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Policy **Brief**

Transitions in the land sector and environmental integrity: safe and just pathways towards climate neutrality

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BACKGROUND

Reaching net zero CO_2 (balance of residual emissions and sinks) by 2050 is needed to maintain the global mean temperature on Earth below 1.5°C in 2100. This central message of the 1.5°C special report by IPCC (2018) has led to multiple carbon neutrality commitments by countries, private sector and local authorities. The race to net zero CO_2 is a fundamental driver of transformation in all sectors of the economy and therefore needs to be supported, but it needs to be framed to ensure the environmental integrity of carbon neutrality commitments as well as of trading mechanisms. Maintaining environmental integrity requires addressing simultaneously several challenges during race to zero: climate change, biodiversity, land degradation and desertification, water resources, food security, poverty and other SDG-related topics (see IPCC, 2019). This policy brief conveys four key messages:

KEY MESSAGES

1 – Carbon dioxide removal deployment in the land sector, although of crucial importance, will remain limited, calling for urgent and ambitious mitigation efforts.

2 - Maintaining and increasing soil organic carbon stocks have multiple co-benefits.

3 - Soil organic carbon stocks are finite, reversible and fragile.

4 - Inclusive and structured consultation process for policy decision guarantees the environmental integrity of carbon neutrality commitments.

KEY MESSAGE 1:

Carbon dioxide removal deployment in the land sector, although of crucial importance, will remain limited, calling for urgent and ambitious mitigation efforts.

In the AFOLU sector, actions for carbon dioxide removal (CDR) such as reforestation, afforestation and soil carbon sequestration appear as the only mature and ready to use options for carbon removal.

According to scientific knowledge, the technical potential of global soil organic carbon sequestration is important: recent estimates range from 2 to 5 Gt CO_2 yr^{-1}. However, achieving - even a large part of - this technical potential could be possible only under complex social, economic and political conditions. In fact, the deficit of proper enabling environments, including for land tenure rights and governance, in very different contexts and for millions of actors on the ground, hampers to reach this objective. Moreover, de-risking transitions towards carbon sequestration in soils and biomass requires financial incentives, tailored knowledge suited to local conditions and low-cost but accurate carbon stocks monitoring methods.

Large scale use of biomass for energy use, or for energy use and carbon capture and storage (BECCS), if deployed at several Gt CO_2 yr^{-1} level, will increase the demand for land conversion and will have adverse effects on all other challenges (IPCC, 2019). More precisely, the recent IPCC-IPBES co-sponsored Biodiversity and Climate Change Workshop Report identified the sustainable mitigation potential of bioenergy and BECCS as 1-2.5 Gt CO_2 yr^{-1} (Pörtner *et al.*, 2021). However, to achieve the Paris Agreement, 1/3 of the scenarios from the Integrated Assessment Modeling Consortium pointed out the need to deploy large scale BECCS to over 5 Gt CO_2 yr^{-1} removals by 2050 (and some up to 16 Gt CO_2 yr^{-1} ; Creutzig *et al.*, 2021). Even more concerning, recent research finds that 97% of IPCC pathways where bioenergy BECCS are deployed at scales lead to further land-use conversion (Turner *et al.*, 2018; Creutzig *et al.*, 2021).

In addition, other CDR options, such as Direct air Capture or Enhanced Weathering are non-mature and rely on technologies that are still at extremely early stages of development, and thus far from possible deployment before decades.

Thefore, if mitigation measures are not drastically improved in all sectors, cascading effects of climate change could make adaptation measures insufficient, and would prompt always more important carbon removal needs (IPCC, 2019). It is thus extremely important that countries and actors take ambitious mitigation efforts starting now to reduce greenhouse gases emissions as close as possible to zero, rather than bank too much on hypothetical future large-scale CDR options to compensate for continuing greenhouse gas (GHG) emissions (Pörtner *et al.*, 2021). Considering the limitations of BECCS and other mitigation options in the land sector, special attention should be given to sustainable land management, meant to maintain or increase soil organic carbon stocks, which is the only mitigation option with no competition for land.

