OXFAM
RESEARCH BACKGROUNDER

Zero Hunger, Zero Emissions

Land-based climate change mitigation, food security, and equity

Kristal Jones

OXFAM

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Author information and acknowledgments

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ACRONYMS AND ABBREVIATIONS

BECCS	bioenergy with carbon capture and storage
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas
$GtCO_2eq$	gigatons of carbon dioxide equivalent
HLPE	High-Level Panel of Experts of the United Nations Committee on World Food Security
IFPRI	International Food Policy Research Institute
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
NDC	nationally determined contribution
OECD	Organisation for Economic Co-operation and Development
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goal
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

The goal of this report is to identify the threats to equity posed by certain land-based climate change mitigation strategies and the potential impacts of these threats on food security and other human rights, in order to sound the alarm on current and potential future inequalities. At the same time, this report highlights opportunities to decrease greenhouse gas (GHG) concentrations while enhancing multidimensional equity, and thus safeguarding food security and other human rights, by keeping equity at the core of land-based climate change mitigation actions.

Equity requires removing barriers to equality as well as building new systems that facilitate the realization of all people's capabilities to live a full life. As a complement to the ambitious targets set by the Intergovernmental Panel on Climate Change (IPCC), the global civil society community focused on human rights must be prepared to argue for policies, processes, and systems that protect and enhance equality and equity as outcomes on par with GHG reductions from land-based climate change mitigation strategies. In the context of climate change, gender, economic, and climate equity are inextricably linked: individuals and communities who have been historically marginalized on the basis of gender and economic capabilities have the potential to be further marginalized by land-based mitigation activities.

Oxfam America is interested in addressing food security and climate change through holistic, rights-based approaches to changing national and global policies as well as practices on the ground. Land sits at the center of many of these strategic priorities and provides an important framing for Oxfam's work on food security, climate change mitigation, and securing of rights for marginalized communities. At the same time, land-based climate change mitigation is increasingly the focus of national governments and international institutions, as well as of private industry and carbon markets. Oxfam must have a clear and representative synthesis of the existing evidence about the opportunities, trade-offs, and potential future impacts of land-based climate change mitigation to ensure that these activities do not undercut equity and negatively impact food security and other human rights.

This research therefore looks at widely proposed land-based climate change mitigation practices and processes in order to characterize their current and future impacts on emissions, food security, *and* equity. Recent global reports have synthesized the evidence on the potential impacts of land-based climate change mitigation strategies and agroecological practices on emissions. Some academic and civil society work also considers the equity implications of certain land management strategies with the potential to contribute to mitigation.

However, there is a need for a holistic and integrated assessment of how to balance climate change mitigation goals with commitments to equity and human rights.

This research uses a modified systematic review process to scan both the literature and the data currently available to characterize, predict, and identify relationships among land-based climate change mitigation needs and strategies; food security; and gender, economic, and climate equity. The strategies included in this paper are those consistently identified across the literature as the most promising in terms of reducing GHG concentrations and offering potential synergies with other development goals. The information- and data-gathering process was conducted in a sequential three-part manner. The first step was to identify and gather the key documents that have been generated and approved by the global community that sets the agenda for climate change action. The next step was to identify recent research (both peer-reviewed and programmatic) that specifically documents the impacts of land-based climate change mitigation strategies on food security and gender, economic, and climate equity. This process is considered a modified systematic review because it did not include every paper returned with the above-defined search criteria. Instead, it includes those papers with a large number of citations, those supported by global research institutions, and those that covered understudied aspects of climate change mitigation or equity. The final data-gathering step, after analysis of both the global documents and the literature focused on multidimensional equity, was to identify key sources of data at the global scale that represent or can help visualize where there are needs and opportunities for both land-based climate change mitigation and enhanced equity.

This report fills a gap in the global conversation by further synthesizing the disparate evidence bases on reducing GHG concentrations and on addressing potential food security and other equity implications of land-based climate change mitigation activities. Making informed and comprehensive policy and programming decisions requires assessing both the biophysical and social impacts of climate change mitigation strategies. The results of this report highlight both opportunities and potential trade-offs, showing how Oxfam, its partners, and the broader community of climate change and development actors can proactively achieve reductions in GHG concentrations while ensuring food security and other human rights.

Key findings

- Some changes in land use strategies to address climate change mitigation may have large positive impacts on GHG concentrations and large negative impacts on food security and equity. These are generally considered negative emissions strategies and include bioenergy with carbon capture and storage, afforestation, and reforestation.

- Other changes in land management strategies to address climate change mitigation may have moderate to large positive impacts on GHG concentrations and large positive impacts on food security and equity. These are generally strategies to reduce degradation and improve ecological health through ongoing human activities; they include forest management, agroforestry, soil health management, and pastureland management.
- Data on the impacts of land-based climate change mitigation strategies on food security are more robust than data on many other aspects of gender, economic, and climate equity. There is a consistent need for more consideration and documentation of the potential for inequality in land-based climate change mitigation strategies that do not explicitly consider equity implications.
- Rights-based land management and climate justice provide two frameworks for operationalizing actions designed to meet the dual goals of climate change mitigation and enhancing equity.

Recommendations for Oxfam:

- Place-based and localized efforts to implement land-based climate change mitigation activities should
  - maintain and whenever possible enhance land as a net carbon sink; and
  - reduce the net GHG emissions from agricultural production in ways that increase efficiency and productivity.
- Efforts at systemic change to improve the impacts of land-based climate change mitigation activities should
  - highlight the need for enhanced ambition regarding GHG reductions, food security, *and* equity in the 2020 nationally determined contribution (NDC) process and in land-based development projects; and
  - push for investments in land-based climate change mitigation to consider multidimensional equity directly and to prioritize projects and processes that consider synergies and trade-offs in context.

TOWARD AN EQUITABLE ZERO-EMISSIONS, ZERO-HUNGER FUTURE

As recent reports by the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Environment Programme (UNEP) make clear, global climate change remains a threat to all aspects of human and ecological health and well-being. Furthermore, current actions by governments, corporations, and individuals are essential but not yet sufficient to minimize the long-term likelihood of global temperature increases (IPCC 2018; UNEP 2019). The "emissions gap" between emissions reductions necessary to achieve stable global temperatures and the current rates of greenhouse gas (GHG) emissions highlight the urgency of climate change mitigation actions globally. At the same time, food security remains a consistent and resurgent challenge globally: rates of undernourishment increased annually from 2016 to 2018, and rates of child and adult obesity are increasing as well (FAO et al. 2019).

In the context of global efforts to address and combat climate change and to improve food security, sustainable land use and land management have the potential to achieve great impact and synergy across priorities.[1] Land also features prominently in many countries' nationally determined contributions (NDCs) to mitigating climate change. Land is a source and a sink of GHGs, and there are both opportunities and limits to how land can contribute to climate change mitigation and sustainable development.

- Land can be used to sequester GHGs to limit global warming and the climatic change associated with it.
- Land is the foundation of adequate food production, a necessary but not sufficient starting point for achieving food security.
- Land is an economic resource and a cultural heritage, and access to land is often a key component of economic and gender equity.
- Changes in land use and land governance as a result of climate change mitigation commitments have the potential to hurt or help equity globally, with differential impacts by geography and social position.

1. For more on this potential, see NASEM (2018), Dooley et al. (2018), Sanz et al. (2017), UNCCD (2017), Smith et al. (2013), Harper et al. (2018), Ross and Agostini (2016), and UNFCCC (2015).

The goal of this report is to identify the threats to gender, economic, and climate equity posed by certain land-based climate change mitigation strategies and the potential impacts of these threats on food security and other human rights, in order to sound the alarm on current and potential future injustice. At the same time, this report highlights opportunities to decrease GHG concentrations while enhancing multidimensional equity, and thus safeguarding food security and other human rights, as long as attention to power dynamics and human rights is kept at the core of land-based mitigation actions.

The Oxfam America Food Systems team is interested in addressing food security and climate change through holistic, rights-based approaches to changing national and global policy as well as practices on the ground. The "zero-hunger zero-emissions" focal area within the Food Systems team's recent strategic plan articulates this priority in the context of a broader organizational focus on multidimensional and intersectional equity. Land sits at the center of many of these strategic priorities and provides an important framing for Oxfam's work on food security, climate change mitigation, and securing of rights for marginalized communities. At the same time, land-based climate change mitigation is increasingly the focus of national governments and international institutions, as well as of private industry and ecosystem services markets.[2] To ensure that mitigation strategies involving land do not undercut multidimensional equity and negatively impact food security and other human rights, Oxfam must have a clear and representative synthesis of the existing evidence about the opportunities, trade-offs, and potential future impacts of land-based climate change mitigation strategies for emissions, food security, and many types of equity.

This research will therefore characterize the current and future impacts on emissions *and* equity of land use and land management practices and processes that are being championed by major international organizations and global commitments as contributing to climate change mitigation. Recent global reports have synthesized the evidence on the potential impacts on emissions of land-based climate change mitigation strategies (IPCC 2019a) and of agroecological practices (HLPE 2019), and slightly older work has focused on the equity implications of certain land management strategies with the potential to contribute to climate change mitigation (HLPE 2019; EIA and CIEL 2015; Seymour et al. 2014). This report fills a gap in the global conversation by further synthesizing these disparate evidence bases.

The contribution of this research for Oxfam America is to integrate the findings from these various sources—all of which have a primary focus on either land-based climate change mitigation, food security, or multidimensional equity—and to identify both the trade-offs and opportunities that exist among these priorities.

2. These include carbon markets, where private actions that capture or sequester carbon are paid for by polluters or other interested parties, as well as markets to pay for private actions that maintain or enhance water quality, soil health, and other ecosystem characteristics that benefit the broader public.

Further, this report whenever possible highlights in a systematic way where in the world these various impacts are currently seen and where we can expect trade-offs and opportunities in the future. The results of this research synthesis and review will support Oxfam's strategic goal of identifying programming and policy areas that can maximize co-benefits between land-based climate change mitigation, food security, and equity, and will help identify high-priority areas around the world where there are opportunities to implement these findings.

LAND, CLIMATE, FOOD SECURITY, AND EQUITY: OVERVIEW AND DEFINITIONS

Within the broad context of sustainable development, there is an increasingly acute focus on the potentially catastrophic effects of climate change as aggregate greenhouse gas concentrations increase and global temperatures rise as a result. The Sustainable Development Goals (SDGs) include a specific focus (especially in Goals 12, 13, and 15) not only on limiting the impacts of climate change but also on addressing the root causes through decreased consumption, increased resource use efficiency, and appropriate land management techniques. However, in many global and national conversations there continues to be more focus on supporting climate change adaptation and building resiliency to the impacts of climate change, especially in the agricultural sector, than on mitigating the impacts by addressing and reversing root causes (FAO 2018c). This lack of focus on climate change mitigation is due largely to power dynamics among the countries involved in international conventions. In some countries, including the United States, it is politically sensitive to suggest that global business as usual (in terms of energy extraction and consumption, as well as economic processes more generally) is incompatible with truly sustainable development.[3]

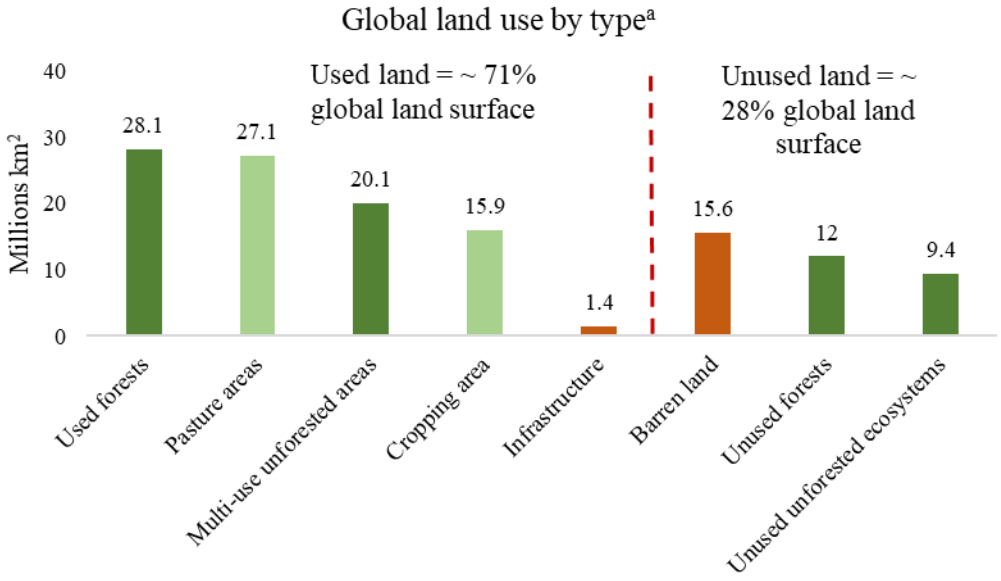
Even in countries more politically accepting of the scientific consensus about the origins of modern climatic change, climate change mitigation actions remain limited by the political difficulties realities of identifying who is disproportionately contributing to greenhouse gas emissions and thus from whom change is required. However, there are some promising moves toward addressing climate change through mitigation efforts at local, national, and global levels. Most prominent are the NDCs to global emissions reductions, agreed upon in principle by member-states of the United Nations Framework Convention on Climate Change (UNFCCC) in 2013 (UNFCCC 2015). Signatories of the 2015 Paris Agreement were required to set emissions targets and commit to their NDCs, and 184 parties to the agreement did so. Of these, almost 150 also signaled an intention to seek international financial support to implement their efforts (Ross and Agostini 2016), highlighting the gap between planned changes and capacity

3. For one recent example, see an open letter signed by 49 sustainable and alternative agriculture organizations to the United States Permanent Representative to the FAO requesting an end to US obstruction of the recent HLPE (2019) report on agroecology: https://nffc.net/statement-in-support-of-the-un-committee-on-world-food-security-agroecology-and-small-scale-food-producers-and-against-us-obstructionism/.

to effect change. NDCs are required to be updated every five years, with the second round due to be submitted in 2020.

As countries prepare to update and state their second NDCs, many international organizations are highlighting the ways that land use and land management, including agricultural production, can contribute to climate change mitigation efforts as well as to broader development goals, including the SDGs (Fransen et al. 2019; FAO 2018b; Ross and Agostini 2016). Figure 1 provides a best-guess estimate of the distribution of global land use by land use type circa 2015 and highlights the role that land used by humans will necessarily play in any land-based climate change mitigation strategies (Arneth et al. 2019).

Figure 1: Distribution of global land use by type, circa 2015



Dark green represents lowest intensity management and highest carbon sinks, light green represents moderate intensity management, orange represents low carbon sink (due to either high intensity or no management)

Source: These numbers are the summary "best guesses" provided by the data reviewed and synthesized in IPCC (2019a, chapter 1). Author's visualization.
Note: Used forests are those managed for timber and other products. Pasture areas are intensively and extensively managed grazing areas. Multiuse unforested areas include grasslands, savannas, and tundras used for gathering wild products, grazing, etc. Cropping area includes all agricultural production (excluding livestock). Infrastructure includes all settlements as well as mining and energy extraction. Barren land includes rock and ice. Unused forests include intact and primary forests. Unused unforested ecosystems include grasslands and wetlands not utilized by people.

Figure 1 demonstrates the extent of opportunities for land-based climate change mitigation activities on currently used lands. For example, just over one-fifth (22 percent) of land globally is composed of used or managed forests—an area roughly the size of Europe and South America combined and equivalent to about 2.5 times the area of unused forests. This situation highlights the need to include forest management as a key climate change mitigation strategy. Figure 1 also

shows that land-based mitigation strategies will be necessary on lands used by people for a variety of livelihood strategies, since over two-thirds of the global land surface is currently used and managed by humans in some way.

