DEEP DECARBONIZATION PATHWAYS

CLIMATE AMBITION BEYOND EMISSION NUMBERS

Taking stock of progress by looking inside countries and sectors

LAND USE

Johannes Svensson, María José Sanz Sánchez, Alexandra Deprez, Aline Mosnier

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Contact

Henri Waisman, henri.waisman@iddri.org

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Taking stock of progress by looking inside countries and sectors

Johannes Svensson (IDDRI), María José Sanz Sánchez (BC3), Alexandra Deprez (IDDRI), Aline Mosnier (SDSN).

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How is this document relevant to the Global Stocktake?

This document is part of a collective report that assesses the evolution of climate ambition in 26 countries and 3 hard-to-abate sectors through a granular and context-specific analysis of trends and progress of national and sectoral transformations.[1] This approach allows identifying what hinders and spurs action in countries and sectors, and understanding the conditions that can support enhanced ambition, which could be political, social, economic, governance.

These insights are directly relevant to four overarching functions of the Global Stocktake in support of its desired outcome, i.e. "to inform Parties in updating and enhancing, in a nationally determined manner, their actions and support in accordance with the provisions of the Paris Agreement, as well as enhancing international cooperation for climate action" (Article 14.3 of the Paris Agreement):

- Create the conditions for an open and constructive conversation on global cooperation (on e.g., technology, trade, finance, etc.), based on an in-depth understanding of the international enablers of enhanced country ambition.
- Organize a process for knowledge sharing and collective learning, based on concrete examples of actions already in place or being discussed, including best practices.
- Create space for open dialogues across different stakeholders to support better coordination of actions, based on a detailed understanding of the levers to be activated to enhance ambition in national and sectoral transitions
- Facilitate ownership by decision-makers of the climate challenge and the risks and opportunities of the low-emission and resilient transition, based on context-specific and granular analysis of barriers and enablers.

More specifically, the collective report in general – and this document in particular – can contribute to address some of the key guiding questions for the Global Stocktake[2], notably:

- What actions have been taken to increase the ability to adapt to the adverse impacts of climate change and foster the climate resilience of people, livelihoods, and ecosystem? To what extent have national adaptation plans and related efforts contributed to these actions (Decision 19/CMA.1, paragraph 36(c))?
- How adequate and effective are current adaptation efforts and support provided for adaptation (Article 7.14 (c) Paris Agreement)?

1 The full report « Climate ambition beyond emission numbers - Taking stock of progress by looking inside countries and sectors" can be found at: https://www.iddri.org/en/publications-and-events/report/climate-ambition-beyond-emission-numbers-taking-stock-progress

2 Draft Guiding Questions for the Technical Assessment of GST1 (version 20th October 2021), available at: https://unfccc.int/sites/default/files/resource/Draft%20GST1_TA%20Guiding%20Questions.pdf

- What are the barriers and challenges, including finance, technology development and transfer and capacity-building gaps, faced by developing countries?
- What is the collective progress made towards achieving the long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions referred in Article 10.1 of the Paris Agreement? What is the state of cooperative action on technology development and transfer?
- What progress been made on enhancing the capacity of developing country Parties to implement the Paris Agreement (Article 11.3 Paris Agreement)?
- To achieve the purpose and long-term goals of the Paris Agreement (mitigation, adaptation, and finance flows and means of implementation, as well as loss and damage, response measures), in the light of equity and the best available science, taking into account the contextual matters in the preambular paragraphs of the Paris Agreement:
  - What are the good practices, barriers and challenges for enhanced action?
  - What is needed to make finance flows consistent with a pathway towards low GHG emissions and climate-resilient development?
  - What are the needs of developing countries related to the ambitious implementation of the Paris Agreement?
- What is needed to enhance national level action and support, as well as to enhance international cooperation for climate action, including in the short term?
- What is the collective progress made by non-Party stakeholders, including indigenous peoples and local communities, to achieve the purpose and long-term goals of the Paris Agreement, and what are the impacts, good practices, potential opportunities, barriers and challenges (Decision 19/CMA.1, paras 36(g) and 37(i))?

Foreword

Henri Waisman, Marta Torres Gunfaus, Anna Perez Catala, IDDRI.

Country commitments as reflected in enhanced Nationally Determined Contributions submitted to the UNFCCC are insufficient to put the world on track to achieve the collective objective of the Paris Agreement to hold temperature increase below 2 °C or 1.5 °C above pre-industrial levels. Furthermore, concrete policies and actions adopted by countries on the ground are often not sufficient to achieve these NDC targets. These conclusions highlight the need to increase ambition and to provide convincing evidence to accelerate action in the immediate and short term to give effect to this ambition. Yet these assessments are not sufficient to effectively guide the progressive increase of ambition, as organized by the cyclical process of the Paris Agreement.

APPROACH

With this imperative in mind, this report adopts a different, complementary, perspective on climate ambition. It seeks to open the box of emission pathways, by considering multiple dimensions of the conditions that will make these pathways possible. These are technical, economic, political, social and governance considerations in need of attention to enable the required far-reaching and systemic transformation towards the long-term goal. On the one hand, the revision of emission targets needs to be directed by an assessment of how drivers of emissions should change to trigger transformation. On the other hand, converting emissions' targets into pertinent concrete implementation requires well-designed policy packages and investment plans that are also informed by a clear and detailed understanding of the starting point, priorities and interplays between the available levers of transformation.

This bottom-up assessment aims at contributing to the process of collective learning in support of the progressive increase of collective ambition, as inserted at the core of the Paris Agreement paradigm. Approaching climate ambition through the lens of underlying transformations calls for reflecting the heterogeneous nature and the multi-faceted aspects of transitions in different sectors and countries. This forces a move away from a purely global perspective to a more granular approach based on country- and sectoral perspectives. Thus, the report explores trends and progress on these transformations, as locally observed over the past years, notably since the Paris Agreement. This 'backwards looking' approach can help identify where developments are going in the right direction, where they should be accelerated and where major tensions remain that should be addressed as a priority to avoid undermining the transition. The picture of the state of the ambition discussion, firmly embedded in the country and sectoral realities, can provide means for reflection and action within the international climate community, particularly to inform focus areas for advancing the collective ambition agenda.

STRUCTURE OF THE REPORT

This sectoral report highlights a selection of the main recent advances and remaining barriers for a far-reaching sectoral transformation towards, and where relevant beyond, net zero sectoral emissions. It examines relevant scientific and academic debates, as well as relevant sectoral- and climate policy influencing the climate- and environmental impact of the sector.