KEY MESSAGE 2:

Maintain and increase soil organic carbon stocks has multiple co-benefits.

Soil organic carbon stock (0-1 m depth) is twice the amount of carbon in the atmosphere and three times that in the vegetation. Increasing soil carbon builds a precious reservoir and helps to offset GHG emissions. Moreover, soil organic carbon (SOC) stocks have many potential co-benefits for adaptation and for food security (see the 4 Per 1000 Initiative), biodiversity, ground water stress and water quality (Keesstra *et al.*, 2016; IPCC, 2019). Because of its multifunctional role and its sensitivity to land management, SOC was selected as one of three indicators for assessing Land degradation neutrality (Cowie *et al.*, 2018), one of the targets of SDG 15.

Preventing losses of - and maintaining or increasing SOC stocks - would not only contribute to mitigate and adapt to climate change but would also increase soil health and food security, and combat desertification and biodiversity losses. The related soil health benefits from sequestering carbon may help to close yield gaps in arable soils due to associated improvements in nutrient supplies, water-holding capacity, and soil structural stability.

Closing yield gaps would also reduce the need for further agricultural expansion and GHG emissions associated to land degradation.

To optimize land-based interventions, the first step involves the assessment of land potential and land degradation status in order 'to do the right thing, in the right place, at the right time, at the right scale' to foster hierarchical actions accordingly. There is 'no one size fits all' sustainable land management option. For farmers the profitability of practices is arguably the most important determinant of adoption of new practices. Long term policies are needed to trigger and incentivise changes in agricultural practices for maintaining or improving SOC stocks. These policies should address short term, medium term and long term impacts of sustainable land management practices (e.g. agroecology, agroforestry...) to fulfil farmers' present needs as well as climate, biodiversity, and land degradation long term objectives. In that perspective, not only individualized practices have to be considered, but also the dynamics and structure of food systems. Moreover, perpetuation of SOC sequestration over a period of a century or more implies to design public policy instruments taking into account the evolution of food systems and their adaptability to climate changes as well as to changes in other dimensions. Policy instruments should therefore enable adaptation processes of the whole food system, seeking for sustainability.

KEY MESSAGE 3:

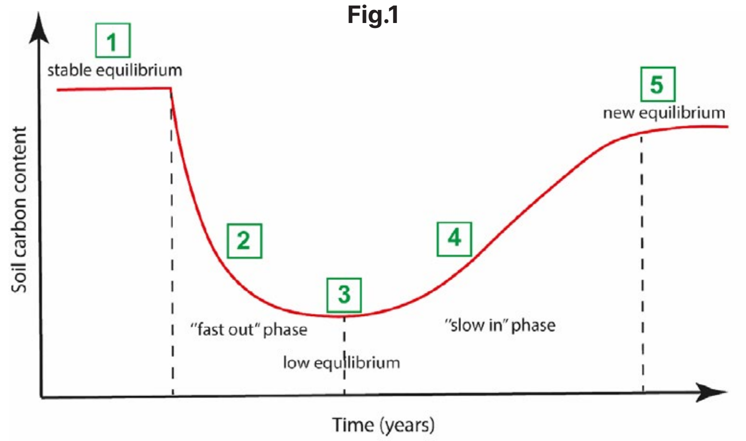
Soil organic carbon stocks are finite, reversible and fragile.

Carbon sink saturation (i.e., the maximum capacity of a soil to retain organic carbon), ***carbon sink reversibility*** (i.e., non-permanence risk) and ***carbon sink sensitivity*** of soil organic carbon (SOC) stocks are key dimensions when considering SOC contribution to climate change mitigation.