CLIMATE CHANGE MITIGATION AND LAND

Climate change mitigation and adaptation strategies cut across diverse sectors, including food systems, water management, energy production and consumption, land use and planning, and more. However, while they are often stated in one breath, mitigation and adaptation are two quite distinct sets of approaches to addressing the changing global climate. Per the IPCC, climate change mitigation (Edenhofer et al. 2014: 37) and climate change adaptation (Field et al. 2014: 40) are defined as follows:

Definitions of climate change mitigation and adaptation

Climate change mitigation: *A human intervention to reduce the sources or enhance the sinks of greenhouse gases*

Climate change adaptation: *The process of adjustment to actual or expected climate and its effects … to moderate or avoid harm or exploit beneficial opportunities*

Much work being done in the development space on climate change adaptation focuses on helping communities that disproportionately bear (or will bear in the future) the brunt of climate change to modify aspects of their food, water, energy, and land use systems to better withstand climate pressures (Grow Africa 2018; Branca et al. 2013). However, as most countries begin to reflect on their second NDCs and how to balance emissions levels with the need to adapt to current climate challenges, there is an increasingly explicit observation that some adaptation strategies could actually increase emissions (Fransen et al. 2019; Smith et al. 2013). Climate change adaptation also raises many important equity and rights questions, including who decides what types of adaptation strategies to adopt and how the financial and time costs associated with adaptive strategies impact access to those strategies for different types of people and communities (Resource Equity and Landesa 2016; Oxfam International 2015; EIA and CIEL 2015).

There is a smaller but growing body of work focused on climate change mitigation strategies and their incorporation into broader development practice (Dooley et al. 2018). Most climate change mitigation strategies rely in some way on land, whether as a site of carbon sinks (forests, soil, peatlands), a location for renewable energy infrastructure, or a location of human activity that can be modified to reduce emissions per unit of production (McGlynn and Chitkara 2018;

Smith et al. 2013). Recent work by international organizations and nongovernmental organizations has cataloged the various land use practices with the potential to contribute to climate change mitigation. The United Nations Convention to Combat Desertification (UNCCD), for example, identifies five broad land use categories and close to 20 types of actions that can be taken to limit or reduce GHG emissions (Sanz et al. 2017). Project Drawdown, a research-oriented nongovernmental organization, provides a set of climate 'solutions' associated with decreased GHG concentrations, as well as estimates of the aggregate impact of each solution through the year 2050 under several adoption scenarios (Project Drawdown 2017). The High Level Panel of Experts (HLPE) on Food Security and Nutrition of the United Nations Committee on World Food Security released a 2019 report on agroecology and other sustainable agriculture practices, focusing on the implications for food security and nutrition and highlighting climate impacts as a secondary outcome (HLPE 2019). Finally, the IPCC special report *Climate Change and Land* includes a focus on the trade-offs and synergies from land-based climate change mitigation strategies for aggregate emissions and human well-being broadly defined (IPCC 2019a).

CLIMATE CHANGE MITIGATION, LAND, FOOD SECURITY, AND EQUITY

Based on the rights-based perspective taken by Oxfam, it is paramount to acknowledge that climate change mitigation activities have the potential for differentiated human impacts (both positive and negative). The concept of equity provides the foundation for assessing these potential impacts, as well as an important starting point for describing how climate change mitigation activities can achieve reductions in GHG concentrations without engendering systems and impacts that perpetuate inequality. Working definitions of inequality and equity (Oxfam International 2019b; Adhikari 2017), two distinct but related concepts in a rights-based frame, are as follows:

Definitions of inequality and equity

Inequality: The uneven distribution of power and resources among people and groups based on divides such as class, religion, age, disability, race, ethnicity, education, geography, gender, and sexual orientation. An inequality lens acknowledges the interconnection between these multiple dimensions of inequality and consistently asks who does and does not have access to power and resources, and why.

Equity: Developing systems and structures that address differentiated vulnerabilities and opportunities by ensuring the tools and processes needed to secure all

individuals' human rights. These tools and processes must reflect an intersectional understanding of histories, needs, and capabilities.

There are immediate and obvious inequality implications of failing to address global climate change. For example, certain individuals, communities, and regions are currently experiencing outsized impacts of rising sea levels, increased temperatures, and changeable and erratic rainfall patterns. This is an unequal distribution of risk and potential harm simply based on geography. Because a changing climate is and will continue to have adverse impacts on many aspects of human health, well-being, and livelihoods, existing inequalities will be further exacerbated by inaction. In this report, we focus on food security (FAO 2018a) as the most tangible form of inequality that will be helped or hindered by different land-based climate change mitigation strategies.

However, mitigation strategies must be assessed not only on the degree to which they reduce inequality in basic risk exposure, but also on the degree to which the systems, structures, and actions taken help or hinder multidimensional equity. There are important equity issues associated with many climate change mitigation strategies, and because land-based mitigation strategies rely on a finite and fundamental resource, equity challenges and opportunities associated with these strategies are especially acute. The research presented in this paper takes an intersectional approach to multidimensional equity, focusing on three types of equity and their points of overlap with food security: gender equity (UNESCO 2003; Oxfam International 2019a), economic equity (Sen 1999; Nussbaum 2011), and climate equity (IPCC 2018).

Certain land-based climate change mitigation strategies could have negative impacts on gender equity and food security. Gender equity would suffer if, for example, the gathering of nontimber forest products, an activity that often contributes to women's livelihoods and health, is no longer allowed in forests designated for conservation (Agarwal 2018). A gender equity lens on a rights-based approach to food was recently framed by Quisumbing et al. (2019) in the IFPRI annual food policy report. This approach moves beyond a food security or a gender mainstreaming frame, which focus primarily on adequate (equal) provision of food and other necessities. Instead, the framework put forth by Quisumbing et al. focuses on ensuring that the benefits and the process through which those benefits are secured are of value to women and strengthen their ability to make future choices in a broad range of domains. In other words, ensuring gender equity means safeguarding women's human rights *and* their ability to decide how to achieve those rights.

Equity issues associated with land-based climate change mitigation strategies

Food security

Food security is conceptualized here to include availability, accessibility, utilization, and stability of safe and nutritious food for all.

Because food is a basic human right, food security is an inequality issue, and achieving food security requires the pursuit of multidimensional equity.

Gender equity

Gender equity is conceptualized here as policies and processes that acknowledge the unique challenges and desires of women, based on their own contexts and histories.

Land-based climate change mitigation strategies that are implemented within existing political and social systems have the potential to perpetuate inequality on the basis of gender in terms of access to and benefits from many types of natural resources.

Economic equity

Economic equity is conceptualized here as policies and processes that ensure that all people have the freedom and are allowed the capabilities to meet their own livelihood needs. This includes ensuring access to natural resources.

Land-based climate change mitigation strategies have the potential to exacerbate economic inequality by marginalizing individuals whose economic livelihoods rely on land uses that are not compatible with mitigation plans.

Climate equity

Climate equity is conceptualized here as policies and processes that acknowledge common but differentiated responsibilities in terms of mitigating past emissions and shouldering the burden of current mitigation activities and transitions to a lower-emissions future.

Land-based climate change mitigation strategies are, by definition, place-based and thus have the potential to impose outsized demands on certain people to engage in mitigation activities and forgo land use and management that could contribute to human development.

Although food security, gender equity, economic equity, and climate equity are each defined in specific terms, the intersectional approach also requires that the impact of one type of inequality be considered on the others. Most often discussed is the potential trade-off between food security and land-based climate change mitigation, in the form of competition for land between agricultural production and mitigation activities like biofuel production, forest management, and afforestation (Landesa 2012). Gender, economic, and climate equity are also concerns associated with some land-based climate change mitigation strategies,

especially those that dictate specific and tightly managed uses of large areas of land (Buck et al. 2019; Obersteiner et al. 2016; Johl and Lador 2012). This report explores two key approaches to operationalizing and directing equity actions in the context of land-based climate change mitigation: climate justice and rights-based land management. Climate justice includes the concepts of per capita emissions and equal atmospheric space, and it asserts that no individual's consumption and emission of GHGs should exceed a level that is sustainable for all individuals in aggregate (Civil Society Equity Review 2018; Yu et al. 2011). It calls for climate fair shares and acknowledges that climate change mitigation activities will impose differential responsibilities and have differential impacts. It also notes the need to facilitate "just transitions" to a low-emissions global economy (Smith 2017; Civil Society Equity Review 2018). Rights-based land management is another approach to addressing equity issues for which there is a small and focused body of work (EIA and CIEL 2015). For example, recent analyses have highlighted the outsized amount of carbon stored in forests managed by indigenous peoples and local communities, as well as describing the tenure arrangements needed to secure their right to manage forest resources for both carbon storage and other purposes, including to support food security (Buck et al. 2019; Frechette et al. 2018).

Equity requires removing barriers as well as building new systems that facilitate the realization of all people's capabilities to live a full life. The global climate models and socioenvironmental scenarios put forth by the IPCC clearly state that adequate climate change mitigation efforts (to keep global warming to below 1.5°C) will require moderate to substantial wide-reaching changes in land use. It is therefore paramount that the global civil society community focused on human rights be prepared to argue for policies, processes, and systems that reduce inequality and protect and enhance equity as outcomes on par with GHG reductions from land-based climate change mitigation strategies. An intersectional approach to equity acknowledges that inequality and oppression are experienced differently depending on a combination of personal and social characteristics (Mason 2016). Thus addressing inequality requires challenging multiple power imbalances at the same time—in other words, taking a systemic and structural approach to analyzing and shifting power dynamics. In the context of climate change, gender, economic, and climate equity are inextricably linked: those individuals and communities who have been historically marginalized on the basis of gender and economic capabilities have the potential to be further marginalized by land-based climate change mitigation activities.

GLOBAL EMPHASIS ON LAND-BASED CLIMATE CHANGE MITIGATION

In late 2018 the IPCC released the first of three special reports[4] commissioned as part of the Sixth Assessment and meant to support ongoing global efforts to anticipate and address the causes and impacts of climate change. The first report focuses on expected impacts of a 1.5°C increase in global temperatures (above preindustrial levels) and broadly explores mitigation possibilities and implications for sustainable development and equity (IPCC 2018). The second report, released in 2019, looks specifically at the role that land and land-based ecosystems play in contributing to and mitigating greenhouse gas fluxes, and at relationships between human land management decisions, climate change mitigation, and human well-being (IPCC 2019a). Both reports summarize the scientific evidence base and then translate those findings to state what the evidence demonstrates and with what level of confidence.[5] Taken together, these reports provide a comprehensive summary of the scientific evidence base surrounding the causes and impacts of current climatic change and the possible pathways toward reducing the severity of future climatic change. Both IPCC reports also highlight the potential of specific approaches to food production to mitigate climate change while enhancing food security and multidimensional equity, and the potential of extensive land-based negative emissions technologies (which seek to remove CO_2 from the atmosphere through terrestrial capture) to threaten food security and other aspects of equity.

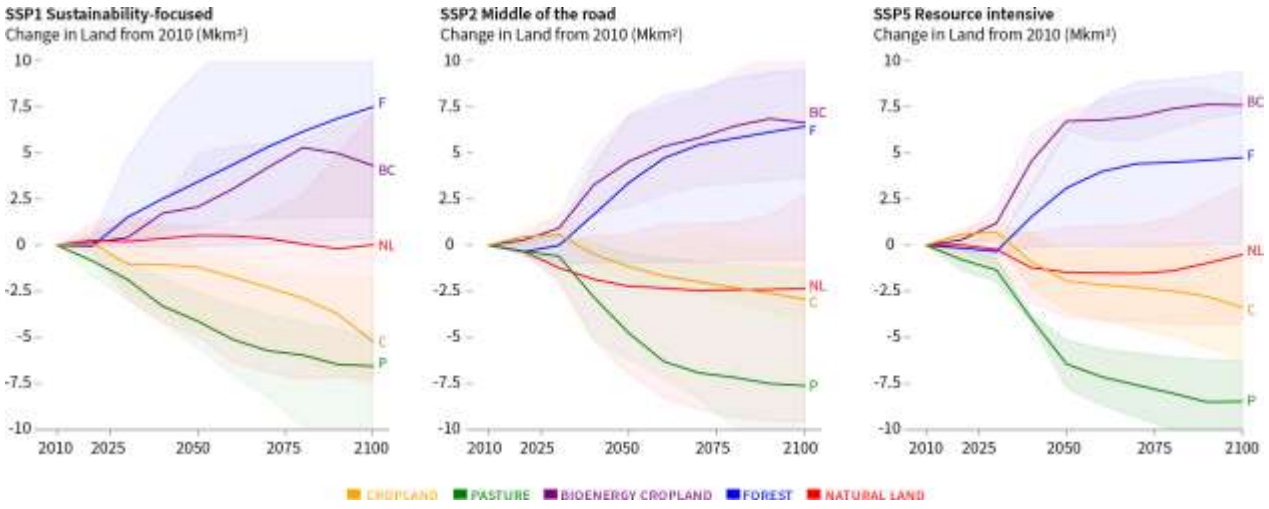
The IPCC reports are the most fundamental articulation of the state of global practice; they both summarize what we know and set the agenda for where global bodies and their member states will focus their climate-related efforts. The first IPCC report states with medium to high confidence that engaging in climate change mitigation efforts that keep global warming to 1.5°C has clear equity implications for populations in vulnerable geographies (coastlines, arid environments), with Africa and Asia having the largest shares of potentially vulnerable people (IPCC 2018, 10). Keeping the average global temperature increase to 1.5°C rather than 2°C will reduce the number of people exposed to climate-related risks by several hundred million by 2050 (IPCC 2018, 9). This single statement and the evidence that underlies it highlight the fundamental relationship between climate change mitigation and many types of equity: those

4. The first report, released in late 2018, was an overview of the impacts of global warming of 1.5°C. The second report focused on climate change and land, and third report focused on oceans. Only the first two reports are discussed here.
5. IPCC reports use a confidence scale to express the strength of conclusions within the evidence base and the agreement across all sources summarized. This scale is as follows: very low, low, medium, high, very high.

individuals, communities, and countries that are currently high emitters have a greater responsibility to cut their emissions to prevent adverse impacts for the individuals most vulnerable to climate risks. The evidence synthesized in the first IPCC report also states with high confidence that current NDCs (as stated in 2015) will not be adequate to limit global warming to 1.5°C; thus current commitments do not adequately address the equity dimensions of climate change (IPCC 2018, 18).

Each individual climate change mitigation strategy, land-based or otherwise, has the potential to generate both synergies and trade-offs in terms of impacts on global temperature increases, contributions to SDGs, and by extension certain aspects of equity, depending on geography and implementation process. For example, the first IPCC report states with high confidence that there are clear and relatively large synergies between land-based mitigation strategies and reduction of global hunger (SDG2; IPCC 2018, 20). At the same time, most future pathways to maintaining 1.5°C of warming require substantial use of negative emissions technologies, many of which could require broad-scale land-use conversion and have associated negative implications for food security, economic equity, and gender equity (Shukla et al. 2019). A summary finding from the IPCC special report *Climate Change and Land*, presented in Figure 2, demonstrates three feasible scenarios that provide pathways to safe levels of global temperature rise (generally defined as less than a 2°C temperature increase over preindustrial levels). All three scenarios, each of which represents a different combination of climate change mitigation actions, require substantial changes in land use for mitigation-specific activities. This means a large increase in forested areas and areas dedicated to bioenergy crops and a substantial decrease in areas dedicated to crops and pastures.

Figure 2: Three feasible pathways to safe levels of global temperature rise (<2°C) and associated changes in land use



Source: Shukla et al. (2019, Figure TS.15).

Land plays a complex role in climate change mitigation and sustainable development, and that is the starting point for the IPCC special report *Climate Change and Land* (Shukla et al. 2019, TS.15). Land is a key site of GHG fluxes (as both source and sink), as well as a foundational and nonfungible input into many aspects of human health and well-being. The IPCC special report *Climate Change and Land* summarizes a focused, detailed evidence base and has the potential to set the policy and practice agenda for land-based climate change mitigation going forward. Some key findings from this report include the following:

- **Globally, land remains a net carbon sink**, largely owing to the natural processes associated with forests, many of which are enhanced by the land-based climate change mitigation strategies of forest management, reforestation, and afforestation.

- Globally, **agricultural production** (including crops, livestock, and forestry) is a **key source of anthropogenic emissions**.

- **Land-based climate change mitigation accounts for roughly one-quarter of the total mitigation contributions** contained within the current (2016–2020) NDCs.