This report is part of a full series of 26 country chapters and three sectoral chapters. The full report includes a "summary for decision-makers" to present 10 cross-cutting messages emerging from the country and sector analysis, as a guide to the selection of priorities for collective action in the post-COP26 period.

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You will find the full report at: https://www.iddri.org/en/publications-and-events/report/climate-ambition-beyond-emission-numbers-taking-stock-progress

A narrative of climate ambition in key hard-to-abate sectors

Land use sector

The purpose of this chapter is to take stock of recent progress and remaining challenges for AFOLU[1] to become neutral in terms of its greenhouse gas (GHG) emissions before 2050, and a net sequestering sector thereafter, in a way consistent with the Paris Agreement. Beyond emissions trends, it considers the underlying enablers and remaining barriers of increased climate ambition for AFOLU, looking at economic, technological, social, environmental and institutional elements. After a cross-cutting overview in section 1, the chapter will consider more in-depth agriculture (section 2) and LULUCF (section 3). A fourth section discusses specifically questions around the governance of the global sink, while the final section touches upon transversal challenges, including integrating non-carbon objectives into policy, improving AFOLU finance, and the sustainability thresholds of bioenergy.

This chapter has been written thanks to the support of the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

OVERVIEW

The Paris Agreement anchors the central and unique role of the AFOLU sector in achieving global GHG neutrality, but research also highlights that a contribution in the upper echelons of the identified sectoral mitigation potential risks trade-offs with other sustainability objectives and that climate change impacts increase the risk of carbon sink reversals and cause a declining sequestration capacity.
The AFOLU sector is widely acknowledged as having a key role in order to "achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century" (Article 4.1) through four complementary roles: i) implementing deep reductions of sectoral emissions, which represent today 24% of global GHG emissions; ii) protect and expand its carbon sink, in particular through reforestation, afforestation and increases in soil carbon, iii) substituting fossil fuels by supporting the production of bioenergy (with or without carbon capture and storage); iv) changing the production mix toward low-GHG products (Svensson *et al.*,

1 AFOLU is short for *agriculture, forestry and other land use*, and is often split into the sub-sectors agriculture (comprising emissions from agricultural production) and LULUCF (comprising emissions and removals from land, including agricultural land). LULUCF itself stands for *land use, land use change and forestry*.

2021). Altogether, recent global assessments show that AFOLU can provide between 4-40% (median 25%) of the mitigation required for a 1.5°C pathway until 2050, depending on the type of economy-wide mitigation and notably the mitigation ambition in other sectors (Roe et al., 2019). Research also highlights the importance of keeping the deployment of bioenergy and BECCS to a sustainable scale, given than large-scale deployment and required land use would risk bringing close to or overstepping planetary boundaries (Heck et al., 2018). Given their biological nature, large terrestrial biological sinks, such as tropical forest, are likely to suffer from the increasing impacts of climate change leading to increases in emissions due to extreme events such as fires and droughts or more complex diebacks (Shukla *et al.*, 2019; IPCC, 2021). Terrestrial carbon sinks also show signs of saturation to the CO_2 atmospheric fertilization, such that global terrestrial carbon sinks sequester a smaller share of global CO_2 emissions (IPCC, 2021).

The Paris Agreement has triggered a renewed interest and focus for mitigation action in the AFOLU sector in international and domestic climate policy.

The land use sectors have always been considered in climate discussions but have long featured in a rather limited role as illustrated by the modest inclusion of the sector in the Clean Development Mechanism (CDM) of the Kyoto Protocol and its exclusion from the EU's Emission Trading Scheme. The inclusion of the sector into carbon markets was considered to risk delaying mitigation action in other sectors, and to overflood the emerging carbon markets with cheap credits from the LULUCF sector in the context of a non-universal agreement. During and since the lead-up to the Paris Agreement, the design of a universal agreement and the adoption of a very ambitious global goal ensured that the sector assumed a more central role in international discussions on mitigation and in the implementation on the ground. One concrete example is the EU's relatively recent *LULUCF regulation* – agreed upon in 2018 and in force since early 2021 – which strengthened the integration of the LULUCF sector into the EUs climate policy by setting out rules for accounting and reporting LULUCF emissions and removals toward the EU's climate targets. The regulation addressed several accounting challenges from the Kyoto Protocol. Furthermore, many countries have included activities related to the AFOLU sector in their NDCs. The inclusion of forest and agriculture in the UNFCCC negotiations through REDD+ by the adoption of the Warsaw Framework at COP19 and the establishment of the UNFCCC's Koronivia Joint Work on Agriculture (KJWA) at COP23 triggered number of large-scale collective processes in the margins of the multilateral processes addressing the sector directly. These include various initiatives to provide international finance to forestry (e.g. for REDD+ activities through the UN REDD Program, the Forest Carbon Partnership Facility and Initiative for Sustainable Forest Landscapes, the Amazon Fund, the Central African Forest Initiative), and to a lesser extent, other carbon sinks and agriculture (e.g. the 4p1000 initiative on soil carbon). Furthermore, there is an increased policy interest around the emerging concept of *Nature-based solutions*, which appeared in the adaptation context in particular related to cities but is now adopted by the mitigation community as a concept that not only considers mitigation but also adaptation and other services such as biodiversity (Griscom *et al.*, 2017).

The integration of AFOLU into national and international policy is faced with multiple important challenges, including regarding our understanding of- and capacity to quantify GHG fluxes in AFOLU. This capacity has improved over the last decade but remains flawed compared to other sectors.