Carbon sink saturation – For most carbon management practices, SOC stocks do not increase indefinitely. Moreover, the rate at which soils store additional carbon begins to decline after some decades. Eventually, a new steady state is reached when a higher carbon stock is achieved. The time period of carbon sequestration before this new steady state is reached strongly depends of the soil type, management practices, the climate regime, and pre-existing SOC depletion. It is also very dependent on the land use and the carbon compartments (vegetation, soil).

Carbon sink reversibility – Maintaining high SOC stocks, such as with cover cropping and manuring in croplands, requires the continuation and improvement of soil carbon management practices, even after a new steady-state is reached. If this is not the case, SOC will decrease. Changes in SOC content are generally nonlinear. Thus, SOC changes are usually the fastest during the first years following the adoption of a new practice, and hardly exceed a few decades until a new equilibrium is reached. Additionally, after a change in land use, the rate of C gain is usually lower than the rate of C loss. In this 'slow in - fast out' temporal scheme (Fig.1), the quantity of SOC that can be stored in a given soil is finite and saturates after a few decades. The strategies to perpetuate SOC may differ depending on the current dynamics of SOC (Fig.1): equilibrium with high content of SOC, 'fast out' phase, equilibrium with low content of SOC, 'slow in' phase.

Fig.1



Carbon sink sensitivity – Soils can become either sources or sinks of carbon - with e.g. temperature increase, change in soil moisture or in nutrient (N, P) availability, or with rising levels of atmospheric CO_2, depending on the balance between gains via photosynthesis and losses via respiration (Rocci *et al.*, 2021). The future of soil carbon sinks is therefore uncertain. However, it is less uncertain than the future of above-ground biomass carbon (fire, clear cuts). Recent findings indicate that during the 2010–2019 period, Brazilian Amazonia forest degradation contributed three times more than deforestation to carbon emissions, the area of forest degradation exceeding that of deforestation (Qin *et al.*, 2021).

Despite these uncertainties, there is a clear benefit to implement sustainable land management targeted towards SOC stocking.

KEY MESSAGE 4:

Inclusive and structured consultation process for policy decision guarantees the environmental integrity of carbon neutrality commitments.

Notwithstanding the many fruitful changes towards transformation in different sectors and countries all over the world, triggered by the race to carbon neutrality, the integrity and credibility of commitments to carbon neutrality have to be carefully evaluated, especially in the land sector. This calls for the strengthening of National GHG inventories in the AFOLU sector, in order to better reflect changes, including in soil organic carbon stocks. Moreover, more explicit and robust foundations for the Nationally Determined Contributions and Long Term Low Emissions Development Pathways, submitted by countries in the framework of the Paris Agreement, are needed. Closer collaborations with scientists and stakeholders could be beneficial for that purpose.

As far as the evolution of SOC stocks is concerned, uncertainties and lack of precision of MRV methods, as well as inadequacy of their time and space scales relative to those of public actions, currently hamper the consideration of carbon sequestration in national public policies as in the climate international governance. Current scientific capacities and methodologies may contribute to precise SOC stocks potentials at country and sub-country level, and to improve cost effective MRV methods.

Moreover, current scientific research, expertise and foresight capacities may also contribute to develop and assess pathways and scenarios addressing different scales and multiple objectives in the land sector (climate change together with biodiversity loss, desertification, food security and poverty among other topics related to SDGs) and to propose options for improving enabling environments in specific contexts.

But to be useful, this knowledge-based multi-objective approach has to be associated with policy-making process spaces allowing the participation of the diversity of relevant stakeholders, including the civil society and citizens.

In particular, to accompany transitions and transformations towards sustainability in a more effective way, these stakeholders have

- To hybridize their knowledges
- To be integrated in debates and decisions schemes upfront
- To take part to in *itinere* and *ex post* evaluation of strategies, policies and measure
- To enlighten the elaboration of strategies and pathways, including the hierarchy of decisions to be implemented at the right time, at the right places and at the right scales. They may also produce knowledge on non-regret options, synergies and trade-offs and timelines for action.

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