- Expansion of **land-based climate change mitigation strategies based on negative emissions** may increase demand for converting land to forests or bioenergy production and thus could **have negative implications for food security** and other types of equity.

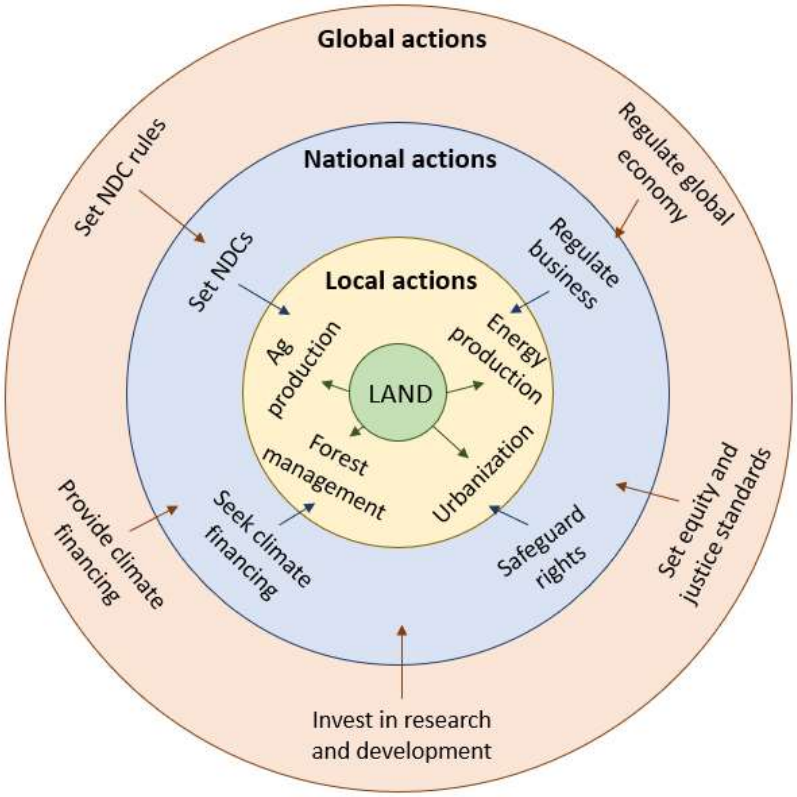
The heavy emphasis on increasing negative emissions through specific types of land-use change in the pathways visualized in Figure 2 suggests a prioritization of climate change mitigation over equity issues in many future scenarios. Thus the high-level take away from the IPCC report, as well as other guidance specifically focused on enhanced NDCs, is a need to invest in land-based mitigation strategies that maintain and enhance the net sink that currently exists in many ecosystems, as well as land-management strategies that decrease net emissions from agricultural production (Fransen et al. 2019). At the same time, the report states with very high confidence that if not implemented appropriately, ramped-up and more stringent strategies for land-based climate change mitigation have the potential to generate severe trade-offs and inequalities in terms of food security, economic equity, and climate equity (Fransen et al. 2019, 45). Land-management strategies can contribute as well to climate change adaptation in agricultural systems, as increased efficiency, decreased reliance on external inputs, and improvements to the natural resource base are all key strategies. The report specifically focuses on sustainable land management strategies as multidimensional sets of practices that can help mitigate climate change through increased carbon capture and decreased emissions, as well as help promote food security, gender equity, and economic equity (IPCC 2019a).

FRAMEWORK LINKING LAND-BASED CLIMATE CHANGE MITIGATION, FOOD SECURITY, AND EQUITY

Although inequality is a key concern for many global organizations, most interventions to protect and enhance equity come from national governments and local institutions. One of the challenges of identifying and analyzing the potential trade-offs and complementarities between land-based climate change mitigation activities, multidimensional equity, and food security and other human rights is the mismatch in scale between actions and impacts. Land itself is a physical, local resource, yet land use is generally legislated by actors and policies at national and global scales. Concrete land use and land management actions take place in particular places, and many of the equity issues associated with those decisions also play out locally. For example, increased forest protection in the Amazon could limit agricultural expansion, which could have negative economic equity impacts on some local farmers, while at the same time advancing climate change mitigation and thereby reducing the risk for those same farmers of vulnerabilities associated with further climate change.

The framework presented in Figure 3 provides a starting point for understanding how policies and processes at different jurisdictional scales influence where and how land-based climate change mitigation strategies are enacted and how impacts are ensured or avoided (similar framing is found in chapter 5 of the IPCC special report *Climate Change and Land;* Mbow et al. 2019, Table 5.6). Overall, contemporary global processes seem to be facilitating climate change mitigation actions. The Paris Agreement and the associated NDCs, as well as the climate finance that is part of the mitigation and adaptation activities associated with the NDCs, have the potential to slow emissions rates (UNFCCC 2015).

Figure 3: Land at the center of local, national, and global actions on climate change mitigation and equity



Source: Author.

The relationships represented in Figure 3 reflect several observations and assumptions. First, global processes are broadly helpful to addressing equality and equity concerns, although most of the emphasis is currently on food security (St-Louis et al. 2018). There are calls for a greater climate equity focus in climate finance, especially in the Green Climate Fund, as well as for a stronger focus on mitigation activities in the agricultural sector that can have co-benefits for economic equity and food security (Johl and Lador 2012). Second, national actions can help or hinder local actions that seek to link climate change mitigation to multidimensional equity. Currently national policies supporting equity are highly variable across the globe, with some countries aligning national policies and investments with climate change mitigation goals as well as an orientation toward just transitions and other types of equity (Smith 2017). As of this writing a few key countries—namely Brazil and the United States—are not engaging with global processes or developing national policies in a way that contributes positively to mitigation or equity goals (Piotrowski 2019). Overall, many policies and processes are in place at multiple levels to address both mitigation and equity concerns but making real advances will require aligning financial resources and political will.

METHODOLOGY

This research used a modified systematic review process to scan both the literature and the data currently available to characterize, predict, and identify relationships among land-based climate change mitigation needs and strategies, food security, and gender, economic, and climate equity.

RESEARCH QUESTIONS

1. What does the evidence base demonstrate are the impacts of current and future land-based climate change mitigation strategies on GHG concentrations, food security, and multidimensional equity?

2. How can multidimensional equity be addressed within the processes and structures mobilized to enact land-based climate change mitigation strategies?

3. Where are land-based climate change mitigation strategies likely to have the most potential to generate synergies and trade-offs across GHG concentrations, food security, and multidimensional equity?

    1. What impacts can we expect in the future, and where can we anticipate these activities happening?

    2. Focus on hotspot: Amazonia

EVIDENCE GATHERING

This research draws on the synthesis provided in the two IPCC reports released in 2018 and 2019 (IPCC 2018, 2019a) and focuses on the gaps left by these and other similar global analyses of the relationships between climate, land use and land management, and multidimensional equity outcomes. Specifically, we used a modified systematic review process to gather relevant recent empirical literature focused on the observed and predicted impacts of land-based climate change mitigation strategies on food security, gender equity, economic equity, and climate equity. The strategies included in this paper are those consistently identified across the literature as the most promising in terms of reductions in GHG concentrations as well as potential synergies with other development goals. We also looked across multiple leading data integration, collation, and

visualization efforts to identify evidence for the current extent and future potential of land-based mitigation strategies.

The information and data-gathering process was conducted in a sequential three-part manner. The first step was to identify and gather the key documents that have been generated and approved by the global community that sets the agenda for climate change action. These include reports and commentary by the IPCC, the UNCCD, the FAO, the World Committee on Food Security, and the IPBES.[6] We focused on summaries that have emerged out of efforts to build global governance for climate change for two reasons. First, these organizations, and their member states and parties, are the entities that have the power to implement climate change mitigation on a global scale (see Figure 3 for the relationships among jurisdictional levels in the context of land-based mitigation). Second, Oxfam America and the Oxfam confederation are active members, observers, and participants in these global conversations, and these are the spaces in which Oxfam has an opportunity to influence both the policies and practice of climate change mitigation.

After gathering and synthesizing the evidence base presented in key global documents, we focused evidence gathering on two additional steps. We identified recent research (both peer-reviewed and programmatic) that specifically documents the impacts of land-based climate change mitigation strategies on food security, and gender, economic, and climate equity. We developed a list of search terms associated with each mitigation strategy and each dimension of equity (see Appendix A) and used them in combination in both open-access search engines (Google and Google Scholar) and proprietary search engines (Web of Science). We defined recent as anything from 2010 onward, and we conducted a separate search of the period 2018–19 to ensure that key findings from recent research were not lost in the search algorithms that prioritize citation numbers and thus privilege work that has been available for longer. This process is considered a modified systematic review because we did not review every paper returned with the above-defined search criteria. Instead, we included in our review those papers with a large number of citations, those supported by global research institutions, and those that cover understudied aspects of climate change mitigation or equity.

The final data-gathering step, after analysis of both the global documents and the literature focused on multidimensional equity, was to identify key sources of data at the global scale that represent or can help visualize where there are needs and opportunities for both land-based climate change mitigation and enhanced equity. These data were identified through a combination of approaches: key articles reviewed during initial analysis referenced some global data efforts, and some of these articles included data sets created by the authors and available for

[6] These documents are the following: IPCC (2019a, references 97 and 98), Sanz et al. (2017), FAO (2018b,c), HLPE (2012, 2013, 2017, 2019), and IPBES (2019).

download. For many other data sources, the author of this report was aware of current research efforts to maximize the impact of remotely sensed data and other types of satellite imagery, and these efforts were the starting point for data gathering and integration. To be clear, the data used in the 'Spatial distribution of land-based climate change mitigation strategies' section of this report do not directly measure equity or climate change mitigation potential. However, they do depict the current extent and locations of biophysical characteristics that are related to the land-based mitigation activities reviewed in Evidence on current and future impacts of land-based climate change mitigation strategies' section of this report.

One key finding of the data-gathering process, which was not a surprise but was important to confirm, is the dearth of data disaggregated on the basis of gender or economic status, especially at resolutions finer than the national scale. This "data deprivation" has been noted in the context of tracking development goals generally (Serajuddin et al. 2015). The IPCC special report *Climate Change and Land* includes many uncertainties in its estimates of the human impacts of climate change mitigation efforts owing to the lack of consistent information on and measurements of multidimensional equity (IPCC 2019a).

ANALYSIS

The three-step process of gathering research evidence and data was conducted in an iterative fashion with analysis, so that each analytical step informed and framed subsequent evidence gathering. After gathering a set of documents (mostly notably those listed above) that reflect the current state of knowledge and discourse in the global community, I systematically analyzed the definitions and framing of land-based climate change mitigation and multidimensional equity, and integrated those into both the framework presented in Figure 3 and the framing of this report presented above. We also looked across these key global documents to identify a set of land-based mitigation strategies that are consistently included in climate models, policy guidelines, financing options, and development strategies. This list, provided at the beginning of the following section, is drawn from the evidence base at the global level and clearly focuses on seven broad strategies of land-based climate change mitigation. The identification of this list then provided a starting point for subsequent evidence-gathering efforts, as described above.

The second phase of analysis, of both the literature and the spatial data, was largely descriptive and comparative and used both quantitative and qualitative techniques. The modified systematic review of research literature that documents the impacts of land-based climate change mitigation on multidimensional equity resulted in an evidence base of key recent literature. However, this evidence

base is highly heterogeneous in terms of the types of data used to measure concepts associated with gender, economic, and climate equity. Many studies are primarily qualitative in nature, while others include partial quantitative measures that are not easily comparable. We therefore applied qualitative thematic analysis to summarize this evidence base not as a numerical average or range, but as a set of common themes that emerged from a systematic review of the literature.

Finally, analysis of the spatial data identified to reflect certain current and future land-based climate change mitigation strategies consisted of visualizing each measure separately and at times combining multiple data sources and measures. These analyses are descriptive and not inferential—in other words, we identify the co-occurrence of certain actions or biophysical realities but do not suggest that there is a causal relationship between them.

EVIDENCE ON CURRENT AND FUTURE IMPACTS OF LAND-BASED CLIMATE CHANGE MITIGATION STRATEGIES

Land-based climate change mitigation, a broad and multidimensional category in the global discourse, includes a wide range of both land use and land management practices. Land use practices associated with negative emissions include increasing forest cover and bioenergy production, with the latter including carbon capture and storage (Anderson and Peters 2016). Land management practices for climate change mitigation include a wide range of approaches to lower GHG emissions from human activities such as agricultural production of all kinds, forestry and forest management, and the extraction of other natural resources including nonrenewable and renewable energy. Given that an estimated 23 percent of current global GHG emissions come from agriculture, forestry, and other land uses, there is a clear opportunity to mitigate climate change by changing land management practices in these sectors (IPCC 2019a).

Drawing on three key global efforts at defining land use as it relates to climate change mitigation (IPCC 2019a; Project Drawdown 2017; Sanz et al. 2017) as well as other related literature, **this report summarizes the evidence base on the current and future impacts and locations associated with seven land-based climate change mitigation strategies**:

1. Bioenergy production
2. Afforestation
3. Reforestation
4. Forest management
5. Agroforestry
6. Soil management
7. Pastureland management

Strategies 1, 5, 6, and 7 are explicitly associated with agricultural production systems and are themselves subsets of the practices reviewed by reports focused on climate change adaptation and mitigation in the context of food security (including HLPE 2019; St-Louis et al. 2018; and Ross and Agostini

2016). All seven of these strategies were selected because they have been consistently identified and discussed across multiple climate change mitigation reports over the past several years and because they all have direct implications, both positive and negative, for food security and multidimensional equity. The box below defines strategies and organizes them by whether they are land use or land management strategies. The distinction between land use and land management strategies is important for the discussion of equity: land use strategies generally require a change from how land is currently being used (and thus the potential to negatively impact current users) while land management strategies generally can be implemented in current land uses and potentially by the current land users.

Definitions of land-based climate change mitigation strategies that are dominant in the global discourse

Land use strategies

Bioenergy production: Production of first-generation biofuels, primarily ethanol from corn, as well as second-generation production of bioenergy using inputs like wood, agricultural residue, and grasses. Bioenergy production with carbon capture and storage (BECCS) captures CO_2 released during the energy conversion process and injects it into geological formations (i.e., underground).

Afforestation: Planting trees on land that has not historically been forested.

Reforestation: Planting trees on land that was historically forested and was cleared or converted to some other land use.

Land management strategies

Forest management: Management of existing forests to, among other things, minimize degradation and restore and maintain forest health.

Agroforestry: Integration of trees into agricultural crop and livestock systems.

Soil management: Active management of soils, primarily in croplands and pasturelands, to restore and increase organic carbon, improve soil fertility, and decrease erosion. Includes the use of biochar as a soil amendment.

Pastureland management: Management of grazing practices on both intensively (>100 animals per km2) and extensively (<100 animals per km2) managed permanent pasturelands to restore and improve ecological health.

