematic mapping of their underground soil resource. Participation over time will also increase the value of the longitudinal measurements, with the ability to track not only soil organic carbon levels over time, but also a range of macro and micro nutrients. The motivation for participation becomes as much about a new and improved approach to agriculture, as it is for accessing increased revenue from better soil management.
Technical	Technical challenges relate primarily to the soil measurement system. Soil cores are taken at depths of between 1 to 1.5m according to sample points selected on the basis of simple random stratified sampling. Collecting soil samples and delivery for laboratory analyses can be problematic from a logistics and cost perspective. The strength of the measurement system though is that it fosters innovation by allowing a wide range of soil improvement practices as eligible activities, as the integrity of carbon credits is provided by the integrity of the soil measurement system. Each project also becomes directly comparable to other soil carbon projects, as they are all measured to a defined standard.
Scale-up Options	Corporate Carbon has actively contributed to the development of a new soil agricultural system method,[196] which it sees as a potential game-changer for mainstreaming soil carbon projects in Australia. The new method allows greater flexibility in implementing soil carbon techniques, widens the scope of permitted activities, simplifies baseline calculation, monitoring, and sampling-based verification, and brings in new technological approaches for measurement.

Soil carbon projects are innovators: for farmers, local communities, as well as investors. They also point the way: towards scale and long-term impact. When regulators take note, the actual sort of transformations may follow suit.

9. Looking Ahead

Soil carbon is on its way to receiving a level of climate policy recognition commensurate with its potential for the net-zero emissions pathway of the Paris Agreement. Different initiatives – namely the 4 per 1000,[197] the Global Alliance for Climate-Smart Agriculture[198] and the Global Peatlands Initiative –[199] along with the 2017 UNFCCC mandate[200] to work on "issues related to agriculture", notably (though not exclusively) "improved soil carbon, soil health and soil fertility under grassland and cropland as well as integrated systems", have raised awareness and created momentum for actual policy development on soils. Soil carbon – in its role as a key pillar of "nature climate solutions" –[201] is also increasingly acknowledged by business[202] as well as in its wider societal context, and it makes headlines globally.[203]

The enthusiasm comes with caveats, however. Firstly, the new market mechanisms of the Paris Agreement are not yet operational, and it may take some time for them to become operational. When they do, it is not yet certain that soil carbon will fall within their scope. The permitted scope of intervention formats under Article 6 of the Paris Agreement has not yet been defined. This may be less of an issue under Article 6.2 (the bilateral trading mechanism), which is likely to allow for more freedom in defining the scope. Yet, in the context of Article 6.4 (the new sustainability mechanism), agreement among nations concerning the scope and type of projects and programs will be crucial. Not all countries consider land use a priority matter for the purpose of Article 6.4. Furthermore, while the vast majority of countries have expressed their support for actions to improve sustainable agriculture in their NDCs, only a minority of countries have made specific provisions for specific targets in the agricultural sector or for soil carbon emissions. In fact, a number of developing country governments have expressed concerns that the use of agricultural soils should be subject to any mitigation targets at all.[204] This may complicate the trading environment, as there is a growing consensus that transfers should go hand-in-hand with ambitious baselines, moving beyond what is considered to be "mere offsetting".[205] This could translate into an expectation that a sector must be "capped" before it is ready for Article 6 transfers.

Secondly, investments in climate-smart agriculture, and investments in natural climate solutions in general, struggle with high and numerous implementation risks, with investors lamenting the lack of high quality investment opportunities.[206] There is a growing number of funds, facilities and accelerators to provide solutions,[207] yet the challenges are massive. They range from knowledge and technology gaps to capital impediments, ill-targeted subsidies,[208] and ambiguous land tenure regimes,[209] which both trigger instability and curb investment.

Against this backdrop, achieving an annual growth rate of 0.4% – as the 4 per 1000 initiative envisages – becomes highly ambitious. Incentives from emissions trading offer opportunities, yet they will not bring about change single-handedly and not without concerted action on different levels. Carbon projects can spread much-needed technologies and skills, but governments must stand ready to support them with legal and governance reforms, planning security, and scaling mechanisms. Public climate finance has to play an integral part in providing such support. The existing nationally appropriate mitigation actions (NAMAs) – among them initiatives to improve carbon efficiency in beef (Brazil) and other livestock supply chains (Honduras), the cultivation of coffee (Costa Rica), low-carbon rice cultivation (Thailand, Uganda) –[210] point in a promising direction, in which projects are turned into programs, relying on strong government support. Governments must also, in the long run, be prepared to remove the wrong kind of subsidies and introduce climate-smart incentives – such as sectoral emissions trading for farming – and they must improve the investment and trade climate, strictly prioritizing the production, trade and consumption of sustainably sourced food products. This is a task for the recipient just as much as for the supplying countries.[211]

Soil carbon projects are laboratories for transforming the agricultural sector to reach sustainable growth, climate change resilience, and climate change mitigation. Soil carbon projects are innovators: for farmers, local communities, as well as investors. They also point the way: towards scale and long-term impact. When regulators take note, the actual sort of transformations may follow suit.

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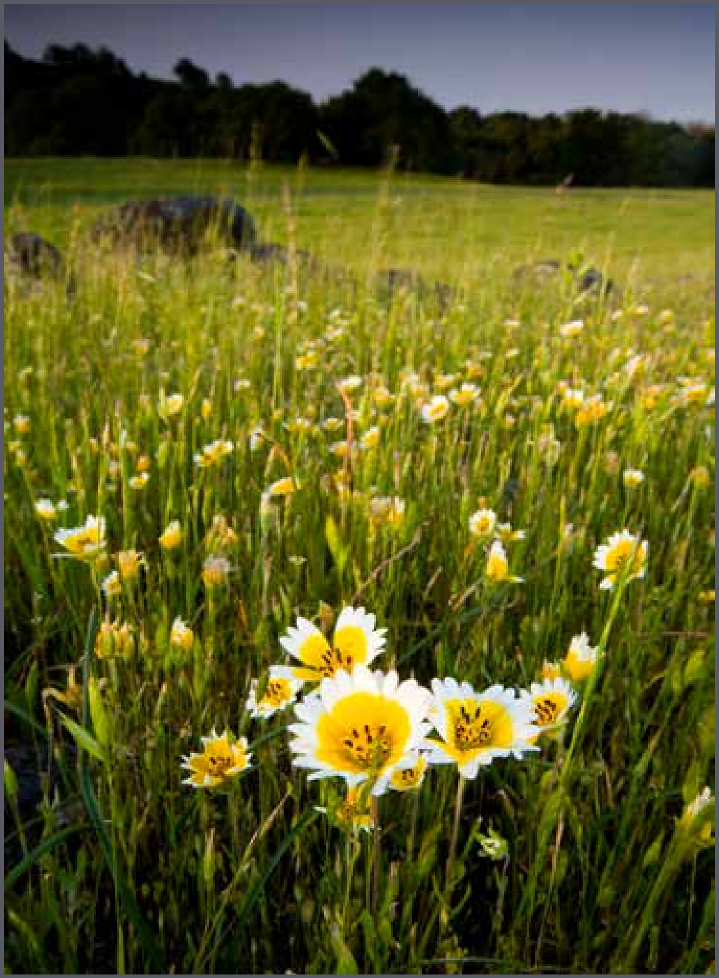
“Much can and should be done on the practical side to improve soil carbon standards and the investment environment for soil carbon projects in the short term.”



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