Policy Briefings

BASQUE CENTRE FOR CLIMATE CHANGE
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Sustainability, that's it!

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LAND USE MITIGATION: CAN IT REALISTICALLY CONTRIBUTE TO FILL THE GAP TO ACHIEVE THE 1.5 AND 2 ºC GOALS?

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The Paris Agreement and NDCs: land sector role

In Paris, the 196 parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to limit the increase in global average temperature above pre-industrial levels to "well below 2 °C" — and preferably to 1.5 °C, by balancing the human-driven greenhouse-gas budget sometime between 2050 and 2100. Reaching this balance requires a simultaneous dramatic transformation in the energy and land use sectors. In the land use and agriculture sectors by dramatic emission reductions while also creating CO2 sinks (negative emissions), especially in forests. In the context of their willingness to contribute to mitigation, 120 countries included emissions reductions in either agriculture, land use change and forestry, or both in their Nationally Determined Contributions (NDC) submissions (Forsell *et al*., 2016). If all conditional and unconditional NDCs are implemented, reductions from land-use change related emissions would account for 10%-30% of total emissions reductions by 2030 (Forsell *et al*., 2016, Grassi *et al*., 2017). But, to limit warming to 1.5°C (and 2°C), more ambitious action is needed to transform the sector into a net carbon sink.

Highlights:

- *The agriculture and land sectors (AFOLU) contribute approximately 24% of total GHG emissions, with approximately 50% from land use and 50% from agriculture.*
- *IPCC scenarios for staying below 2°C include large scale removals of greenhouse gases from the atmosphere starting sometime already in the 2020's and increasing in scale over the remainder of the 21st century.*
- *Whether or not the present sink will persist in the future and how the foreseen technical potential could be materialized are the largest uncertainties in future carbon cycle.*
- *Implications of the implementation of large scale natural solutions, especially of large removals, demand further assessment and consideration so that policy instruments for them could eventually be designed appropriately.*
- *The success of land use mitigation options depends on how the barriers for implementation are addressed and engagement from stakeholder is fundamental.*

Agriculture and Land Use emissions, where we stand?

The agriculture and land sectors (AFOLU) contribute approximately 11Gt CO2e (24%) of GHG emissions, with approximately 50% from land use and 50% from agriculture (Smith *et al*., 2014). This was confirmed by the latest global carbon budget (Le Quéré, 2018), that estimated the emissions of the land use sector in 4.9 ± 3.0 GtCO2-eq yr-1 for the decade 2007-2016, about 12% of global emissions. However, terrestrial systems also sequester approximately one third of annual anthropogenic emissions, allowing when addressing the land sector, the opportunity not only to decarbonize, but also generate negative emissions (Smith *et al*., 2014). Processes which cause the largest GHG emissions in the land sector include deforestation and conversion of forests to pasture or cropland, land degradation, direct emissions from enteric fermentation by livestock, cropland management as well as other agricultural practices and consumption patterns. It is also worth to mention that due to increasing demand for food, fuel and fiber, agricultural emissions are projected to increase by 30% relative to the 2001-2010 average by 2050 (Tubiello *et al*., 2015).