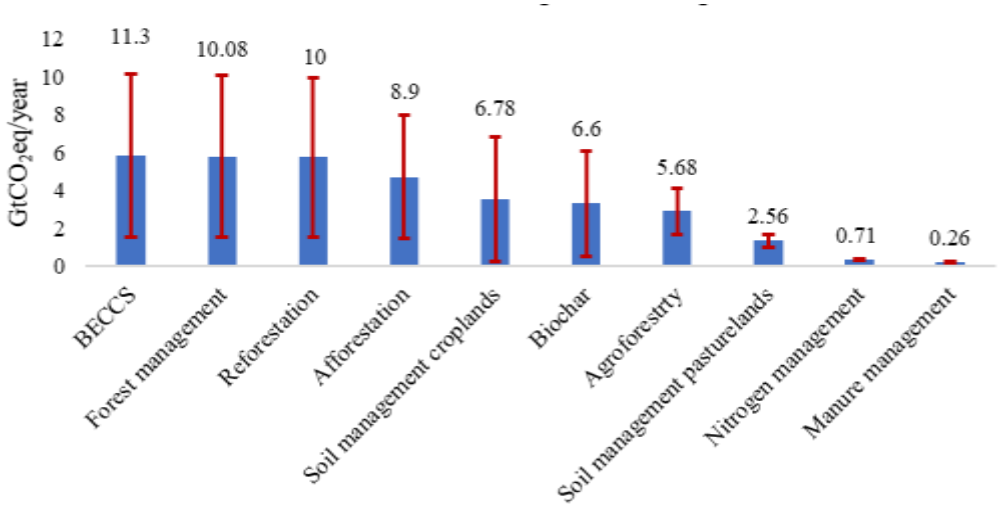
OVERVIEW OF IMPACTS OF LAND-BASED CLIMATE CHANGE MITIGATION STRATEGIES ON GHG CONCENTRATIONS, FOOD SECURITY, AND MULTIDIMENSIONAL EQUITY

The global consensus based on a high-level review of the existing evidence base suggests that large-scale changes to both land use and land management will be necessary to achieve the scientifically identified targets for GHG concentrations and emissions and associated global temperature rise. While balance sheets like those presented in the IPCC reports make sense at a global scale, they are difficult to operationalize and implement at local scales, where land use might shift to being monolithic and focused solely on climate change mitigation. There is also a consensus that there are equally large and challenging equity issues associated with land-based mitigation strategies. As the IPCC report states: "There is high confidence that scenarios with large land requirements for climate change mitigation may not achieve SDGs, such as no poverty, zero hunger and life on land, if competition for land and the need for agricultural intensification are greatly enhanced" (Arneth et al. 2019, 97). All of these scenarios have the potential to diminish food security and multidimensional equity if they generate competition for land and top-down land use laws that limit access to both land and the resources that come from it (Meyfroidt 2018; Hasegawa et al. 2018).

Figure 4 depicts the IPCC summary of the evidence base on potential mitigation impacts of each of the land-based climate change mitigation strategies listed in the box above (as well as a few others) (Shukla et al. 2019, Figure TS.5). The figure highlights the relative contributions of negative emissions strategies (a maximum total mitigation impact of roughly 36.8 $GtCO_2eq$/year when biochar is included) and land management strategies (a maximum total mitigation impact of roughly 26.07 $GtCO_2eq$/year). These estimates are similar to other efforts to quantify the total impacts of natural (land-based) climate solutions (estimated to provide 23.8 $GtCO_2eq$/year of mitigation impact) (Griscom et al. 2017). Although these estimates include an extremely wide range of data points and high degrees of uncertainty, taken together they provide a starting point for considering the potential relative contribution of different land-based climate change mitigation strategies and categories of strategies.[7]

7. For reference, estimated total global GHG emissions in 2018 were 35 GtCO2eq/year (Le Quéré et al. 2018).

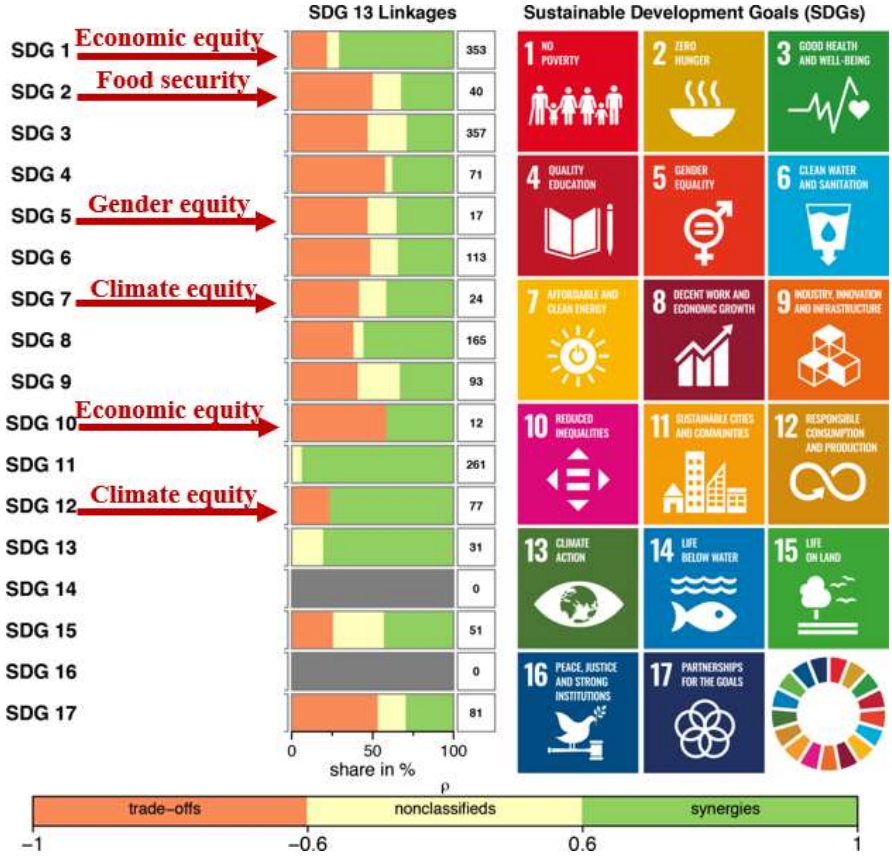
Figure 4. Estimated average and total range of GHG emissions offsets and decreases of land-based climate change mitigation strategies



Source: Numerical estimates from the IPCC synthesis of the evidence base on mitigation options from 2020 to 2050 (Shukla et al. 2019). Author's visualization of numerical estimates.
Note: Blue bars represent the middle value between lowest and highest estimates. Red bars represent the full range of estimates, with highest estimates labeled at the top.

Figure 5 shows the ways that the gender, economic, and climate equity implications of land use shifts are tightly intertwined. Designating land for use solely for climate change mitigation has the potential to greatly decrease access and thus exacerbate current gender and economic inequalities. In many land management and land use systems, gender equity in access to land and other natural resources is already a challenge and intersects with economic equity in locations where land tenure more broadly is not secured. For example, recent work by Oxfam International in Colombia documents how women in rural areas are working to maintain their right and access to land in the face of highly unequal landownership and a lack of civil institutions to enforce basic land tenure rights (San Pedro 2019). Climate equity is also an ongoing challenge in land-based climate change mitigation and could be further undermined if monetary payments from changes in land use are not shared with those living in close proximity to that land and whose livelihoods might need to change to maintain land use. Land-based climate change mitigation can also worsen climate equity by creating stranded assets (such as uncultivated land or trees that can't be cut down), as well as by expecting outsized contributions and impacts from mitigation in certain places where forests are most appropriate ecologically (Rautner et al. 2016). Changes in land use and increased conversion of land to negative emissions technologies will decrease the overall area available for agricultural production and will likely reduce food security if investments are not also made in sustainable intensification and agroecological approaches (Mbow et al. 2019; HLPE 2019).

Figure 5: Trade-offs between SDG 13 (climate action) and SDGs associated with multidimensional equity



Source: Adapted from Mbow et al. (2019, Figure 5.16).

Figure 5 provides further evidence of some of the equity impacts of land-based climate change mitigation strategies and highlights the challenging nature of measuring gender, economic, and climate equity. Adapted from the IPCC special report *Climate Change and Land*, Figure 5 is itself an adaptation of work done by Pradhan et al. (2017), who worked to operationalize and analyze the existing evidence on the complementarities and trade-offs associated with pairs of SDGs. SDG13 (climate action) and the SDGs associated with food security, gender equity, economic equity, and climate equity show both strong potential synergies and strong potential trade-offs, depending on the specific metric of each goal. The aggregation across many metrics and units of analysis makes it difficult to identify the specific mechanisms through which actions taken within SDG13 could negatively impact another SDG. However, the analysis originally presented in Pradhan et al. points to the strong possibility of trade-offs and harms that could come from certain approaches to climate action, as well as the potential for large co-benefits and improvements in current inequalities. Doelman et al. (2019) focus specifically on the trade-offs between SDG2 and SDG13 and find a need for increased intensification of agricultural production to offset the impacts of large-

scale land-based climate change mitigation strategies, suggesting a path forward for balancing potential trade-offs through further changes in land management. Similarly, Agarwal (2018) highlights the potential trade-offs on all sides that come from not adequately addressing gender equity (SDG5) in efforts to address climate action and conservation goals.

IMPACTS OF LAND-BASED CLIMATE CHANGE MITIGATION STRATEGIES ON GHG CONCENTRATIONS, FOOD SECURITY, AND MULTIDIMENSIONAL EQUITY BY PRACTICE

This section summarizes the evidence base on the impacts of the land-based climate change mitigation strategies listed in the previous subsection on GHG concentrations, food security, and multidimensional equity.

Observed and potential impacts of bioenergy production

Bioenergy production features prominently in most of the ambitious climate change mitigation pathways described in the recent IPCC reports (IPCC 2018, 2019a). This bioenergy is not corn- or sugarcane-based ethanol, an approach to biofuel production that has been largely championed by only two countries—Brazil and the United States—although there is an increasing production footprint in Europe as well (USDOE 2019; Naylor and Higgins 2018; Rulli et al. 2016). Instead, most global climate scenarios and NDCs that reference bioenergy focus on second-generation biofuels, including agricultural production and residue, forest products (woody biomass), and cellulosic materials like grasses (Boysen et al. 2016; Tilman et al. 2009). While early estimates of the net positive impacts of bioenergy production on climate change mitigation were optimistic, most assessments of the overall impact of bioenergy production and use now account for both the direct impacts associated with consuming bioenergy with carbon capture and storage (BECCS) and the indirect impacts of land-use change necessary to product sufficient quantities of bioenergy to replace fossil fuels (Dooley et al. 2018; Creutzig et al. 2015; Tonini et al. 2012). The evidence base summarized in the IPCC report highlights the large gap between the potential impacts of BECCS and the actual implementation of the technology, which has not yet been achieved (IPCC 2019a).

Other studies have assessed the feasibility of BECCS and have found that in the United States, for example, the maximum feasible contribution of BECCS to climate change mitigation is 0.09 $GtCO_2eq$/year (Baik et al. 2018), roughly 1.5 percent of the IPCC's median estimate of global annual impact of BECCS (see Figure 4 and Table 1). Fajardy and MacDowell (2018) sum up one of the trade-

offs associated with using bioenergy for climate change mitigation: the approaches and their overall impacts are “heavily dependent on which service provided by BECCS is most valued: carbon dioxide removal or power generation.” In addition, when the full ecological implications of bioenergy production are considered, there is the potential for indirect negative impacts on ecosystem health, which can further impact long-term mitigation opportunities at the landscape scale (Montanarella et al. 2018). For example, increased harvest of woody biomass from forests as bioenergy stock can decrease water availability because of the need for constant regrowth as well as increase loss of biodiversity through land conversion.

Strong and precise critiques of the equity implications of BECCS highlight the fact that as a practice it undermines the responsibility borne by those who currently consume more than their fair share of fossil fuels and will not be required to scale back if climate change mitigation strategies focus on technological solutions rather than ecosystem- and rights-based land management strategies (Smolker 2019). Van der Horst and Vermeyle (2011, 2435) summarize the main challenge to improving multidimensional equity in bioenergy production: “The significant levels of government funding for biofuels stand in strong contrast to the problematic environmental and social governance of international biofuels supply chains.” Increased demand for land for biofuel production has undermined access to food globally as land is converted from food crops to energy crops, food production decreases, and food prices increase (Naylor and Higgins 2018; Tirado et al. 2010; Ewing and Msangi 2009). At the same time, some authors have found that bioenergy production can improve economic equity when producers are able to access new markets that pay a higher premium for bioenergy crops than for food crops (Naylor and Higgins 2018; Gamborg et al. 2012). A growing concern associated with bioenergy production is the “foreignization of land” and the related phenomenon of large-scale land acquisitions (IPCC 2019a; Renzaho et al. 2017; HLPE 2013). Shifts in landownership and land tenure rights away from local diversified use and toward monocropping undermines all types of equity, especially gender equity, because women are already less likely to have secure land rights.

There is far less evidence on the actual equity impacts of BECCS than of biofuel production, because only a handful of large-scale operations are currently being implemented. However, the potential equity implications are similar to those observed with the production of crops for biofuel and biodiesel. Changes in land management for bioenergy production would largely draw from current grasslands and pasturelands, with economic equity implications for individuals and communities that currently use those lands for their livelihoods (IPCC 2019a). Converting degraded and marginal lands to bioenergy production can undermine gender and economic equity because these lands are often used by vulnerable individuals and households who do not have access to higher-quality agricultural lands (HLPE 2013; Montanarella et al. 2018). There is also potential

for synergy between BECCS and economic equity if forest plantations explicitly managed for bioenergy production provide economic opportunities to those individuals who own and manage them, and especially if land tenure rights are included in governance structures (Montanarella et al. 2018; Boysen et al. 2016).

Observed and potential impacts of afforestation and reforestation

Afforestation and reforestation, two key negative-emissions approaches to land-based climate change mitigation, are usually lumped together in empirical and predictive assessments of their impacts on GHG emissions. The role of forests in climate pathways like those discussed in Figure 2 highlights the types of trade-offs engendered by investing in negative emissions. In terms of mitigation impacts, IPCC estimates (IPCC 2018, 2019a) and others highlight the huge mitigation potential that comes from expanding tree cover (Nave et al. 2019), primarily owing to the carbon capture associated with above- and belowground biomass (Lewis et al. 2019). There are some ambiguous aspects of forest expansion and climate change mitigation, mostly related to the local and regional impacts of land cover change and the biogeochemical cycles associated with it (Kreidenweis et al. 2016). Overall, however, there is a strong scientific consensus that tree cover expansion will enhance the net GHG sink provided by land (Yosef et al. 2018; Nave et al. 2018; Lu et al. 2018). Notably, many of the empirical and predictive studies of the climate change mitigation impacts of tree cover expansion focus on reforestation of areas that were forested in the recent past (50–75 years or less). Studies of afforestation have found that when afforestation occurs on lands currently used for crops or pasture, it has a smaller impact on carbon capture in soils than when afforestation occurs on degraded or abandoned lands, since currently used lands are likely to be more intensely managed in ways that increase soil carbon (Liu et al. 2018; Lal 2018).

Afforestation has been highlighted as having the most negative impact on all aspects of equity owing to the need to appropriate land already in other uses and convert it to permanent forest cover (Peña-Lévano et al. 2019; IPCC 2018; Rose and Sohngen 2011). However, if afforestation occurs primarily on lands that are not currently used to meet human needs, these equity issues are greatly reduced and the relative potential for climate change mitigation impact is maximized (Silva et al. 2019). In contrast, reforestation most often occurs in areas with other kinds of current human land use, which might have led to deforestation in the first place (see Figure 6). Making decisions about where and how to convert land back into forest cover brings up many of the equity implications of land use change associated with negative emissions (Hawes 2018; Pascual et al. 2014; Le et al. 2012).

The IPCC report states with high confidence that reforestation and forest expansion will necessarily compete with existing land uses and thus have the potential to decrease food security and to worsen gender and economic equity by

limiting access to land and by increasing pressure on other natural resources (Arneth et al. 2019). At the same time, there is substantial evidence that the ecosystem services provided by reforestation can increase adaptive capacity and thus decrease local communities' vulnerability to the impacts of climate change (Locatelli et al. 2015). These ecosystem services can also have a positive impact on food security through overall improvements to ecosystem health (Meyfroidt 2018; Smith et al. 2013). And in the context of carbon markets and associated development approaches to incentivizing climate change mitigation activities, reforestation can generate monetary benefits for individuals charged with restoration and maintenance, thereby increasing economic equity and climate equity through payments for the ecosystem services generated (Goldstein 2014; Paterson and Bryan 2012; Beddoe 2010). Notably, some studies also highlight the two-way street between securing equity and ensuring mitigation impacts. For example, Legesse et al. (2018) found that secure land rights—one aspect of economic equity—are necessary to ensure the mitigation impacts of forest and land restoration. In contrast, an example of carbon forestry projects in Mexico that focused on farmer priorities for tree species provided economic benefits (through faster time to harvest) at the expense of long-term carbon capture (Pascual et al. 2014; Torres et al. 2010).