The complexities of the carbon accounting in the LULUCF sector, and the challenge they pose for transparency, have been a key obstacle to the full consideration of this sector in mitigation. Challenges are due to the biological nature of the emissions and removals, and the difficulty of separating anthropogenic emissions and removals from natural ones. This explains why the UNFCCC reporting continues to separate Agriculture (only anthropogenic emissions) from LULUCF (that include emissions and removals in managed lands as a proxy for anthropogenic emissions) despite the structural links between the two sectors. Nonetheless, our understanding of AFOLU GHG fluxes have improved since the early 2000s. Key advances include the continuous improvements of the guidance for estimates that led to subsequent IPCC Guidelines for National

GHG Inventories, starting with the 2003 GPG for LULUCF, followed by the IPCC 2006 Guidelines volume 4 (AFOLU), and the recent 2019 Refinement of the 2006 Guidelines. Nonetheless, estimations of LULUCF GHG fluxes still feature very significant uncertainties, much higher than for energy-related emissions (Friedlingstein *et al.*, 2020). The high uncertainties in the LULUCF emissions and removals estimations lead the separate treatment of the sector under the EU's climate policy architecture (the sector is governed by the LULUCF regulation, as opposed to the Effort Sharing Regulation and the Emission Trading Scheme that governs other sectors). Many countries also still find it difficult to incorporate forest carbon flows into their Biennual Update Reports (BUR's) and Biennual Reports (BR´s) (Lee and Sanz, 2017) – and this is likely to remain a problem in the Biennual Transparency Reports set to replace the BUR's and the BR's in 2024. This leads to the risk that policies to reduce net emission levels from forests take a backseat with regards to policies on emission sources accounted for in the BURs. Also, large discrepancies, estimated to 4.5 Gt CO_2eq. per year only for forest by Grassi et. al. (2018), between top-down estimates by global models and the composite of national GHG inventories could create serious challenges for the 2023 Paris Agreement Global Stocktake. These gaps are caused notably by different treatment of non-anthropogenic emissions, feedback processes and impacts of climate change (Grassi *et al.*, 2021). Lately, efforts have been made to reconcile top-down global estimates with bottom-up estimates from aggregated national GHG inventory data (Grassi *et al.*, 2021). These disparities complicate the passage between national and global emission trajectories, making it difficult to evaluate national progress towards collective global goals.

Despite the increased focus on AFOLU in climate research and policy discussion, the sector does not feature ambitious emission reductions, reflecting a number of important remaining challenges to be overcome to trigger ambitious targets and actions for the sector.

Agricultural emissions have increased over the last decade by around 6% (FAO, 2020a), while global emissions from LULUCF have decreased only marginally over the last decade, and even increased in some regions such Africa (FAO, 2020a). Little analysis has been conducted to understand why the numerous initiatives launched since 2008 that focused on reducing emissions from deforestation (such as the Forest Carbon Partnership Facility, UN-REDD, the Amazon Fund, the Biocarbon Fund Initiative for Sustainable Forest Landscapes (ISFL), and many bilateral and/or capacity building programs) have not been as effective as envisioned. Challenges posed by transparent and robust accounting of GHG emissions from the sector are one of the key obstacles to collective action on the sector supported by structured cooperation. Despite some technological challenges, for instance in relation to advanced biofuels, the key remaining barriers for unblocking further climate ambition in AFOLU are a combination of socio-economic, political, and institutional issues which require well-tailored policy packages and strong governance arrangements to address domestic drivers (i.e. for land tenure and carbon ownership), as well efforts in addressing international drivers (e.g. increasing demand of commodities such as palm oil, beef, wood, etc). Although many financial supports were given to capacity building and pledged for result base payments, a large gap remains for investments to implement policies and measures.

ADVANCES AND CHALLENGES RELATING TO AGRICULTURE

Global estimates identify limited technical mitigation potential in agriculture.

Global modelling assessments estimate the technical mitigation potential of agriculture at 0.3-3.6 $GtCO_2$eq./year, which represents at best a reduction of about 50% by 2050, excluding demand oriented mitigation actions (Roe *et al.*, 2019). This limited potential reflects challenges for properly integrating mitigation options of the sector in the global models (Grisscom et al 2017; Rogelj *et al.*, 2018; Roe *et al.*, 2019), but also intrinsic challenges of the sector, notably the "limited mitigation potential of key emission" sources (enteric fermentation, rice cultivation) without compromising food security, the marginal effect of currently known mitigation options on the emission intensity of production and the challenges posed by reduction of the demand of agricultural products in relation to evolving lifestyles which illustrate the complex linkages with the overall food system.

Even where technical mitigation potential is available, the progress on emission mitigation in agriculture can be limited by socio-economic barriers, such as risk aversion, the dispersion of agricultural actors and the lack of secure land tenure rights. Uncertain profits, high transaction costs, and lack of farmers' collaterals reduce investments in agriculture.

Because agriculture depends on the combination of human actions and natural processes (climate, pests, diseases, pollination), "outcomes in agricultural production are highly uncertain" and partly independent of human will. Farmers are therefore risk averse and might avoid innovative mitigation options that increase the perceived level of risk, especially if financial investment is required. This risk aversion, and the challenges it poses for agricultural mitigation, is not captured by global estimates of the total mitigation potential from agriculture when the concrete feasibility of technical potential is assessed. These assessments also do not capture risks from a changing climate (e.g. reduced yields due to changing weather patterns or more frequent heatwaves). Agricultural actors around the world are on average small enterprises, often constituted by families with few or no employees, notably in the developing world. It is estimated that there are about 570 million farms worldwide, including 500 million family farms (Lowder et al., 2014). Farms are spread across the whole territory and depending on the quality of infrastructures and extension services, they might be hard to reach. This makes it more difficult for agriculture than for other sectors to transfer the appropriate new tools and/or skills for adoption of mitigation options and to design policies supporting changes in production methods. In this context, branch organisations have a key role to play. Farmers in certain countries have uncertain claims to the land they cultivate (unclear land tenure), which means that they lack collateral for taking loans for investments, and create a certain unwillingness to make investments in land they risk losing. Both act as a barrier for investments. Even if income losses during the first years of certain mitigation practices could be largely compensated by higher gains in the medium and long term, farmers might not want to change practices. This is especially the case if they are tenant farmers, which would see the long-term benefits accrue not to them but to the owners of the land. Increasing the carbon stock in agricultural lands is one example. The carbon stock increases (for instance through planting trees, changing tilling practices) and the ecosystem services that come with (improved soil health and yields), take time. Costs, such as the labour for planting trees, are however immediate. Secure land rights is therefore a prerequisite for farmers to adopt practices that increase the carbon stock in the lands they culitvate.

Systemic approaches to the food system beyond supply side measures only, are necessary to unlock the potential for far-reaching emission reductions in the sector. Yet, agricultural demand policies are rarely explored.