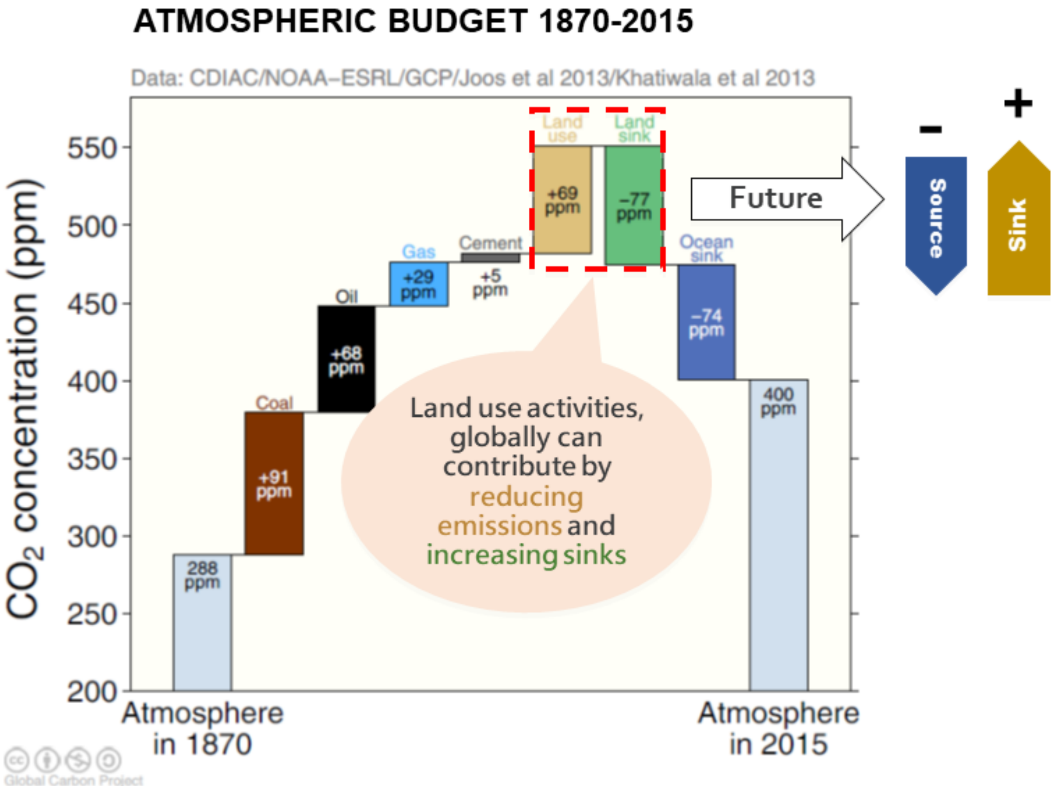

Figure 1. Contribution of the land emissions and removals to the atmospheric budget (1870-2015). Source: adapted from the Global Carbon Project

Despite of the recent optimism about the potential for maintaining and substantially enhancing the land sink though natural solutions (Griscom *et al*. 2017), there are still large uncertainties about its suitability on the ground. Whether or not the present sink will persist in future and how the foreseen technical potential could be materialized are the largest uncertainties in future carbon cycle. We need urgent research to ascertain the resilience of remaining biosphere carbon sinks, if we want to reduce the uncertainties in the global carbon cycle.

How 1.5 and 2 °C pathways include the land sector?

A balanced greenhouse-gas budget either requires that industry and agriculture produce zero or close to zero emissions, the land use sector reduces emissions (in particular by reducing deforestation), an active removal of greenhouse gases from the atmosphere, or a smart combination of all.

IPCC scenarios for staying below 2°C include large scale removals of greenhouse gases from the atmosphere starting sometimes already in the 2020's and increasing in scale over the remainder of the 21st century. Also for more ambitious targets (1.5ºC), tens of giga-tones per year must be removed in accordance with the recent research on GHGs pathways to achieve the Paris Agreement goals (Rogelj, *et al*. 2015). Such removals could be achieved partly by known processes of afforestation or ecosystem restoration, but novel techniques may also be needed as the ones beyond the land use related grouped under the label of "carbon dioxide removal" (CDR) technologies. The various approaches to achieving such removal will likely come with significant potential implications regarding the successful achievement of the Sustainable Development Goals (SDGs). These implications demand further assessment and consideration so that policy instruments for carbon dioxide removal could eventually be designed appropriately. Among the CDRs the land sector, through reducing emission and enhancing negative emissions is being considered as a potential huge contributor, by scientists and countries (see above the NDCs).

Land sector options

The most promising options include forest restoration and reducing deforestation, sustainable intensification of land use practices, enhanced agricultural productivity and demand side options such as diet changes reducing food waste.

Carbon dioxide removal (CDR) technologies

Carbon dioxide removal refers to a set of proposals for actively removing carbon dioxide from the atmosphere to limit global warming and its effects. They are also named "negative emissions technologies", it is assumed that these proposals could, if implemented effectively at global scale, allow to stay below 2ºC and prevent a number of climate change related impacts and risks (i.e. ocean acidification, sea level rise, ecosystem degradation, etc). The main proposed technologies include large-scale afforestation and forest ecosystem restoration, bio-energy with carbon capture and storage, enhancing soil carbon content by adding biochar, enhanced weathering or ocean alkalinization, direct air capture and storage, and ocean fertilization. These different approaches are briefly explained in the following table.