Observed and potential impacts of forest management

The summary finding of the IPCC special report *Climate Change and Land*—that land overall continues to be a net carbon sink globally—is due in large part to the fact there remains substantial forest cover globally, and the majority of these forests are used and managed to meet human needs (see Figure 1; IPCC 2019a). Forest management is a necessary starting point for land-based climate change mitigation, as substantial biomass is stored above- and belowground in existing forests, and keeping this carbon in place is an important component of all mitigation scenarios (Erb et al. 2018). Many climate models and verification efforts have been made to better understand the climate change mitigation impacts of wood harvest and have concluded that improved forest management can provide a balance between long-term climate change mitigation and human use (Yan 2018; Law et al. 2018; Pingoud et al. 2018; Houghton and Nassikas 2018; Noormets et al. 2015). Forest management consists of reducing deforestation, restoring degraded conditions, and improving wood-harvest timing and practices. The mitigation impacts depend in part on what happens to the removed biomass. In many NDCs the contribution of forest management is focused on reducing deforestation rates relative to a comparison period (often 1990–2010) (Grassi et al. 2017). However, recent advances in some private carbon markets have begun to explore how to reward forest management that uses improved harvesting practices to maximize carbon sequestration.

Forest management for climate change mitigation reduces forest conversion and degradation, restoring and improving carbon capture as well as overall forest

health. Healthy forests have the potential to contribute to a wide range of types of equity, through the provision of ecosystem services that can enhance food security and provide opportunities for economic equity (HLPE 2017; Vira et al. 2015; Pimentel et al. 1997). Developing and ensuring tenure and rights frameworks that preserve access to healthy forests support gender and climate equity by ensuring that multifunctionality is preserved (Essougong et al. 2019; Frechette et al. 2016). Equally important are findings that forests managed by individuals and communities with formal or informal rights to manage, use, and make decisions about how the forest is used generate the most co-benefits across all categories of climate change mitigation and multidimensional equity (Frechette et al. 2016; Frechette et al. 2018; Seymour et al. 2014).

The Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism was established by the UNFCCC to provide incentives and compensation at both the national and local level for forest protection for climate change mitigation. A substantial body of work assesses the positive and negative outcomes of REDD+ projects on gender and economic equity, as well as on climate equity insofar as forests could become stranded assets. One recent summary concluded that overall REDD+ projects have harmed gender equity, largely because measures to safeguard women's rights to land and natural resources have not been adequately implemented (Larson et al. 2018; Tyagi and Das 2017). Other studies have found more ambiguous outcomes, depending on context, and have specifically noted that some REDD+ projects that provide a path to securing tenure rights have enhanced gender and economic equity (Kane et al. 2018). In both REDD+ projects and other community-based and collective forest management efforts, the research strongly demonstrates that gender equity must be predicated on strengthening and safeguarding women's tenure rights and other rights associated with access to land and natural resources (Resource Equity and Landesa 2016; Colfer and Minarchek 2013). Strengthening tenure rights has complementary impacts on climate equity as well, by reducing the potential that people will bear burdens associated with forest management for climate change mitigation purposes without being compensated.

Most studies focused on equity in forest management assess distribution of money and decision-making power, and the resulting impacts differ depending on context (Friedman et al. 2018). Economic and climate equity can be substantially enhanced through community-based forest management that balances long-term carbon storage with economic opportunities for wood products. In some places, recent inclusion of forest management in carbon markets provides an additional opportunity to enhance economic equity through payments for ecosystem services (van Kooten 2018; Hajjar and Oldekop 2018). Van der Gaast et al. (2018) summarize the limited evidence base from forestry-related projects within the Clean Development Mechanism and conclude that improvements in carbon accounting are making carbon credits for forest management increasingly viable for required and voluntary markets. Similar findings from the United States

highlight the potential synergies between climate change mitigation and economic equity in forest management (Kelly and Schmitz 2016). However, other research suggests that there is still too much uncertainty in carbon accounting in forest management to adequately value the potential contributions of forest management to climate change mitigation efforts, thus limiting the potential for economic and climate equity for communities that manage and maintain existing forests (Klapwijk et al. 2018; Grassi et al. 2017).

Observed and potential impacts of agroforestry

As a land-based climate change mitigation practice, agroforestry bridges the negative emissions and forest management approaches summarized above and the agricultural land management practices highlighted in agroecological and sustainable land management principles (IPCC 2019a; HLPE 2019; Sanz et al. 2017). The climate change mitigation benefits per tree are similar to those estimated for reforestation and forest management, since trees incorporated into agricultural production systems are being planted and maintained in multiuse croplands and pasturelands, which means that soil organic carbon is already higher than on barren lands (see Figure 9 below). However, recent evidence suggests that within cropping and pastureland systems, agroforestry systems can sequester 10–20 percent more soil carbon than those lands without trees, and that agroforestry has the potential to sequester up to 5.3GtCO_2eq/year (Shin et al. 2018; Ramos et al. 2018). Branca et al. (2013) also highlight the consistent finding in the evidence base of the additional contribution of aboveground biomass provided by agroforestry.

The synergies between agroforestry and multidimensional equity are clear and consistent and often rely on a key aspect of economic equity: land tenure and land rights. It has long been recognized that without secure rights to access and use land, producers are substantially less likely to invest in trees because they have no assurance of reaping the long-term benefits that trees provide (Unruh 2008; Fortmann 1985). More recent studies have identified significant differences in the adoption of agroforestry and other integrated agricultural practices based on the type of land tenure held (Curry et al. 2019; Nkomoki et al. 2018). Because agroforestry is an approach to land management that increases overall diversity on the landscape, many of the climate equity benefits come from increased adaptive capacity and reduced vulnerability to climate change (Schoeneberger et al. 2017; Pandey et al. 2015). Other studies, however, have highlighted challenges similar to those noted in the forest management literature, including that the mitigation burden on producers to maintain agroforestry systems might be valued in the current carbon market systems in ways that offset yield decreases (Middendorp et al. 2018).

On the food security side, a systematic review of the evidence base conducted by Ota et al. (2018) found a consistent positive relationship between agroforestry

and food security. These impacts come largely from the co-benefits to soil and water quality of incorporating tree cover into cropping and rotational systems (Adidja et al. 2019; Kaczan et al. 2013). Because of the yield and productivity increases associated with agroforestry systems, most studies also find positive relationships between agroforestry and economic equity as income sources are diversified (Adidja et al. 2019). Furthermore, Ota et al. (2018) highlight the potential for contributing to gender equity given that agroforestry requires relatively little technology or access to land to achieve positive impacts.

Observed and potential impacts of soil management in croplands

Soil management in croplands for climate change mitigation encompasses a wide range of techniques, and the evidence base associated with their observed and potential impacts is similarly varied. Sustainable management of croplands for carbon sequestration includes reducing disturbances from tillage and conversion, managing fertilizer inputs to minimize nitrous oxide emissions, and increasing carbon sequestration potential by restoring soil health through appropriate tillage and increased use of cover crops (Lal 2018; UCS 2017; Branca et al. 2013). Lal (2018) estimates that the aggregate biophysical potential of soils to sequester carbon is roughly 10 percent of current annual emissions. Through root growth and minimal decomposition, cover crops, for example, could sequester one-twelfth of the total emissions from agricultural production if cultivated on 25 percent of global croplands (IPCC 2019b). Improved use of synthetic and organic fertilizers could greatly decrease nitrous oxide emissions and provide indirect mitigation benefits as well as decreasing demand for fertilizer production (Grewer et al. 2018). The net emissions from some soil management practices must be considered when assessing their mitigation potential. For example, industrial agricultural systems plant cover crops with tractors, which generate GHG emissions through fuel consumption that offsets the carbon capture potential of the crops themselves. A similar issue arises with the use of high-tech precision agriculture for fertilizer management, which generates emissions through tractor use as well as by relying on computing infrastructure.

Many agricultural development projects focus on improved and sustainable land management practices to enhance food security and climate equity (through adaptive capacity) without explicitly considering the co-benefits for climate change mitigation (Palm et al. 2010; Garrity et al. 2010). For example, Woolf et al. (2018) found that sustainable land management projects focused on restoring and improving soil health for food security had unintended synergies with climate change mitigation impacts. Branca et al. (2013) note that sustainable land management practices are often adopted as sets of practices (so that soil management, water management, and agroforestry might all be adopted together, for example) because this approach has a greater impact on food security. In such cases the mitigation impacts of these sets of practices also

stand to be greater than just the soil management portion of the overall change in land management.

The equity implications of soil health management for climate change mitigation are generally positive. For example, low-tech precision agriculture, which improves fertilizer management without the use of computers or tractors, can address some economic and gender equity issues associated with lack of access to capital for costly inputs. Soil management on croplands also generally improves food security by increasing productivity and food availability, as well as by improving economic equity and thus food access. Soil health management still requires the use of both synthetic and organic fertilizers, depending on the setting, to ensure synergies rather than trade-offs with multiple aspects of equity. Prescribing only organic management will limit economic and climate equity by decreasing overall productivity potential and increasing the mitigation burden as well as threatening food security for farmers in low-carbon soil settings and in degraded areas (HLPE 2019). A recent paper by Zhang et al. (2019) on the under-conceptualized links between gender and soil health argues that gendered management decisions and values will impact the potential climate change mitigation and equity impacts of soil health management. Soil health management has the potential to contribute positively to climate equity as well by increasing adaptive capacity and decreasing vulnerability to climate-related impacts (UCS 2017).

Observed and potential impacts of pastureland management

Management of pasture as a land-based climate change mitigation strategy includes a variety of practices, including reduced stocking rates and improved grazing practices to restore and increase vegetative cover and decrease soil erosion, as well as manure management to improve soil health and decrease emissions (DeLonge and Basche 2018; Lal et al. 2018). As shown in Figure 1, potential and actual pasturelands cover a substantial portion of the Earth's surface that is used by people, and thus sustainable land management practices on these lands have the potential for large climate impacts owing to the potential extent of implementation (O'Mara 2012). On the grazing practices side, Gerber et al. (2013) estimate that improved grazing and cultivation of legumes in some grassland areas could reduce emissions by 0.53 $GtCO_2eq$/year through increased carbon sequestration. Improved grazing practices that allow for revegetation, like rotational grazing, have the potential to generate climate change mitigation co-benefits by increasing carbon sequestration and allowing for smaller herd sizes that maximize production efficiency (Byrnes et al. 2018; FAO 2017). Gerber et al. (2013) estimate the impacts of current improved pastureland management practices and conclude that if all producers in a given location adopted the practices of the top 10 percent most efficient producers in that location, overall emissions from the sector could decrease by 30 percent. Other syntheses suggest more efficient livestock production rather than

increased extensification, to reduce the need to convert more land to livestock production, as well as reallocation of livestock production to areas of the world better suited to sustain it (Havlik et al. 2014; Godde et al. 2018).

Sustainable management of pasturelands has the potential to improve food security and economic equity in multiple ways. Improved livestock production practices that limit the pressure to convert cropland to grazing land or feed production have synergies with enhanced availability of cropland and thus food production—hence the large estimated impacts presented in Table 1 (Havlik et al. 2014). However, the livestock sector is an important case in which equitable transitions are challenging to discuss (Mbow et al. 2019). As Golub et al. (2013, 20894) note, “Ruminant meat producers face the greatest market adjustments to land-based climate policies” because the potential climate change mitigation impact of improving production practices is much smaller than other sustainable land management strategies. Thus, there is potential for negative impacts on economic equity if livestock production shifts away from regions with higher per-animal emissions (Golub et al. 2013; Havlik et al. 2014).

A global emphasis on decreased meat consumption has clear negative impacts on food security as well as implications for economic and climate equity, given that current consumption rates and thus responsibilities vary widely according to economic status and geography. In addition, meat plays an important role in ensuring food and nutrition security in many parts of the world, especially for women and children (Reynolds et al. 2015; O’Mara 2012). At the same time, sustainable pastureland management can contribute positively to climate equity by making both productivity and grazing ecosystem health less vulnerable to the impacts of climate change (DeLonge and Basche 2018). Finally, gender equity in pastureland management is an understudied area, in part because of the gender bias in livestock production. However, in communities that rely on rangelands and livestock for their livelihoods, the economic equity impacts, positive and negative, of improved pastureland management will have indirect gender equity impacts as well (Wangui 2014).

COMPARATIVE SUMMARY OF THE EVIDENCE BASE

Table 1 presents a summary of the evidence base synthesized in the sections above. The colors represent the positive (green), neutral or varied (blue), and negative (brown) relationships observed and predicted between each of the seven land-based climate change mitigation strategies, food security, and multidimensional equity (gender equity, economic equity, and climate equity). There is a conceptual interest in equity impacts but little systematic review outside of impacts on food availability as one aspect of food security.

Table 1: Comparative evidence base of impacts on GHG emissions and multidimensional equity of land-based climate change mitigation strategies

Land-based climate change mitigation strategies	GHG emissions[a] ($GtCO_2eq$/ year)	Food security (People)	Gender equity (People)	Economic equity (People)	Climate equity (People)
Bioenergy (BECCS)	5.85 (0.4–11.3)	-150 million			
Afforestation	4.7 (0.5–8.9)	-100 million[b]			25 million[b]
Reforestation	5.75 (1.5–10)				
Forest management (avoided degradation and deforestation, active management)	5.78 (1.48–10.08)	100 million			25 million
Agroforestry	2.90 (0.11–5.68)	1.3 billion			2.3 billion
Soil management in croplands (tillage, cover, and fertilizer)	3.885 (0.28–7.49)	60–225 million			3.2 billion
Pasture management (soils and manure)	1.58 (0.33–2.82)	1 billion			1–25 million

Source: Author

Note: Dark green = highly positive impact; green = somewhat positive impact; light blue = neutral or indirect impact; brown = negative impact. Minus sign indicates the number of individuals estimated to potentially be harmed by the strategy.

[a] Median estimate (range of estimates).

[b] Pooled estimate for afforestation and reforestation activities

Table 1 highlights the overall challenge of balancing ambitious land-based climate change mitigation with multidimensional equity. As presented in Figure 2, most IPCC scenarios and projections include large investments in negative emissions strategies, primarily BECCS and expanded forest area (through afforestation and reforestation). However, as Figure 5 and Table 1 demonstrate, these strategies have large trade-offs and potential negative impacts on all aspects of equity. At the same time, Table 1 highlights the observed and potential opportunities to mitigate climate change and enhance food security and multidimensional equity by using sustainable land management and low-external-input principles associated with agroecology.

It should be noted that most of the estimates for impacts on food security and adaptive capacity have low confidence. Most of the estimates of climate impacts have medium or high confidence. Furthermore, the unit of analysis for all IPCC reports is the entire globe, and thus regional and local variations in the strength and direction of relationships are lost when aggregating the evidence base at such a high level. Taken together, these numbers should not be used to downscale and estimate the impact of land-based climate change mitigation strategies in any specific location. The number should only be used to look across the set of strategies and to compare relative positive and negative impacts within and among strategies.

POTENTIAL FOR AGROECOLOGY TO CONTRIBUTE TO CLIMATE CHANGE MITIGATION, FOOD SECURITY, AND MULTIDIMENSIONAL EQUITY

Given that 23 percent of current global GHG emissions come from agriculture, forestry, and other land uses, there is a clear need to shift production and management practices in many of these systems to decrease overall emissions. In the run-up to the 2020 NDCs, several key global institutions have explored sustainable land management for climate change mitigation in the context of agricultural production (Fransen et al. 2019; FAO 2018b; Ross and Agostini 2016). One clear and consistent message is that many current agricultural and forestland management practices are not sustainable or compatible with climate change mitigation goals into the future. In a separate and complementary effort, the HLPE released a 2019 report exploring the potential for improving food security through agricultural production practices that are socially equitable and ecologically viable (HLPE 2019). The report focuses on agroecology as a set of practices and an approach to food production whose core principles include limiting external inputs and recycling nutrients and biomass, as well as ensuring equity in decision-making and access to resources (HLPE 2019, 41). The ecological principles for agroecological production described in the HLPE report are similar to the sustainable land management principles for agricultural production described in other recent reports associated with the Paris Agreement (St-Louis et al. 2018; Sanz et al. 2017).