Given the limited technical potentials and further socio-economic constraints with agricultural supply-side mitigation options, the reduction of agricultural emissions requires an integrated approach in which demand-side actions play a central role to engender structural changes in the production patterns. Important examples of such demand side actions in agriculture include replacing animal proteins with vegetal proteins in countries where animal products are consumed at levels above healthy diet reference levels, and reducing food waste. These levers are increasingly recognised as having an important mitigation potential, and as being synergistic between emission mitigation and other objectives (Smith *et al.*, 2013; Roe *et al.*, 2019), and diet change could provide up to 8Gt/CO_2 emission reductions per year, and food waste reduction up to 4.5 Gt/CO_2 reductions per year (Roe *et al.*, 2019). Despite this important role of agricultural demand side policies, they are rarely explored, neither in pathways nor in national or regional policies, and no submitted NDC looks at demand side AFOLU policies (Griscom *et al.*, 2017). The IPCC Special Report on Climate Change and Land (IPCC, 2019) already proposes to structure the mitigation options for the land sector differentiating production and demand side measures.

Agricultural production is closely associated with food security, job creation and poverty alleviation, which means that environmental objectives (including climate) often take second priority when designing sectoral policies and actions. However, research also show that there are agricultural pathways with synergies among the different objectives.

This is a concern in both developed and developing countries. The EU's *Common Agricultural Policy* (CAP) is a good example: the majority of the budget under the CAP is used as income support to farmers (pillar I), while support to rural development, including to improving the environmental footprint of European agriculture, (pillar I) receives a much smaller part. Understanding and exploiting synergistic solutions with potential socio-economic *and* environmental benefits has so far been a challenge. Hence, it is important to adopt GHG reduction strategies that contribute to rural employment, improving farmers' livelihoods, *and* improving the environmental sustainability of agriculture (in terms of biodiversity, GHG emissions, etc.). Policies must therefore be designed to exploit synergies between agricultural job creation, poverty alleviation among farmers, and GHG emission mitigation. While integrated approaches to agriculture, both regarding the integration of both demand and supply side measures (see the paragraph above) and the integration of environmental and development objectives, are gaining ground internationally. The World Food Summit, organised for the first time in September 2021, and the EU's *Farm to Fork* strategy from 2020, both bear witness to this. Furthermore, the Koronivia Joint Work on Agriculture (KJWA), adopted in 2017, which mainstreams agriculture into the UNFCCC processes, emphasizes the importance of agriculture and food security in the climate change agenda and offers a space for policy and expert dialogue between Parties and observers to discuss synergies and trade-offs between adaptation, mitigation and food security across the agricultural sector. However, these insights are still very rarely translated into concrete policies (as illustrated by the disparity between the environmental ambition set in the *Farm to Fork* strategy and the early propositions of the *Common Agricultural Policy* (CAP)).

ADVANCES AND CHALLENGES RELATING TO FORESTRY AND OTHER LAND USE

Even if the overall deforestation rate has fallen over the last decade, about 10 million hectares (approximately the size of Iceland) continue to be converted to agriculture and other land use every year, primarily in the tropics, and some countries have recently experience increases in deforestation rates.

Halting deforestation of carbon-rich and highly biodiverse ecosystems such as tropical forests and peatlands is an essential 'win-win-win' strategy on climate mitigation, adaptation, and biodiversity conservation (land-conversion is the first driver of biodiversity loss globally) (IPCC-IPBES, 2021). For this reason, it has been the focus of numerous national and international initiatives in the past decade (e.g. REDD+[2], which predates the Paris Agreement, and numerous associated international and bilateral initiatives since 2008 to support developing countries pledging several US billions (Norman and Nakhooda, 2014), and more recently, the launch of the Lowering Emissions by Accelerating Forest finance (LEAF) Coalition, a 10-year public-private initiative launched during the US Climate Summit in April 2021). The global rate of deforestation has reduced over the past decade – going from 12 million hectares of annual forest losses in 2010-2015, to 10 in 2015-2020. However, the net loss of forests globally remains very significant (FAO, 2020b). Deforestation has four key drivers globally, of approximately equal importance: commodity production (soy, beef, palm oil, but also mining, etc.), logging and other forestry practices[3], shifting agricultural cultivation[4] and wildfires (Curtis *et al.*, 2018). In some of the central REDD+ countries, such as Brazil and Colombia, recent trends display a reversal of earlier gains and a renewed increase of deforestation rates. In particular, trends in the Brazilian Amazon are very concerning: after a historic 84% decrease in deforestation rate between 2004 and 2012, Brazil has seen a doubling of deforested areas since 2012. Recent research highlights that the Brazilian Amazon has now gone from being a net sink to a net source of GHG emissions (Qin *et al.*, 2021). This situation raises questions around how effectively reduce deforestation over the long run (Heilmayr *et al.*, 2020). In particular, international initiatives to halt deforestation (e.g. REDD+) have had unclear impacts on deforestation rates themselves,

2 Reducing Emissions from Deforestation and Forest Degradation, sustainable management of forest, conservation and enhancement of carbon stocks

3 Defined as large-scale forestry operations occurring within managed forests and tree plantations with evidence of forest regrowth in subsequent years

4 Defined as small- to medium-scale forest and shrubland conversion for agriculture that is later abandon

and have not so far mobilised the finance necessary to address the drivers of deforestation and effective protection of forests, despite capacity building investments and pledges for results based payments.

The capacity to monitor, report and verify (MRV) land use changes related to forestry has improved drastically in the last years, as a critical positive result of international capacity building initiatives on the sector and new datasets.

One major advance in the fight against deforestation is the drastic improvements in forestry MRV a multitude of different countries in the last decade. The number of countries in which forest monitoring can be considered good or very good, whether through national forest inventories or remote sensing, has increased drastically between 2005 and 2020. In particular, the explosion and reduced cost to remote sensing of forestry land use changes has enabled many tropical forest countries to drastically improve their forest monitoring (Karimon Nesha *et al.*, 2021). This is notably a direct impact of the international initiative REDD+, which has disbursed a majority of its funding to support capacity building to improve national monitoring capabilities. These improvements in MRV have also been associated with improved forestry governance and policy enforcement (Karimon Nesha *et al.*, 2021). While it is primarily the capacity to detect changes in forest *area* which has improved, the mapping of forest degradation has also improved (Palahi, 2021). Nonetheless, monitoring forest degradation remain a challenge many countries, including in key tropical forest countries (Lee and Sanz, 2017).

Land-use change due to agricultural commodity supply chains has received growing attention internationally over the past decade as a key lever for further and lasting reductions in deforestation.