Table 1. Overview of different carbon removal concepts (source: Smith *et al*., 2014)

Technology	Explanation of the concept
Afforestation and forest ecosystem restoration	Large-scale planting of forests and restoration of ecosystems that result in long-term storage of carbon in soils or biomass
Bioenergy with carbon capture and storage (BECCS)	Burning biomass for energy generation and capturing and geologically storing the resulting CO_2
Enhancing soil carbon content with Biochar	Biomass burning under low-oxygen conditions (pyrolysis) yields charcoal to be used for enhancing soil carbon
Enhanced weathering or ocean alkalinisation	Enhancing natural weathering by extracting, grinding and dispersing carbon-binding minerals on land or enhancing oceanic carbon uptake potentials by adding alkaline mierals in oceans
Direct air capture and storage	Capturing CO_2 directly from ambient air by a chemical process, followed by geological storage.
Ocean fertilisation	Fertilising ocean ecosystems with growth-limiting nutrients to boost phytoplankton growth, which as a consequence sinks to the seabed thus removing carbon from atmosphere

Technically speaking, potentials for the land use sector to contribute to achieve the Paris Agreement goal are huge. For example, some recent studies (Griscom *et al*., 2017) advocate for 30% higher maximum potential (23.8 GtCO2e yr-1) than previous estimates (11.3 GtCO2eq yr-1) by twenty conservations, restoration, and improved land management actions across forest, wetlands, grasslands, and agricultural lands. Forest options are prominent in this context, in particular, forestry-based carbon removal that can be achieved by either increasing forest area, enhancing forest density or the carbon content of forest soils through reforestation (planting trees in deforested areas), afforestation (planting trees in historically treeless areas), and forest and harvest management. However, land use options are often limited by institutional, environmental, economic and socio-cultural feasibility, and not only by lack of access to appropriate technologies, practices, equipment, capacity building or empirical site specific research. Such institutional and governance issues are often major barriers that are difficult to be included in top down modelling exercises. Understanding the integrative response of a combination of options available in a given context implies that there is an understanding of the specificities of environmental conditions, social constrains and vulnerability, adaptive capacity, and institutional support is this context.

Other option that is raised by many as potentially relevant is soil carbon sequestration, the increase of soil carbon stocks through land management practices such as reducing agricultural tillage, planting species with deep roots. Soil carbon

sequestration can be achieved by partially restoring carbon lost from past land use; losses in soil carbon content are estimated at 230GtC in the last 10,000 years (Lal 2001), but the potential reversing these losses within decades is limited. There are potential benefits for agriculture productivity and ecosystems from enhancing soil carbon such as increased soil fertility, erosion control, habitat improvement, and community development (Lal 2008). However, changing the practices of very large numbers of unsophisticated economic actors in agriculture, and a potentially massive transportation and distribution problem for biochar and other compounds to be introduced into soils constrains their potential for mitigation. It raises the question, whether soil carbon enhancements could be done in a participatory, community driven approach that could strengthen several societal goals.

In summary, the land use sector represents an opportunity. But if the land sector is expecting to contribute to achieve the Paris Agreement goals implementation, in the context of the compliance with SDGs, this can only be facilitated by local engagement, and the creation of an enabling conditions under which the barriers for implementation could be overcome for each specific context. Strengthen governance and institutions and the choice of right policies will be required to address all of these challenges. Which leads to the question, “are we providing policy makers and stakeholders with the tools they need?” It is obvious that more multidisciplinary research is required to understand the interconnections of land with water, food and energy if the mitigation in the land use sector is foreseen as an option to achieve the Paris Agreement.

REFERENCES

Griscom, B. W. *et al*. (2017). Natural climate solutions. PNAS, 114 (44) 11645-11650.

Forsell *et al*. (2016). Assessing the INDCs’ land-use, land-use change, and forest emission projections. Carbon Balance Manage, 11:26.

Grassi, G. *et al*. (2017). The key role of forests in meeting climate targets requires science for credible mitigation. Nature Climate Change 7(3):220-226.

Grassi, G. *et al*. (2018). Reconciling global model estimates and country reporting of anthropogenic forest CO2 sinks. Nature Climate Change (accepted)

Lal, R. (2001). Soil degradation by erosion. Land Degrad. Dev. 12, 519–539.

Lal, R. (2008). Sequestration of atmospheric CO2 in global carbon pools. Energy Environ. Sci. 1, 86–100.

Le Quéré, C. *et al*. (2018) Global Carbon Budget 2017. Earth Syst. Sci. Data, 10, 405-448.

Naudts, K. *et al*. (2016). Europe’s forest management did not mitigate climate warming. Science, 351(6273): 597-599.

Rogelj, J. *et al*. (2015). Energy system transformations for limiting end-of-century warming to below 1.5 °C. Nat. Clim. Change 5, 519 –527.

Smith, P., & Bustamante, M. (2014). Agriculture, Forestry and Other Land Use (AFOLU). In: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

Tubiello, F.N., *et al*. (2015). The Contribution of Agriculture, Forestry and other Land Use activities to Global Warming, 1990–2012. Glob. Change Biol. 21, 2655–2660.

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