What sets the HLPE report apart from most of the other high-level global documents is an explicit identification of social equity principles as foundational to agroecological practice (HLPE 2019). The authors make the case that the agroecological approach has an awareness of the human power dynamics shaping agricultural production systems. It takes a transformational approach to addressing both ecological and social challenges to agricultural production, using multidimensional equity as a means to achieve food security and reduce inequality. In contrast, sustainable intensification is power agnostic at best. It identifies food security as the ultimate goal and does not address many of the negative side effects of the means used to achieve food security. Both the recent HLPE report and past work by the Oxfam GROW campaign underscore the need for a variety of agricultural production practices and approaches in the context of climate change and highlight the lack of a one-size-fits-all solution to climate change mitigation within agricultural production (Wegner and Zwart 2011; Castillo 2014).

A key contribution of the HLPE report is to highlight the need to look across a multidimensional evidence base to understand the broad impacts of any land-based climate change mitigation activity. If one wishes to balance only emissions and food security, the evidence base suggests that agroecological and

sustainable intensification approaches can achieve those goals equally well (HLPE 2019; Wegner and Zwart 2011). However, in places where there are strong concerns about gender or economic equity, drawing on the full set of agroecological principles might provide an opportunity to limit the potential negative impacts of shifts in agricultural production associated with climate change mitigation. Findings like these can help guide national investments in specific activities tied to both NDCs and SDGs, as well as local programming and projects oriented toward building equitable outcomes in agricultural production without contributing negative climate impacts. They also make explicit the equity implications of investments in agricultural production for both climate change adaptation and mitigation, investments that have been increasingly emphasized through mechanisms like the Koronivia Joint Work on Agriculture.[8]

What is lost in global syntheses and summary statements is the nuance and variation that comes from zooming into specific places and specific practices. Global summaries also flatten the structural and hierarchical elements of decision-making and implementation of climate change mitigation and the implications for multidimensional equity. The first IPCC report does put a certain definition of equity at its core: “Equity has procedural and distributive dimensions and requires fairness in burden sharing both between generations and between and within nations.… The Paris Agreement associates the principle of equity with the broader goals of poverty eradication and sustainable development” (IPCC 2018, 31).

There is a more specific recognition in the IPCC documents and elsewhere that because land is a finite resource, there is competition for it, and unequal and unjust power dynamics mean that disadvantaged groups usually lose access to land and its contributions to human health and well-being (HLPE 2019; Montanarella et al. 2018). Borras and Franco (2018) explore the theoretical challenges of applying rights-based and social justice perspectives to land-based climate change mitigation activities. They note the potential contradictions between climate justice, with a focus on addressing imbalances and overall vulnerabilities to climate change impacts, and agrarian justice, which seeks to address gender and economic inequities in terms of access to land and the ability to earn an agricultural livelihood (which could exacerbate climate change). Goldstein and Yates (2014) make a related argument, highlighting the complex nature of land as both a foundation for human existence (and thus implicitly a basic human right) and a commodity in the context of contemporary approaches to addressing challenges of human development and climate change. In plain language, these theoretical arguments have at their core questions about whether land can be the foundation of multidimensional equity (as would be the case if access to and control of a certain amount of it is seen as a basic human

8. See St-Louis et al. (2018) for an overview of the Koronivia Joint Work on Agriculture (KJWA), which created a commitment to fully integrating agricultural production and food security considerations into the international climate agenda. Oxfam International is an observer to the UNFCCC and submitted a statement to the 2018 KJWA session (see FAO 2018b).

right) or whether land must be a site of compromise among, for example, potentially competing goals of food security versus climate equity.

Many civil society organizations, alternative food systems actors, climate activists, and others have begun to operationalize a set of frameworks that can directly engage with the global climate agenda on these terms, by clarifying the role that land plays in the pursuit of multidimensional equity (for example, see Dooley et al. 2018). One key commonality across frameworks is the notion of limits to use, and the nonfungibility of the material contributions land makes to human well-being. Borras and Franco (2018, 1318) note, “Land-oriented climate change mitigation and adaptation initiatives [should be] anchored on the twin principles of ‘maximum land size’ (size ceiling) and guaranteed minimum land access (size floor) that in turn frame land redistribution, recognition and restitution.” In this section, we review two key approaches for maintaining and enhancing multidimensional equity in land-based climate change mitigation activities: rights-based land management and climate justice.

Rights-based land management

Rights-based land management, as an approach and a set of principles, has emerged from civil society organizations concerned that the global focus on land-based climate change mitigation may threaten the rights of both humans and the natural world (EIA and CIEL 2015; Raworth 2017; Dooley et al. 2018; Montanarella et al. 2018). The key principles reflect concepts associated with human rights and the rights of nature more generally, as well as the specific multidimensional character of land as the foundation of ecosystems, a primary input into many aspects of human health and well-being, and a commodity valued and defined by global and national markets. These principles cut across those emphasized in the climate justice framing of equity in climate change mitigation, and the points of overlap strengthen the converging consensus that rights are an essential aspect of equitable climate change mitigation.

Principles of rights-based land management in climate change mitigation

Human rights associated with:

Economic equity: tenure rights and land access must be strengthened and protected.

Scope of ambition: the mitigation burden must be distributed across sectors, and the limits of land-based climate change mitigation and its trade-offs must be recognized.

Right to food: this must include control of natural resources that provide the foundation of food production and self-determination in production and consumption decisions.

Social foundation of planetary boundaries: aggregate emissions targets must ensure a per capita emissions allocation that allows all people to meet their basic needs.

Nonfungibility of industrial and terrestrial emissions: there are differential responsibilities depending on the source of emissions.

Rights of nature associated with:

Planetary boundaries: commitments to avoiding overshoot must be made across scales and across sectors.

Biodiversity conservation: species extinction must be limited.

Rights-based land management specifically highlights the role that indigenous peoples and local communities play in effective and equitable land-based climate change mitigation and adaptation, as well as the role of women, youth, and minorities. The various empirical and synthesis reviews of the impacts of indigenous, local, and customary land rights holders on many measures of climate change mitigation and conservation demonstrate the huge, positive impact their management has on ecological health (Frechette et al. 2018; Dooley et al. 2018; Montanarella et al. 2018). The evidence is clear and strong that securing local people's rights to own, manage, and use forests, pasturelands, and croplands improves impacts of many land-based mitigation strategies on both mitigation and equity. Recognition of the fundamental nature of rights in the context of land tenure and land management is also codified in FAO guidelines for "responsible governance of tenure" (FAO 2012) and more recent implementation guidelines by Grow Africa (2018) and the OECD and FAO (2018). Broadening the focus to include not only formal rights to land title (ownership) but also land tenure, which includes both formal policies and informal customs and norms, underscores the positive equity implications of moving away from viewing land only as an individual private good (Goldstein 2014).

To address specific concerns about the impacts of land-based climate change mitigation strategies on food security, there are myriad recommendations for action that can be broadly categorized as taking a rights-based approach to food.

Clearly articulated almost a decade ago by de Schutter (2010), a rights-based approach to food dovetails with rights-based land management in recognizing the non-substitutability of land for food production (Harper et al. 2018; EIA and CIEL 2015). Rights-based approaches to addressing equity in food systems, like agroecology, food sovereignty, and gender-sensitive agriculture, put the human right to land and its products at the core. As detailed earlier in this report, the practice of agroecology includes not only production decisions but also commitments to social and economic equity within the food system. Food sovereignty overlaps with agroecology in a commitment to self-determination and control of the means of agricultural production and has evolved to provide a consistent critique of market-oriented environmental management and social development (HLPE 2019; Dooley et al. 2018). More recently, the rights-based approach to food articulated within the United Nations framework has adopted much of the framing of food sovereignty, most prominently with the adoption of a resolution by the Human Rights Council on the rights of peasants and other people working in rural areas (United Nations General Assembly 2018).

The UN General Assembly declaration on the rights of peasants includes an explicit focus on the differentiated impacts and limitations people experience in exercising the right to food, including access to land and inputs, economic inequalities that motivate labor migration, and gender dynamics that make women especially vulnerable. Guidelines on gender-sensitive agricultural development and climate change adaptation exist within the UNFCCC, the FAO, and other global governance organizations and generally focus on gender-disaggregated programming and monitoring. Civil society organizations more explicitly link gender with the rights-based approach to food, focusing on the impact that securing women's rights can have both on food production and on broader shifts in power and decision-making (Landesa 2012; FOLU 2019).

Climate justice

Climate justice, the outcome of climate equity, is a multidimensional concept that intersects with food security as well as gender and economic equity. In short, because land-based climate change mitigation strategies use land, a nonfungible and place-based resource that is foundational to many basic human rights, climate justice is a useful framing to evaluate their impacts precisely because it includes and integrates many overlapping equity concerns.

One high-profile aspect of climate justice, which has both equality and equity components, is the need to address differential vulnerability to climate change. Climate justice calls for a review of climate finance, in terms of both overall values and the focus of investments (FAO 2018c; Oxfam International 2018). The evidence base suggests that overall commitments to climate finance associated with achieving NDCs are overreported, and Oxfam International (2018) found that the accounting mechanisms used to report climate financing lead to lower-

than-reported net investments and to relatively small contributions of financing from countries with the largest carbon footprints. The investments are insufficient to address the scope of the climate problem and thus perpetuate the injustice of inequitable exposure to climate risks. Similarly, Wong (2016) reviews literature on the gender equity impacts of certain land-based climate change mitigation and adaption strategies supported by climate finance and concludes that equity has not been achieved, largely because of a lack of emphasis on facilitating women's access to land and capital.

Another aspect of climate equity that can be addressed by climate justice is the differential responsibility for mitigation based on differential GHG emissions from consumption. Concepts of climate fair shares and equal atmospheric space suggest that demand-side changes should be led by individuals, communities, and countries that generate a higher proportion of carbon emissions.[9] The concept of nonfungibility of terrestrial and industrial mitigation, made explicit in the principles of rights-based land management, reflects this climate justice concern (EIA and CIEL 2015). For example, one of the important and consistent summary points identified in the evidence base is that land-based climate change mitigation strategies focused on forest-based carbon capture will have diminishing returns over time, owing to saturation, and thus cannot replace durable emissions reductions (IPCC 2018, 42). Oxfam International (2015) has framed differential responsibility as one aspect of "extreme carbon inequality." The underlying message is twofold: climate equity requires both enforcement of upper limits (not dissimilar to planetary boundaries) and maintenance of a social floor to ensure that responsibilities for climate change mitigation are not regressive (Raworth 2017). Empirically, Fujimori et al. (2019) provide an economic calculation of the potential negative trade-offs between climate change mitigation and food security and conclude that there are multiple relatively low-cost opportunities to operationalize the concept of differential responsibility through international aid, bioenergy taxes, and reallocation of income. However, relying on cash transfers and foreign aid to bolster food security has already been shown to have mixed results (Hjelm 2016). From an equity perspective cash transfers do not address the root causes of poverty and vulnerability (Hickey and Seekings 2020).

Finally, and perhaps most germane to this report, climate justice framings can be used to address the differential mitigation burden of land-based climate change mitigation. For example, Oxfam and others have developed the concept of stranded assets as it relates to fossil fuels, and the potential limits on countries' ability to realize the value of fossil fuel assets in the context of ambitious decarbonization associated with the global climate agenda (Caney 2016). A similar conceptualization of the potential climate injustices associated with land-based climate change mitigation highlights the ambiguous nature of changes in

9. Oxfam is a signatory to this review: Civil Society Equity Review (2018).

land management and land use to achieve mitigation. The concept of stranded assets here refers both to a stranding that could occur if climate change continues unabated (thus making a case for investing in mitigation) and to the stranding of assets that are committed (often by national governments) to the mitigation cause, thus limiting their use (usually by local communities) for other, carbon-emitting purposes (Rautner et al. 2016). A further dimension of the climate justice impacts of land-based mitigation are the co-benefits associated with afforestation, reforestation, and soil carbon management, which often increase food production and in turn food availability (Caldecott et al. 2015).

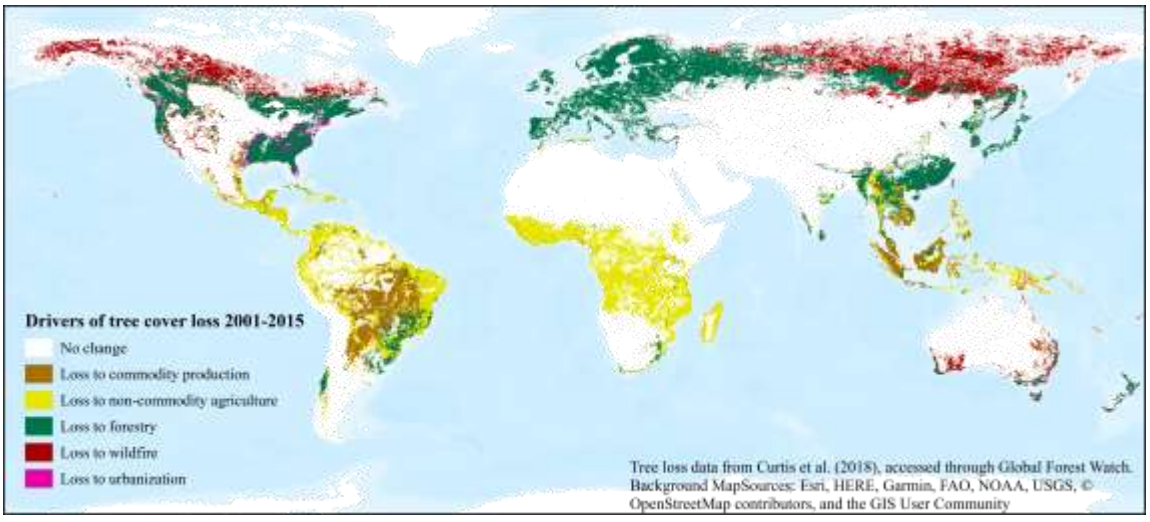
One of the most complicated aspects of the differential mitigation burden is the reality that although some countries' geography is most appropriate and effective for land-based mitigation strategies, these countries might not be well positioned to take on the burden associated with realizing that mitigation potential. Kreidenweis et al. (2016), for example, highlight the biogeochemical feedbacks associated with afforestation: increased forest cover decreases albedo and thus increases surface temperatures as more heat is absorbed. They note that to balance these heating impacts with changes in food production, afforestation should be focused in tropical regions, primarily South America and Southeast Asia, where albedo is already low. Similarly, Frank et al. (2017) find that land-rich countries with lower population densities in the tropical regions have the potential to greatly contribute to climate change mitigation while minimizing impacts on national food security. However, the biophysical realities of efficient land-based mitigation do not consider the relative burden placed on residents of least developed countries where mitigation might be most promising. The concept of just transitions reflects these and related climate justice observations associated with the mitigation burden and emphasizes the need to link economic equity (via production and labor opportunities) to mitigation strategies (Smith 2017).

SPATIAL DISTRIBUTION OF LAND-BASED CLIMATE CHANGE MITIGATION STRATEGIES

Land is a tangible, nonfungible resource, and the actual actions and impacts associated with land-based climate change mitigation strategies occur at local scales. Furthermore, the dynamics between needs, capabilities, inequalities, and opportunities that are summarized in Table 1 are highly variable across space and over time, and summary tables like Table 1 are both a useful starting point and an insufficient basis on which to make programming and policy decisions that impact specific people in specific locations.

This section draws on the wealth of spatially explicit data and information that is currently available and continually increasing in specificity and content. The data are presented in maps that are meant to be easily compared, and they provide a starting point for future regional (national or subcontinental) analyses that could overlay multiple land-based climate change mitigation needs and opportunities with dimensions of equity to identify areas of opportunities and trade-offs. As noted in the 'Methodology' section, there is a dearth of both conceptual measures and empirical data to measure many dimensions of equity. Instead, the interpretation of the maps in this section draws on the summary presented in Table 1, as well as the evidence base detailed in the previous section, to highlight the implications for multidimensional equity of the extent and distribution of land-based climate change mitigation strategies.