Agricultural commodity supply chains have been a major area of focus for international and national action over the past decade across various types of private supply-chain governance measures (including commodity roundtables and certification schemes, a growing number of zero-deforestation voluntary company commitments, investor activism, consumer boycotts and campaigns, etc.) with varying degrees of effectiveness in terms of reducing emissions. The Tropical Forest Alliance (TFA) founded in 2010, represents a recent private governance initiative to address zero-deforestation supply chains, or the 2014 UN Forest Declaration that is a common, multi-stakeholder framework for forest action, consolidating various initiatives and objectives that drive forest protection, restoration, and sustainable use. In turn, the UK COP26 Presidency's FACT (Forest, Agriculture and Commodity Trade) Dialogues – a central initiative of its COP26 'Nature' Campaign – has seen 25 producer and consumer countries commit to exchange and collaborate on issues such as smallholder support, transparency and traceability, R&D, and trade and market development, in order to create greater sustainable forest management and ecosystems conservation.[5]

Enhanced national governance and national policies are critical to ensure continuity of efforts to reduce deforestation, with land tenure and law enforcement being of particular importance.

Land reforms ensuring clear tenure rights are critical to create conditions for *lasting* advances on deforestation (as opposed to easily reversible advances). Indigenous Peoples (IPs) and Local Communities are frequently shown to be the best guardians of forests for climate and biodiversity purposes when their tenure rights are respected or recognized (Garnett *et al.*, 2018). However, existing national policy approaches in many countries still do not incorporate this dimension sufficiently. For example, more than one third of the carbon-rich tropical forest land conserved by Indigenous Peoples is not subject to secure tenure rights (Dinerstein *et al.*, 2019). Indeed, in a context where large portions of land is not clearly attributed for example in Brazil, land owners and managers lack the incentives to protect the forests on their lands, and might be incentivised to deforest land in order to assert their claim to it (Reydon, Fernandes and Telles, 2020). In such situations, even if the central State is pro-active in the fight against deforestation, law enforcement remains an important challenge given the atomization of actors to control. A worst case scenario, in which the state is not taking any action

5 FACT Dialogue Statement, (May 2021) https://www.gov.uk/government/news/joint-statement-on-principles-for-collaboration-under-the-forest-agriculture-and-commodity-trade-fact-dialogue

on this objective leads inevitably to a quick rise of deforestation rates, as demonstrated by events since Bolsonaro's election in 2019.

Recent experience shows that halting tropical deforestation requires a combination of public and private governance across (1) a solid national regulatory framework and policy enforcement, (2) detailed monitoring, reporting and verification (MRV), and (3) zero-deforestation agricultural global supply chain efforts (Griscom et al.*, 2017).*

Extensive research demonstrates that, even if precisely attributing the specific role that each policy plays remains challenging, the spectacular impressive reductions in the Brazilian Amazon over 2004-2012 were brought about by this triad of State policies enforcement and regulations, and private governance. These different components taken independently are insufficient to deliver successful outcome given the interplay between them, and they should therefore be considered as the indivisible building blocks of a package for on halting deforestation. Indeed, the success of private governance policy depends on its articulation with strong and well-designed public policies, especially property registries and deforestation MRV (Heilmayr *et al.*, 2020).

GOVERNING THE "GLOBAL CARBON SINK"

The effective management of LULUCF carbon sinks is a critical condition to reach global carbon neutrality. But, despite growing interest and some experiments, the establishment of effective international cooperation approaches, such as international market-based approaches, and governance supporting this objective remains a key challenge in international climate policy under the Paris Agreement. More systemic approaches driven by local needs and conservation perspectives of the ecosystems holding the most important carbon sinks combined with the global collaborative efforts, including pooling resources, will offer more effective options while respecting the sovereignty and specific circumstances of individual countries.

The stewardship and protection of certain carbon sinks of global importance is a necessary condition to achieve global carbon neutrality, as demonstrated by the growing interest of countries and private companies for offsetting their emissions with removals and for banking on large-scale CDR (Carbon Dioxide Removal) in coming decades in the context of their net zero strategies. For example, recent research estimates that the voluntary carbon market, currently valued at $400 million, could value $10 to $25 billion in 2030.[6] Also, the nature, ambition and timing of actions on carbon sinks indirectly defines the efforts required by other countries and sectors towards the global carbon neutrality objective. These acknowledgments, embedded in the paradigm of the Paris Agreement, highlight that protection of carbon sinks cannot be left to the sole responsibility of individual countries, and should be supported by a structured international cooperation. This is even more true since most of the ecosystems holding the most important carbon sinks globally are located in developing countries, such as the Amazon rainforest, the Indonesian peatland, the Congo Basin or Mekong Valley. Hence, international finance can have a key role to play, especially if it helps trigger resources from private or/and public institutions through investments on sustainable projects on the LULUCF sector. The REDD+ initiative has featured experiments along these lines and numerous attempts have been undertaken to reward the protection of existing carbon sinks (i.e. reducing emissions) and the expansion of carbon sinks (i.e. increasing removals) with the ultimate goal of accessing different result based payments schemes, including voluntary carbon market schemes (CORSIA, VERRA, Label bas carbone, etc). There are however major concerns around the environmental integrity of such exchanges, in particular if they are developed at large-scale. Issues include bio-physical constraints such as the difficulty to ascertain the permanence of land-based removals. The market design is also subject to biases given that the demand for offsets would be based on plans and strategies developed independently by countries and companies without taking into account the limited amount of globally available high-quality credits.[7] Furthermore, there has always been concerns

6 S&P Global, May 2021, "Carbon offsets prove risky business for net zero targets », https://www.spglobal.com/esg/insights/carbon-offsets-prove-risky-business-for-net-zero-targets

7 Ibid.

around the methodologies and baselines used to estimate LULUCF removals on voluntary carbon market projects, and a recent analysis by (West *et al.*, 2020) for the Brazilian Amazon concluded that using historical baselines in the projects leads to excess carbon credits for projects when deforestation at the regional level drops below historical averages.

Finally, and most importantly, in the context of a universal agreement such as the Paris Agreement where all countries have emission reductions targets, clear accounting rules must be established to avoid double counting by clarifying whether the removals contribute to the emission reductions of the country financing their protection or of the country under whose geographical jurisdiction the sink falls.

The fundamental difficulty to address these technical and structural challenges of market instruments despite intense efforts by the international community, notably in the context of the difficult negotiations on the Article 6 of the Paris Agreement, indicates that international cooperation on LULUCF carbon sinks may require a more comprehensive and systemic approach. In addition, given the limits of market-based approaches, international initiatives of global cooperation such as REDD+, may have to be rethought in order to addresses the financial needs of each of the phases of REDD+ (readiness, implementation, rewarding for results) with the most efficient financial instruments, or even to reward efforts as a compensation for conservation (Fletcher *et al.*, 2016) or non-market results base payments schemes (e.g. the REDD+ Results Base Payments GCF Pilot), instead of a pure market-based instrument.