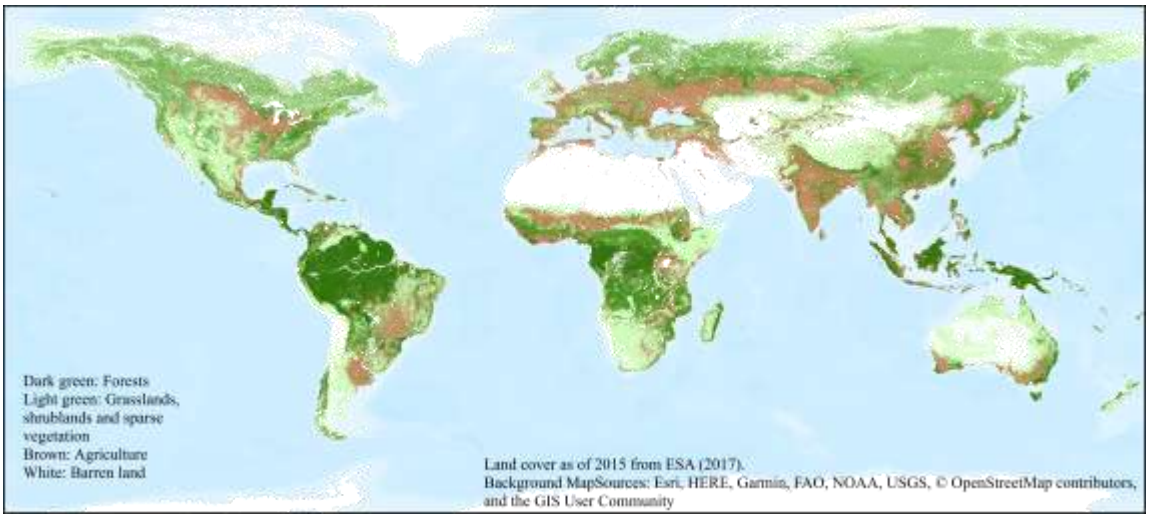
Figure 6: Drivers of tree cover loss, 2001–2015



Source: Curtis et al. (2018).

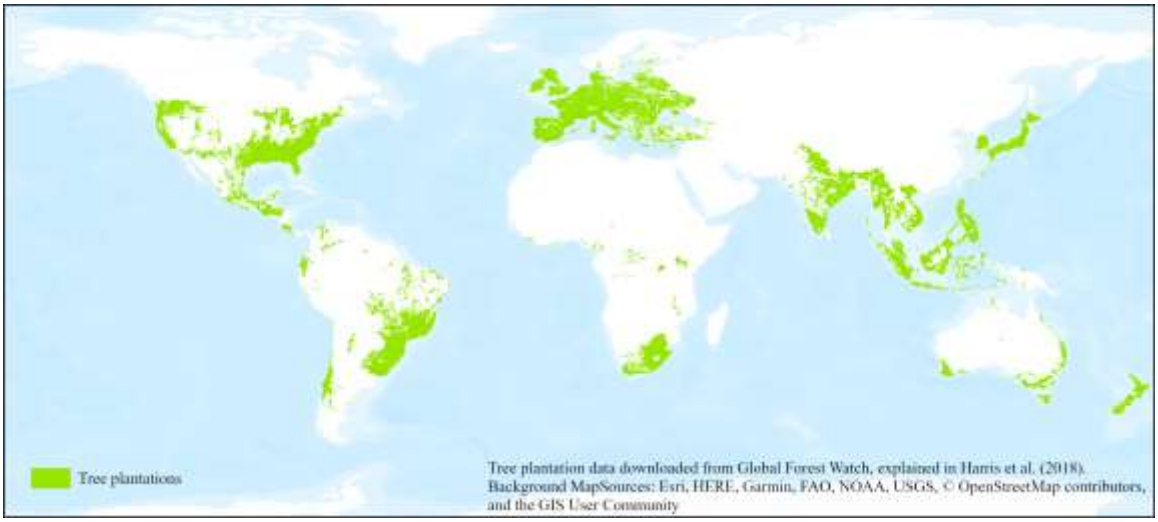
Figure 6 depicts the key drivers of tree cover loss globally in the period 2001–2015 (Curtis et al. 2018). The mutually exclusive categories of drivers are commodity production (including agricultural commodities, mining, and energy extraction), noncommodity agriculture (smallholder and shifting agriculture, meaning land is converted from forest to cropland for a period of time and often revegetated later), forestry (meaning active management of forests for timber and other wood products), wildfire (meaning there is no human intention to use the burned land), and urbanization. Figure 6 demonstrates that in certain key areas of the globe, primarily the southern Amazon basin and southern Southeast Asia, tree cover loss has been driven by commodity production. This is likely due to the expansion of palm oil, soy, and sugarcane cultivation, all of which usually reflect a persistent land use change. Climate change mitigation through reforestation on these lands will require addressing the structural inequalities associated with commodity production (primarily economic inequality, as the means of production are usually concentrated) and could contribute to economic and climate equity if commodity production ceases and land use patterns return to either forestry or agriculture (Sen 2017). In contrast, tree cover lost to agriculture and forestry is often regained over time as land management patterns shift, and as a result accounting for the net GHG emissions from these lands is challenging.

Figure 7: Global land cover, 2015



Source: ESA (2017).

Figure 8: Global tree plantations, circa 2015



Source: Harris et al. (2018).

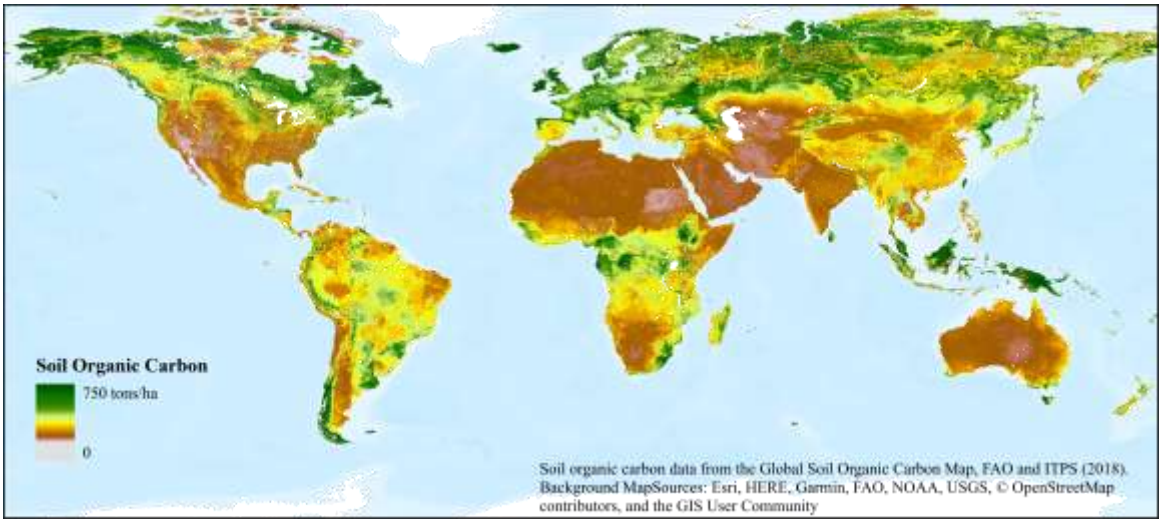
Figure 7 depicts a simplified categorization of land cover in 2015 (ESA 2017), differentiating between forests (dark and medium green), grasslands and shrublands (light green), agricultural lands (brown), and barren land (white). The map visualizes one of the key details associated with the overarching finding from the IPCC special report *Climate Change and Land* that land remains a carbon sink: there is "robust evidence and high agreement that a net loss of forest and tree cover prevails in the tropics and a net gain, mainly of secondary, semi-natural and planted forests, in the temperate and boreal zones" (Arneth et al. 2019, 88). The conversion of forests to nonforested lands is most evident in southeastern South America and much of South and Southeast Asia, and combining Figure 7 with Figure 6 highlights the coincidence of commodity production and permanent deforestation (Sen 2017).

Figure 8 depicts most known tree plantations, including planted forests (for timber and other wood products) and agricultural trees (the data set represents 82 percent of total planted trees globally) (Harris et al. 2018). As noted in the previous section of this report, managing and reforesting lands previously under forest cover for multiple uses are two land-based climate change mitigation strategies that have the potential to not only increase carbon capture but also improve multidimensional equity. For example, community-based forest management that balances long-term carbon storage with economic opportunities for wood products can substantially enhance both economic and climate equity (Friedman et al. 2018).

Taken together, Figure 6, Figure 7, and Figure 8 highlight the potential for variable impacts from negative emissions land-based climate change mitigation strategies, including reforestation, afforestation, and forest management. For example, well-managed tree plantations have the potential to deliver many co-benefits for economic and climate equity if their carbon value can be quantified. At the same time, tree plantations in areas where forest loss has been

associated with commodity production are likely to generate negative impacts for all aspects of equity, owing to the lack of commitment to human rights in much commodity production (Sen 2017).

Figure 9: Global rates of soil organic carbon, 0–30 cm



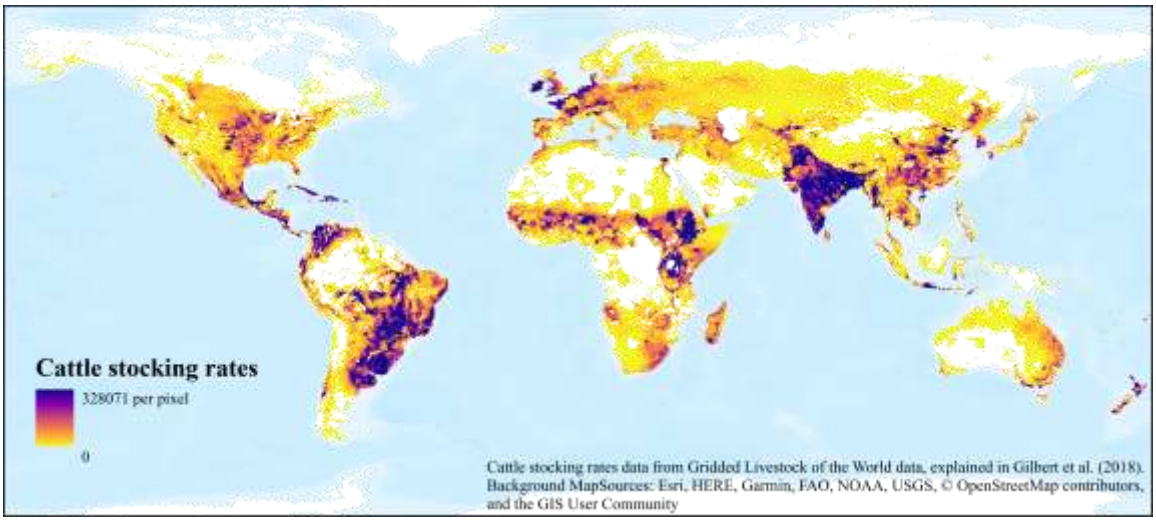
Source: FAO and ITPS (2018).

Figure 9 presents the global distribution of soil organic carbon in the top 30 cm of soil and highlights the vast range of current and future carbon sequestration potential in soils. The data presented in this map are the result of the FAO's long-standing efforts to harmonize and integrate soil health monitoring and reporting at the global scale, both for carbon accounting and to provide guidance to countries and regions on the types of investments needed in soil health (FAO and ITPS 2018).

Figure 9 highlights the need for two important types of land-based climate change mitigation activities. First, in areas of medium and high soil organic carbon, there is a need to maintain stocks through appropriate land management techniques in agriculture, grasslands, and forests, which include minimizing soil disturbance. These types of land management activities have synergies with food security and climate equity because they reduce vulnerability and increase adaptive capacity (see Table 1). Maintaining soil carbon stocks also means avoiding land conversion, especially from forest to agriculture or other land uses that are more likely to decrease such stocks. Locking up existing carbon stocks in forest soils has the potential to undermine multidimensional equity, but at the same time, many variations on agricultural practices can both maintain soil carbon stocks and contribute positively to food security and economic equity. For example, a recent review of long fallow swidden agricultural practices in Southeast Asia, a region with high soil carbon stocks, shows that a shift from swidden to intensified agriculture has substantial negative impacts on both soil carbon and livelihoods (Dressler et al. 2017). Second, in areas of low soil organic

carbon, especially those shown in Figure 6 to have lost tree cover owing to commodity production, there is an opportunity for land-based climate change mitigation strategies that could increase carbon sequestration in soils and vegetation through reforestation, soil health management in croplands, and pastureland management activities, while also improving food security.

Figure 10: Global cattle stocking rates, circa 2015

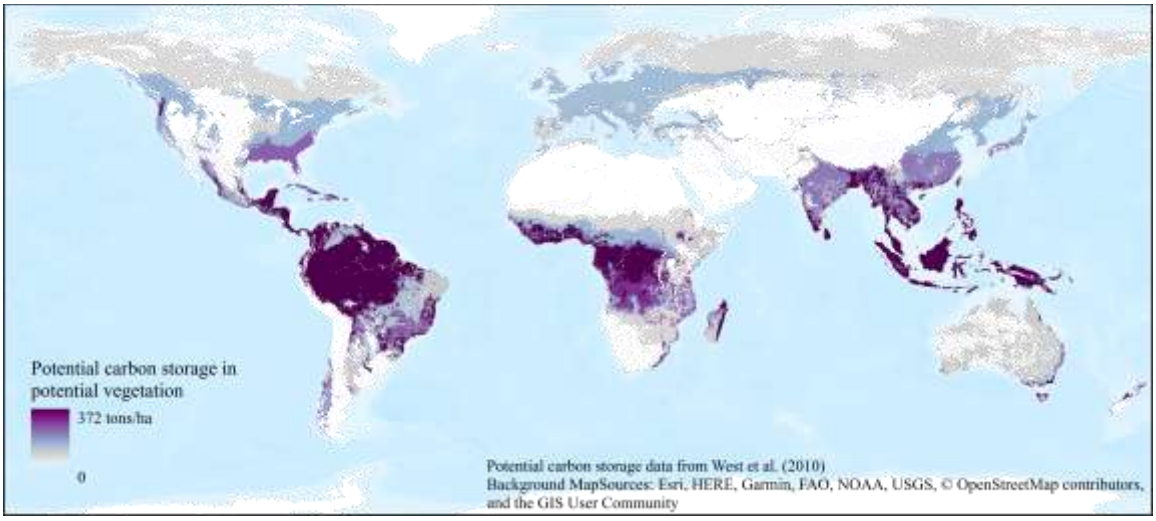


Source: Gilbert et al. (2018).

Figure 10 depicts average cattle stocking rates globally, with a range of 0 to 32 per hectare (Gilbert et al. 2018). While stocking rates depicted in this way, as simply the number of cattle per unit area, are an inappropriate final measure of production intensity, they are a useful starting point when considering the overall sustainable management of pasturelands (Vertès et al. 2019). The data in Figure 10 are the most spatially explicit representation of the current use of pasturelands, and the map highlights a few key points about opportunities and challenges for pastureland management to contribute to land-based climate change mitigation and multidimensional equity. The first is a point detailed in the previous section of this report: just transitions from livestock-dependent livelihood and food production systems to systems focused on other types of agricultural production and land use will unduly affect individuals and communities in certain parts of the world, including much of eastern South America, parts of East Africa, and the Indian subcontinent (Golub et al. 2013; Havlik et al. 2014). Cattle stocking rates are extremely high in these regions, highlighting the current role that cattle play in economic systems there and pointing to a synergistic opportunity for land-based climate change mitigation, food security, and economic equity (see Table 1). If stocking rates were reduced to be more in line with the long-term carrying capacity of healthy pasturelands and soils, carbon could be captured through changing land management practices (Herrero and Thornton 2013). Economic equity could be enhanced through decreased costs associated with external inputs, primarily cattle feed, and food security could be

enhanced through decreased production of animal feed and increased primary food production on those lands.

Figure 11: Potential carbon storage in global vegetative cover



Source: West et al. (2010).