TRANSVERSAL AFOLU ADVANCES AND CHALLENGES

FINANCE

Recent trends highlight the remaining difficulty to mobilize finance flows at the scale required to support increased climate ambition in AFOLU, as well as the challenges in moving away from environmentally detrimental financial incentives (e.g. subsidies to synthetic fertilisers). Identifying investment projects with positive as well as negative environmental effects , and addressing important uncertainties faced by the sector appears critical to kickstart the required massive redirection of finance flows.

Despite significant mitigation potential, including at apparent low cost, and significant adaptation- and other co-benefits in the sector (CPI, 2019), very little financing is available for the green transformation of AFOLU. In particular, finance from the private sector has so far been a challenge for international efforts both in terms of amount, the source, and the reliability. In particular, while originally expected to be a market-based mechanism, REDD+ has struggled to access private finance and has so far received 90% of its funding from public donors (Angelsen *et al.*, 2017). Altogether, the AFOLU sector received 5.2% of all tracked climate finance during 2017-2018, which, although a significant increase from the 2015-2016 period when the sector received a mere 2.5%, remains far too limited to generate investments able to address domestic and international drivers of land use changes. This situation may be notably caused by the significant uncertainties around mitigation potentials, costs, and permanence of carbon storage, which is a core problem to attract finance (Griscom *et al.*, 2017). Furthermore, the management of uncertainties pose challenges for the efficiency of finance for mitigation, since an excessive emphasis on reducing uncertainties as a sign of good enough carbon credits for markets may lead to focus efforts and finance in the wrong places, e.g where the risk of deforestation is lower (Aguilar, Funk and Sanz-Sánchez, 2021). There is some hope that the improvements in MRV might unblock more forestry-related international finance, and in particular, more private finance, given that it improves the capacity of projects to ascertain that paid-for deforestation reductions take place. For example, the recent LEAF initiative launched by Norway, the UK and the US builds on recent advances in forestry MRV to raise 1 billion $ of public-private finance for reducing deforestation[8]. However, the payments for results through market linked mechanisms are likely not go-

8 for more information, see this article in Climate Change News, or this article in the New York Times

ing to be enough to cover the necessary investments for the transformations that are required to lead to sustained and good quality results (e.g. LEAF offers \$10 per tonne of CO_2). Beyond increasing finance for conservation, the OECD also insists on the equal if not greater importance of reforming finance flows that are harmful to biodiversity conservation (OECD, 2019). The World Bank has found that fiscal reforms –such as replacing input or production subsidies with income transfers, or payments for ecosystem services—could play an important role in reducing agricultural pressure on forest clearing (World Bank, 2021).

INTERPLAY WITH OTHER SUSTAINABILITY OBJECTIVES

There is a growing body of knowledge highlighting the interplays between climate and other sustainable development objectives in the AFOLU sector, and integrating these objectives comprehensively must be a core dimension for the international governance and national policymaking of the AFOLU sector. Key societal- and sustainable development objectives include GHG mitigation, adaptation to climate change, biodiversity preservation, ensuring food security, poverty alleviation and job creation. Notably, science is clear that limiting global warming to ensure a habitable climate and protecting biodiversity are mutually supporting goals, and that the mutual reinforcing of climate change and biodiversity loss means that satisfactorily resolving either issue requires consideration of the other (Deprez et al., 2021). Scientific evidence also highlights the need to assess the consequences of mitigation options in the AFOLU sector against other goals. For example, the IPBES GAR identified that bioenergy/BECCS deployment has by far the largest negative biodiversity impact of all low-carbon energy sources (IPBES, 2019; CH 6), and warns of heightened local conflict and placing at risk the SDGs that depend on land-based resources (IPBES SPM, 2019).

The interplays between ambitious climate action and other sustainability objectives in the AFOLU sector remains poorly understood. The adoption of more integrated policy frameworks requires more systematic and robust scientific analysis of these interplays. It is critical that the climate, biodiversity and sustainability scientific communities further develop transformation pathways to reach mid-century net zero emissions in ways that support the preservation of biodiversity, ecosystem integrity, and related planetary boundaries. Indeed, current knowledge on these interplays remains scarce and partial. For example, the scenarios presented in the IPCC SR1.5 report shows that all pathways limiting global warming to 1.5°C requires some land-based CDR, but these analyses do not yet take fully into account the impacts in terms of land-use change, biodiversity loss, food security, and even the feasibility of reaching carbon neutrality if such land-use changes take place. Similarly, the IPCC SR on Climate Change and Land (2019) alerted on the dangers of 'large-scale' deployment of BECCS/bioenergy, namely for food security—noting that by expanding into subsistence agricultural land, a deployment of 11.3 $GtCO_2$/yr could raise the number of food insecure people by over 150 million (Shukla et. al., 2019). This policy-relevant research agenda would notably mean exploring different options, such as pathways with little to no bioenergy expansion, or decoupling of economic growth with biodiversity loss, etc. (Otero *et al.*, 2020). But it also requires profoundly revisiting the conventional methods used to analyse emission reduction scenarios, to ensure that they capture explicitly the most important aspects related to biodiversity. There are some early examples of modelling, mostly from a biodiversity starting point, that try to better integrate climate and biodiversity objectives, such as Kok *et al.* (forthcoming) and IDDRI's "Ten Years for Agroecology in Europe, or TYFA", or who propose exploring more fundamental drivers of change (e.g. economic growth and decoupling (Otero *et al*., 2020).

The need to address together climate change and other sustainability objectives, notably those related to biodiversity, has entered the political mainstream– with momentum accelerating during the 2021 'climate and biodiversity super-year' in advance of COP15 and COP26. Most of the focus of analysis and international discussions has been on synergies, notably through 'Nature Based Solutions' (NBS). Yet, to reach ambitious climate goals

(e.g. mid-century net-zero) while also reaching high goals of biodiversity conservation and ecosystem restoration, there is also a key need to address trade-offs.

The emphasis on NBS is based on the assessment that a series of measures across agriculture, forest conservation and management, and the management of other ecosystems (peatlands, mangroves, etc.) can contribute significantly to ambitious climate objectives – for example Griscom *et al*. (2017) find that 37% of the mitigation to 2030 to reach the 2ºC can be met through 'Natural Climate Solutions' with co-benefits on other ecosystem services. These NBS, and more recently 'Nature Positive' solution, have entered the mainstream climate discussion, as illustrated by the COP26 UK Presidency's 'Nature' campaign, the FACT (Forest, Agriculture and Commodity Trade) dialogues, dedicated discussions in international meetings[9]. However, the design of efficient and actionable climate action in the AFOLU sector requires considering also the trade-offs, since the land sector will increasingly be the key scene of growing tensions between opposing land-uses: food, bioenergy and other land-based mitigation/CDR, and the preservation of biodiversity.

Recent analysis highlighted that limiting the reliance over time on biomass for emission reductions though bioenergy and/or CDR is a key condition to minimize the risks of trade-offs between mitigation and other sustainability goals. It requires notably strengthened global mitigation action in the coming decade and taking into account the systemic and lifecycle effects of AFOLU mitigation measures in carbon neutral pathways.

There is significant policy incitement of bioenergy production (considered carbon neutral under most accounting regimes *in the energy sector*), and its consumption has increased heavily over the last years. This energy features as one of the possible mitigation options to decrease reliance on fossil fuels and, notably, recent research highlights that mitigation pathway all depend on a certain amount of land-based CDR. The amount of CDR varies a lot, between 100 and 1000 Gt of CO_2 emissions removal cumulatively by 2100, depending on the ambition of actions in the short term: the faster we decarbonize now, the more limited CDR from AFOLU we will need in the future. The literature underscores consistently that the reliance on large-scale biomass in mitigation pathways can be a strong concern for a number of reasons. Sustainable thresholds for bioenergy may indeed be quite limited, which raises question marks around mitigation pathways that rely heavily on these solutions. Also, there are also important reasons for scepticism around the sustainability of bioenergy at large scale, given life-cycle analyses indicating that it is not carbon neutral when taking into account emissions from transport etc (Searchinger *et al.*, 2018), given the severe negative impact on biodiversity of current wood biomass burning practices [10] and given the low efficiency of burning wood biomass and the long carbon cycle of woody biomass. [11] Finally, the higher end of the CDR range, corresponding to less ambitious mitigation action in the coming decade, would require, in the second half of this century, growing biomass on an area larger than Australia, or 1/3 of global agricultural land (Huppman *et al.*, 2018), placing massive pressure on land use with risks on food provision and threats to today's ecosystem conservation and NBS.

CONCLUSION

With few exceptions, the remaining challenges for increasing the climate ambition in AFOLU are not technological, in that technical mitigation options exist for many AFOLU emission sources (Searchinger, 2019). Key barriers are instead related to the implementation of different solutions. Nevertheless, the mitigation potential of existing supply side technological mitigation options cannot in and of themselves more than halve agricultural emissions (Roe et al., 2019). Agricultural mitigation is further constrained by concerns over trade-offs with food security, farmer incomes, and socio-economic challenges (e.g. access to credit). Further emission reductions require pol-

9 eg, President Biden's Leaders' Summit, the Petersburg Dialogue, the HAC for Nature and People, the Leaders' Pledge for Nature, and the G7 Environment Ministers' Communiqué

10 Grunwald, M. (March 2021), The 'Green Energy' That Might be Ruining the Planet, Politico https://www.politico.com/news/magazine/2021/03/26/biomass-carbon-climate-politics-477620

11 Ibid, and also, Letter Regarding Use of Forests for Bioenergy (2020) https://www.woodwellclimate.org/letter-regarding-use-of-forests-for-bioenergy/

icy and research that adopts systemic approaches to reducing emissions in AFOLU, integrating both demand and supply side measures (see for instance (Aubert, Poux and Schwoob, 2019) for an example of such an integrated and multi-dimensional approach to the sectoral transformation). Key challenges for conservation and expansion of carbon sinks globally are largely socio-economic and politico-institutional, requiring both global collaboration around resources and agricultural commodity trade, as well as clear land tenure regimes and registries, solid national regulatory framework and policy implementation, and robust MRV at the national level. Furthermore, solutions that exploit synergies between mitigation, food security, poverty reduction, biodiversity conservation, and other sustainable development goals will enable overcoming certain barriers to ambitious emission reductions in agriculture and forestry. While there is a growing awareness of the importance of addressing these issues in an integrated and comprehensive manner, concrete policies that take up this task are still rare. An improved understanding of the interlinkages between different objectives and innovative policy approaches are needed to advance on this issue.