Figure 11 depicts one estimate of the potential for carbon storage if lands currently under a variety of land uses and land management strategies were managed to maximize their vegetative potential (West et al. 2010). The findings from the research that generated these data reinforce several key findings of the evidence base summarized earlier in this report. First, carbon loss in tropical regions when natural land is converted to cropland are twice as great as carbon loss in temperate regions, and crop yields in tropical regions are less than half of those in temperate regions. Second, as shown in Figure 11, the potential for carbon capture and sequestration in biomass is one to three times greater in many parts of the tropics than in the temperate zones. West et al. (2010) conclude that the findings demonstrate the need for land sparing in the tropics and an emphasis both on negative emissions approaches to land-based climate change mitigation and on sustainable land management strategies on forests and pasturelands.

These recommendations maximize the clear mitigation benefits of carbon storage via vegetative cover, depicted in Figure 11, and also raise potential economic and climate equity issues, given that individuals and communities in the tropics are not adequately compensated for the value that maintaining vegetative cover on their lands provides to the global community. This is especially the case in the Amazon Basin, much of Southeast Asia, and some parts of Central Africa. The observation that the high potential for carbon storage often coincides with indigenous and traditionally managed lands has led to efforts to document the value of the carbon currently managed on these lands (Frechette et al. 2016). The results suggest that indigenous and traditionally

managed lands store an outsize proportion of carbon and that these land tenure arrangements, when secure, also support multidimensional equity by addressing historic power imbalances that limited access to land and natural resources (Frechette et al. 2018).

LOCALIZED AND SYSTEMIC OPPORTUNITIES FOR WORKING TOWARD ZERO HUNGER AND ZERO EMISSIONS

The synthesis of the evidence base summarized in this report provides a clear path forward for Oxfam programming that seeks to leverage land-based climate change mitigation strategies to achieve zero hunger and zero emissions.

PLACE-BASED AND LOCALIZED EFFORTS

1. **Maintain and whenever possible enhance land as a net carbon sink.**

    - **Action**: Manage and improve existing forests in ways that are sustainable and community driven

        - ***Key activities***: Secure formal and informal land tenure rights; secure national commitments to respect human rights, including traditional access to land.

    - **Action**: Maintain access to forest products (both timber and nontimber) while improving the overall health of those forests.

        - ***Key activities***: Engage with carbon markets to maximize benefits for local communities.

      Equity outcomes: This will contribute to increased carbon capture, climate equity, and economic equity through the distribution of the benefits of forest management, which can indirectly contribute to food security and gender equity.

- **Action**: Maintain and enhance soil health through reduced tillage, increased cover crops, and improved grazing land management.

    - ***Key activities***: Transfer knowledge and technology; identify strategies that are context-appropriate and feasible (in terms of cost and labor).

  Equity outcomes: This will contribute to both increased carbon capture and increased food security through greater input efficiency and productivity and decreasing erosion, which can indirectly contribute to economic equity.

2. **Reduce net GHG emissions from agricultural production in ways that increase efficiency and productivity.**

    - **Action**: Improve pastureland and soil health management to decrease the need for external inputs like animal feed and synthetic fertilizer.

        - ***Key activities***: Improve grazing and cropping practices like rotation and diversification; secure formal and informal land tenure rights to incentivize long-term investments by producers.

      Equity outcomes: This will contribute to both decreased GHG emissions and increased food security through greater input efficiency and productivity, which can indirectly contribute to economic equity.

    - **Action**: Invest in integrated agricultural systems that include agroforestry and diversification of production practices.

        - ***Key activities***: Transfer knowledge and build capacity, drawing on agroecological and sustainable land management principles as appropriate.

      Equity outcomes: This will contribute not only to increased carbon capture but also to increased food security and gender equity, which can indirectly contribute to economic equity.

SYSTEMIC CHANGE

3. Highlight the need for enhanced ambition regarding GHG reductions, food security, and equity in the 2020 NDC process and in land-based development projects.

- **Action**: Advocate for multilevel engagement in the planning process to ensure that equity issues are not overlooked and especially that climate equity opportunities are maximized.
    - ***Key activities***: Ensure that national commitments are adequate in the aggregate and that they are distributed appropriately to ensure equitable mitigation burdens.

  Equity outcomes: This will contribute to both decreased net GHG emissions and to climate equity by ensuring differentiated responsibilities for mitigation and decreasing long-term vulnerability, which can indirectly contribute to food security and economic and gender equity.

- **Action**: Identify actions that can be supported with national, international, private sector, and nongovernmental resources that can achieve multiple SDGs simultaneously.
    - ***Key activities***: Engage with and monitor emerging and expanding markets for ecosystem services and carbon for practices associated with land-based climate change mitigation, food security, and equity.[10]

  Equity outcomes: This will contribute to climate equity and food security by maximizing investments in mitigation and adaptation activities, which will indirectly contribute to economic equity.

10. Efforts like the recently launched Ecosystem Services Market Consortium (focused on payments for agricultural soil health management) and the well-established REDD+ program.

4. **Advocate for investments in land-based climate change mitigation to directly consider multidimensional equity and to prioritize projects and processes that consider synergies and trade-offs in context.**

    - **Action:** Monitor climate finance portfolios, and engage in synergistic efforts like the Koronivia Joint Work on Agriculture.

        - ***Key activities***: Participate consistently in regional and national multistakeholder discussions, and exercise vigilance in identifying the sources of climate finance for projects in specific countries of interest.

      Equity outcomes: This will contribute to climate equity and economic equity by holding countries that bear an outsized responsibility for GHG emissions accountable for their climate finance commitments, which could indirectly impact food security.

    - **Action:** Scale up and communicate the impacts of rights-based land management approaches taken by Oxfam and its partners.

        - ***Key activities***: Advocate for land tenure and land rights processes within countries, bringing an intersectional lens to the issue of whose rights matter and ensuring that the NDC processes include multiple stakeholders and extend across sectors.

      Equity outcomes: This will contribute to all aspects of climate change mitigation and multidimensional equity by facilitating positive impacts of forest management and agroforestry and minimizing negative equity outcomes in afforestation, reforestation, and bioenergy production.

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APPENDIX A: LITERATURE REVIEW SEARCH TERMS

Land-based climate change mitigation strategies	Climate outcomes	Food security outcomes	Gender equity outcomes	Economic equity outcomes	Climate equity outcomes
Agroforestry	Greenhouse gas emission reduction	Food availability	Women's empowerment	Supply chain consolidation	Equal atmospheric space
Soil health management	Carbon capture	Food production	Women's empowerment in agriculture index (WEIA)	Input market consolidation	Stranded assets
Integrated soil fertility management	Carbon sequestration	Yield	Youth empowerment	Market access	Per capita emissions
Rangeland management		Food access	Gender equity	Producer protections	Rights-based land management
Grazing practices		Food prices	Gender justice	Worker rights	
Bioenergy production		Food stability		Rights-based land management	
Biofuel production		Food sovereignty		Self-determination	
Forest management				Economic autonomy	
Reforestation					
Afforestation					

APPENDIX B: FOCUS ON LAND-BASED CLIMATE CHANGE MITIGATION AND IMPLICATIONS FOR EQUITY IN THE AMAZON BASIN

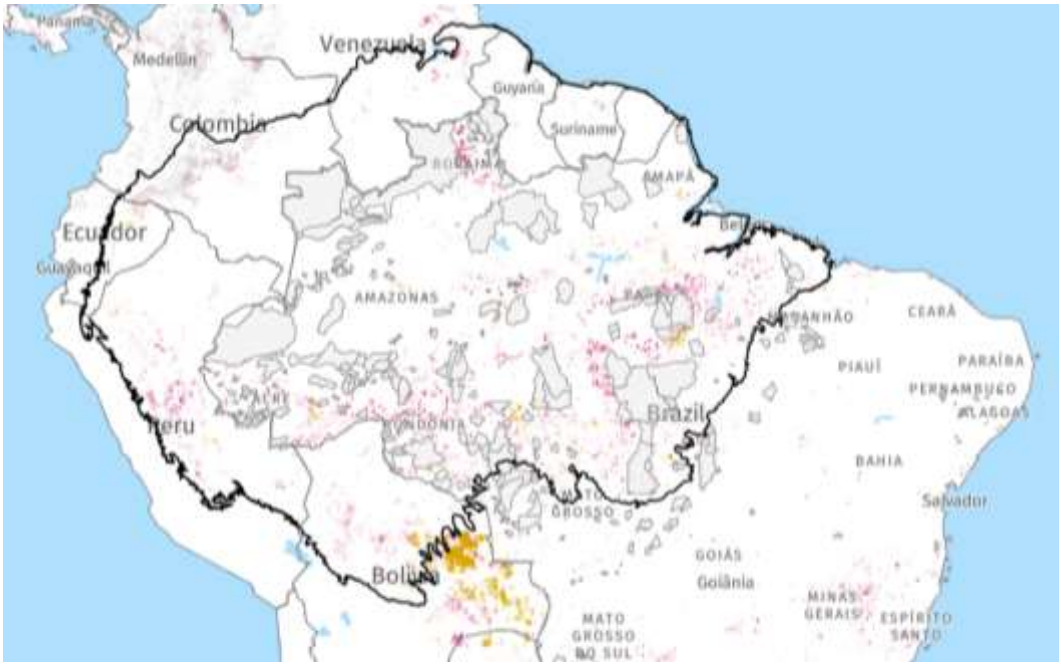
The Amazon Basin and the rainforest that historically covered much of it have long been seen as a critical global carbon sink—the “lungs of the world”—because of the extremely high rates of carbon sequestration by the trees, plants, and soils found there. Equally important on a regional scale are the huge diversity of human cultures and histories past and present in the region.

The relationship between land, climate change mitigation, food security, and equity in the Amazon has varied over the past 30 years, with consistent deforestation in Brazil up until about 2005, and a turnaround and steady move toward zero net deforestation from 2011 to 2015 (Nobre et al. 2016). Over the past three years, many countries in the Amazon Basin have seen increases in deforestation rates, largely for commodity production like palm oil, cocoa, and mining in Peru and Colombia (Piotrowski 2019; Dammert 2018; Valqui et al. 2015) . Deforestation for commodities, both agricultural and mining, reflects economic and gender inequality in the region, as economic power and tenure are extremely concentrated in the hands of a few. The conversion of forests to commodity production has negative implications for GHG emissions and climate equity, and limiting deforestation has therefore been the primary land-based climate change mitigation strategy undertaken by most countries in the region (Piotrowski 2019; Marengo et al. 2108). At the same time, land conversion for commodity production has negative impacts on food security, and food insecurity on the continent has increased slightly over the past few years (FAO et al. 2019).

On the equity side, Oxfam and its partners have a regional strategy focused on ensuring fair access to land and other natural resources as a way to address gender and economic equity while contributing to decreased vulnerability to climate change. However, violence associated with political factions, drugs, and commodity production is severely curtailing any form of equity for marginalized groups in some parts of the region (Dammert 2018; Valqui et al. 2015). In addition, economic inequality and the extreme push to expand commodity production, as shown in Figure 12, as well as a general lack of political will to

enact climate-sensitive policies in Brazil and Colombia, have further contributed to deforestation (Piotrowski 2019).

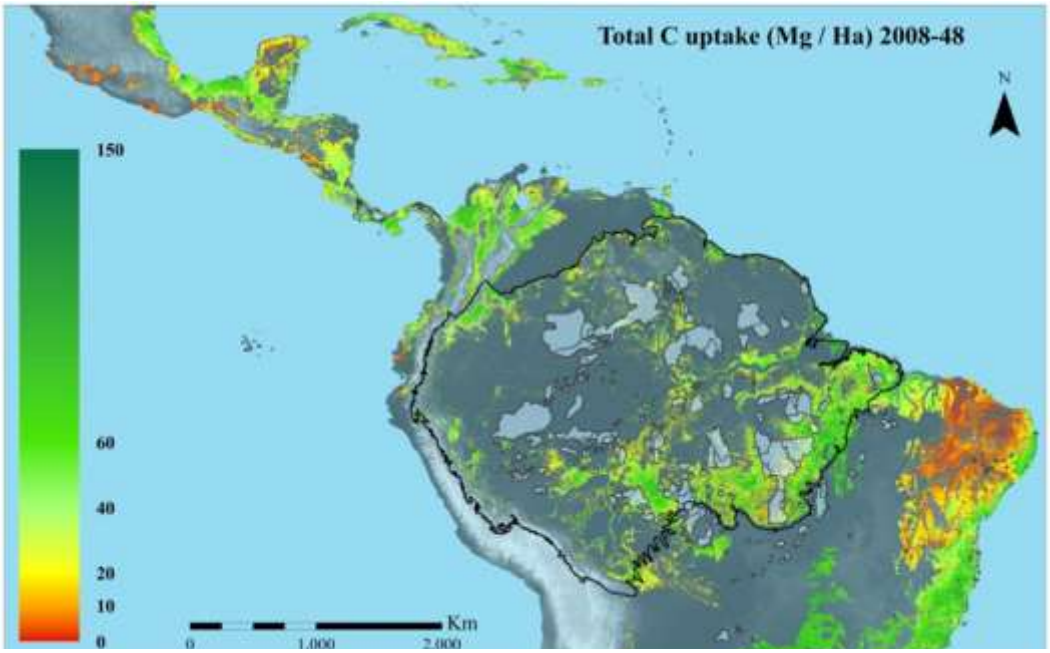
Figure 12: Location of deforestation alerts in the Amazon Basin and overlap with areas of indigenous and local land rights



Forest alerts data source: Accessed through Global Forest Watch.
Land rights data source: Accessed through Global Forest Watch.
Amazon Basin ecoregion boundary: ESRI

Figure 12 depicts the current relationship between indigenous lands in Brazil, and deforestation (in the form of alerts generated through satellite imagery) (Hansen et al. 2016). Deforestation alerts occur predominantly outside of indigenous territories and often on lands directly adjacent to these lands. Figure 12 highlights the potential climate change mitigation impacts of expanding and strengthening indigenous and local land rights, especially as large-scale land acquisition and landownership concentration continue to expand (Piotrowski 2019; Dammert 2018; Valqui et al. 2015). At the same time, the current turn in Brazil and Peru away from climate change mitigation and toward intensified private land use has the potential to generate extreme climate inequities for individuals and communities in forested areas, if the global community expects them to address deforestation. For example, Frank et al. (2017) highlight the potential differential responsibility of middle-income, land-rich countries like Brazil in the context of global climate change mitigation and associated equity issues like food security. They find that Brazil could invest in land-based climate change mitigation strategies that contribute substantially to global mitigation efforts with minimal impact on national food security.

Figure 13: Potential total carbon uptake in young and mid-age forests 2008–2048 in the Amazon Basin and overlap with areas of indigenous and local land rights



Source: Carbon uptake data from Chazdon et al. (2016). Land rights data source accessed through Global Forest Watch. Amazon Basin ecoregion boundary from ESRI.

The Amazon Basin has a clear, unique potential role in global climate change mitigation, and much emphasis has been placed on investing in programs and policies that help reduce deforestation (Watts 2019). The political economy of the region has also led to the creation and expansion of substantial areas under indigenous and local control. Frechette et al. (2018) have noted the large climate change mitigation benefits that can be found on indigenous lands globally; protecting and strengthening land tenure does not feature in NDCs for the Amazon region. In addition, agricultural production in the region is traditionally based on a shifting cultivation system, which has been shown to both improve food security and increase soil carbon (van Vliet et al. 2012).

Figure 13 depicts estimates of the potential carbon sequestration in replanted forests in the Amazon region, overlaid with indigenous areas in Brazil (Chazdon et al. 2016). This is another way to visualize the potential for climate equity, in terms of both responsibility and burden. Most of the currently deforested or young forest areas with climate change mitigation potential are in Brazil, and most of these fall outside indigenous areas. In fact, most of the areas with climate change mitigation potential through afforestation, reforestation, and forest management fall along the southern part of the basin, where intensive agricultural production currently exists (Marengo et al. 2018). Figure 12 highlights the potential positive equity implications if Brazil can address deforestation and invest in sustainable land management practices, and it makes the country's recent rejection of global financial support for such investments troubling (Watts 2019). The case of Brazil also provides important insights for other countries in the Amazon Basin, especially Colombia and Peru, where pressures from commodity production threaten to both decrease climate change mitigation through deforestation and negatively impact economic and gender equity through landownership transitions that do not secure local and traditional rights (Dammert 2018; Guereña 2017).

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