REFERENCES

- Aguilar, A. N., Funk, J. M. and Sanz-Sánchez, J. M. (2021) 'Forest carbon credits: separating the "good" from the merely "good enough"'. WWF. Available at: https://wwfint.awsassets.panda.org/downloads/wwf_us_impact_criterion_v3.pdf.
- Angelsen, A. *et al.* (2017) 'Learning from REDD+: a response to Fletcher et al.', *Conservation Biology*. Blackwell Publishing Inc., pp. 718–720. doi: 10.1111/cobi.12933.
- Aubert, P.-M., Poux, X. and Schwoob, M.-H. (2019) *Agroecology and carbon neutrality in Europe by 2050: what are the issues? Findings from the TYFA modelling exercise.* Available at: https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue Iddri/Décryptage/201904-ST0219-TYFA GHG.pdf (Accessed: 24 September 2020).
- Bongaarts, J. (2019) 'IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services', Population and Development Review, 45(3), pp. 680681. doi: 10.1111/padr.12283.
- CPI, 2019. Global Landscape of Climate Finance 2019. Barbara Buchner, Alex Clark, Angela Falconer, Rob Macquarie, Chavi Meattle, Rowena Tolentino, Cooper Wetherbee]. Climate Policy Initiative, London. Available at: https://climatepolicyinitiative.org/publication/global-climate-finance-2019/
- Curtis, P. G. *et al.* (2018) 'Classifying drivers of global forest loss', *Science*, 361(6407), pp. 1108–1111. doi: 10.1126/science.aau3445.
- Deprez, A., et al. (2021), Aligning high climate and biodiversity ambitions and action in 2021 and beyond: why, what, and how?, IDDRI Study. Available at: https://www.iddri.org/en/publications-and-events/study/aligning-high-climate-and-biodiversity-ambitions-and-action-2021-and
- Dinerstein, E. *et al.* (2019) 'A Global Deal For Nature: Guiding principles, milestones, and targets', *Science Advances*, 5(4), p. eaaw2869. doi: 10.1126/SCIADV.AAW2869.
- FAO (2020a) 'FAOSTAT, 2020'. Rome, Italy: FAO.
- FAO (2020b) *Global Forest Resources Assessment 2020: Main report*. Rome. doi: 10.4060/ca9825en.
- Fletcher, R. *et al.* (2016) 'Questioning REDD+ and the future of market-based conservation', *Conservation Biology*, 30(3), pp. 673–675. doi: 10.1111/cobi.12680.
- Friedlingstein, P. *et al.* (2020) 'Global Carbon Budget 2020', *Earth System Science Data*, 12(4), pp. 3269–3340. doi: 10.5194/ESSD-12-3269-2020.
- Garnett, S. T. *et al.* (2018) 'A spatial overview of the global importance of Indigenous lands for conservation', *Nature Sustainability 2018 1:7*, 1(7), pp. 369–374. doi: 10.1038/s41893-018-0100-6.
- Global landscape of climate finance (2019).
- Grassi, G. *et al.* (2018) 'Reconciling global-model estimates and country reporting of anthropogenic forest CO_2 sinks', *Nature Climate Change 2018 8:10*, 8(10), pp. 914–920. doi: 10.1038/s41558-018-0283-x.
- Grassi, G. *et al.* (2021) 'Critical adjustment of land mitigation pathways for assessing countries' climate progress', *Nature Climate Change 2021 11:5*, 11(5), pp. 425–434. doi: 10.1038/s41558-021-01033-6.
- Griscom, B. W. *et al.* (2017) 'Natural climate solutions', *PNAS*, 114(44), pp. 11645–11650. doi: 10.1073/pnas.1710465114.
- Heilmayr, R. *et al.* (2020) 'Brazil's Amazon Soy Moratorium reduced deforestation', *Nature Food 2020 1:12*, 1(12), pp. 801–810. doi: 10.1038/s43016-020-00194-5.
- Heck, et al. (2018) Biomass-based negative emissions difficult to reconcile with planetary boundaries. *Nature Clim Change* **8**, 151–155. https://doi.org/10.1038/s41558-017-0064-y
- Huppman, D., et al. (2018) IAMC 1.5°C Scenario Explorer and Data hosted by IIASA, Integrated Assessment Modeling Consortium & International Institute for Applied Systems Analysis, 2018. https://doi.org/10.5281/zenodo.3363344

- IPBES (2019) *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES. Bonn, Germany.
- IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn, Germany. https://doi.org/10.1590/1676-0611201600010001
- IPCC (2021) 'Summary for Policymakers', in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. doi: 10.1260/095830507781076194.
- IPBES-IPCC (2021), Co-sponsored biodiversity and climate change workshop report'. doi: 10.5281/zenodo.4782538.
- IPCC (2019). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)].
- Karimon Nesha, M. *et al.* (2021) 'An assessment of data sources, data quality and changes in national forest monitoring capacities in the Global Forest Resources Assessment 2005-2020', *Environ. Res. Lett*, 16, p. 54029. doi: 10.1088/1748-9326/abd81b.
- Lowder, S. K., Skoet, J. and Singh, S. (2014) 'What do we really know about the number and distribution of farms and family farms worldwide? Background paper for The State of Food and Agriculture 2014', ESA *Working Paper*, No. 14-0. Available at: www.fao.org/economic/esa (Accessed: 21 August 2021).
- Lee, D. and Sanz, M. J. (2017) *UNFCCC ACCOUNTING FOR FORESTS*. Available at: www.visilio.com (Accessed: 2 June 2021).
- Norman, M. and Nakhooda, S. (2014) 'The State of REDD+ Finance', *CGD Climate and Forest Paper Series*, (Working Paper 378). Available at: http://www.cgdev.org/publication/state-redd-finance-working-paper-378 (Accessed: 20 August 2021).
- OECD (2019) Biodiversity: Finance and the Economic and Business Case for Action, Report Prepared by the OECD for the French G7 Presidency and the G7 Environment Ministers' Meeting, 5-6 May 2019. Available at: https://www.oecd.org/env/resources/biodiversity/biodiversity-finance-and-the-economic-and-business-case-for-action.htm
- Otero, I., et al. (2020), Biodiversity policy beyond economic growth, Conservation Letter, https://doi.org/10.1111/conl.12713
- Palahí, M. et al. (2021) 'Concerns about reported harvests in European forests', *Nature 2021 592:7856*, 592(7856), pp. E15E17. doi: 10.1038/s41586-021-03292-x.
- Qin, Y. *et al.* (2021) 'Carbon loss from forest degradation exceeds that from deforestation in the Brazilian Amazon', *Nature Climate Change 2021 11:5*, 11(5), pp. 442–448. doi: 10.1038/s41558-021-01026-5.
- Reydon, B. P., Fernandes, V. B. and Telles, T. S. (2020) 'Land governance as a precondition for decreasing deforestation in the Brazilian Amazon', *Land Use Policy*, 94, p. 104313. doi: 10.1016/j.landusepol.2019.104313.
- Roe, S. *et al.* (2019) 'Contribution of the land sector to a 1.5 °C world', *Nature Climate Change*. Nature Publishing Group, pp. 817–828. doi: 10.1038/s41558-019-0591-9.
- Rogelj, J. *et al.* (2018) 'Mitigation pathways compatible with 1.5°C in the context of sustainable development', in *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*. IPCC.
- Searchinger, T. D., et al. (2018). Europe's renewable energy directive poised to harm global forests. *Nature Communications, 9*(1), 10–13. https://doi.org/10.1038/s41467-018-06175-4.
- Searchinger, T. (2019) *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*. World Ress. Washington DC.
- Shukla, P. R. et al. (2019) 'Technical Summary', in *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.*
- Smith, P. et al. (2013) 'How much land-based greenhouse gas mitigation can be achieved without compromising food security and environmental goals?', *Global Change Biology*. *John Wiley & Sons*, Ltd, pp. 2285–2302. doi: 10.1111/gcb.12160.
- Svensson et al., 2021). A low GHG development pathway design framework for agriculture, forestry and land use. *Energy Strategy Reviews*, Volume 37. DOI: https://doi.org/10.1016/j.esr.2021.100683.
- West, T. A. P. et al (2020) 'Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon', PNAS, https://doi.org/10.1073/pnas.2004334117.
- World Bank, (2021) Designing Fiscal Instruments for Sustainable Forests. Washington, D.C. Available at: https://pfbc-cbfp.org/news-partner/Designing-Instruments.html.

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