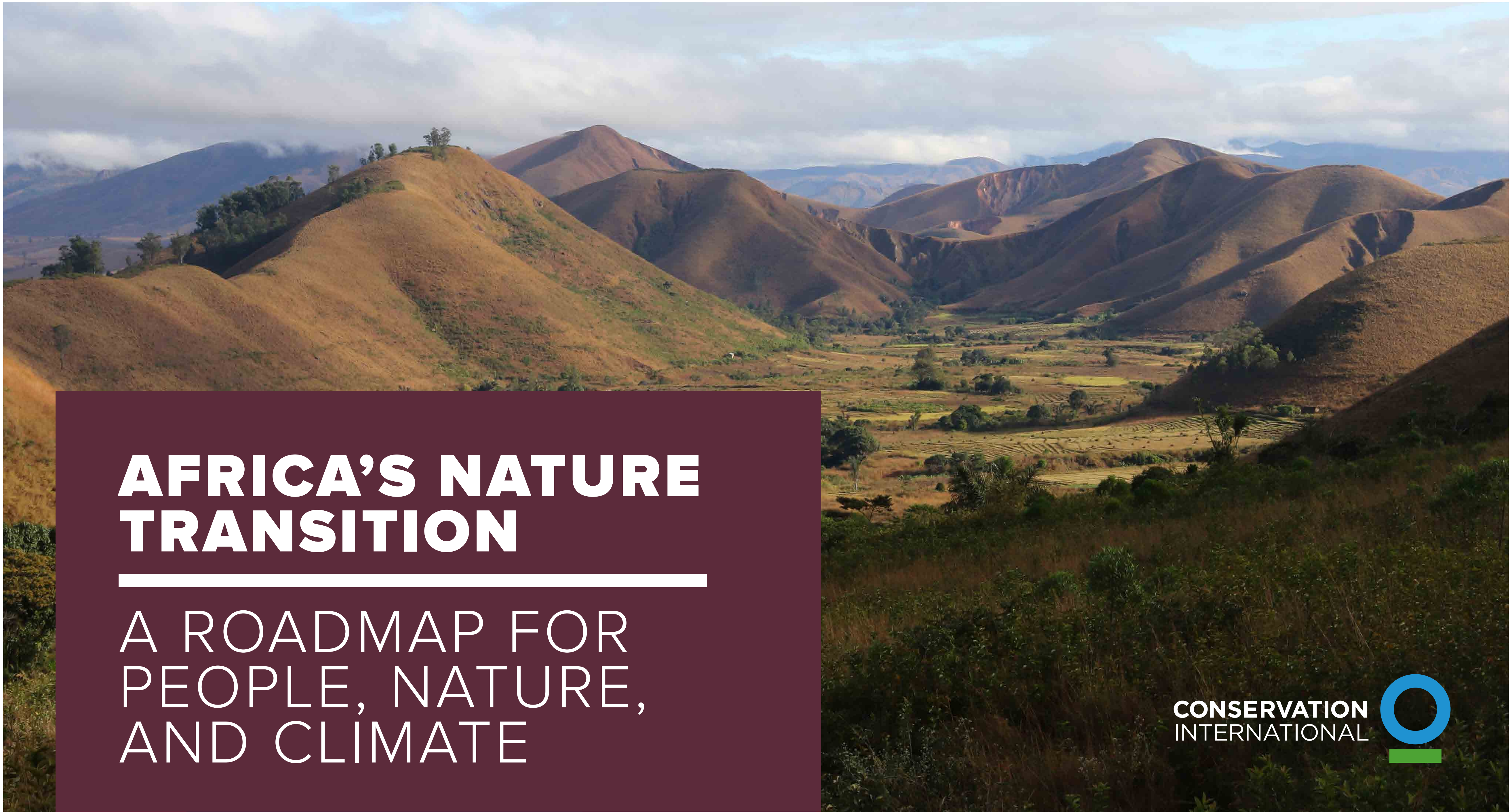


AFRICA'S NATURE TRANSITION

A ROADMAP FOR PEOPLE, NATURE, AND CLIMATE

CONSERVATION INTERNATIONAL

Produced by

CONSERVATION INTERNATIONAL

FUTURE ECOSYSTEMS FOR AFRICA

In partnership with

AGNES African Group of Negotiators Experts Support

unesco Intergovernmental Oceanographic Commission

IOC Sub Commission for Africa and the Adjacent Island States

Lead authors: Perushan Rajah, Virginia Gorsevski, Sally Archibald, Heidi-Jayne Hawkins, Joana Krieger, Daniel Myers, Kavya Pradhan, Timothy 'Max' Wright, and Kim Zoeller

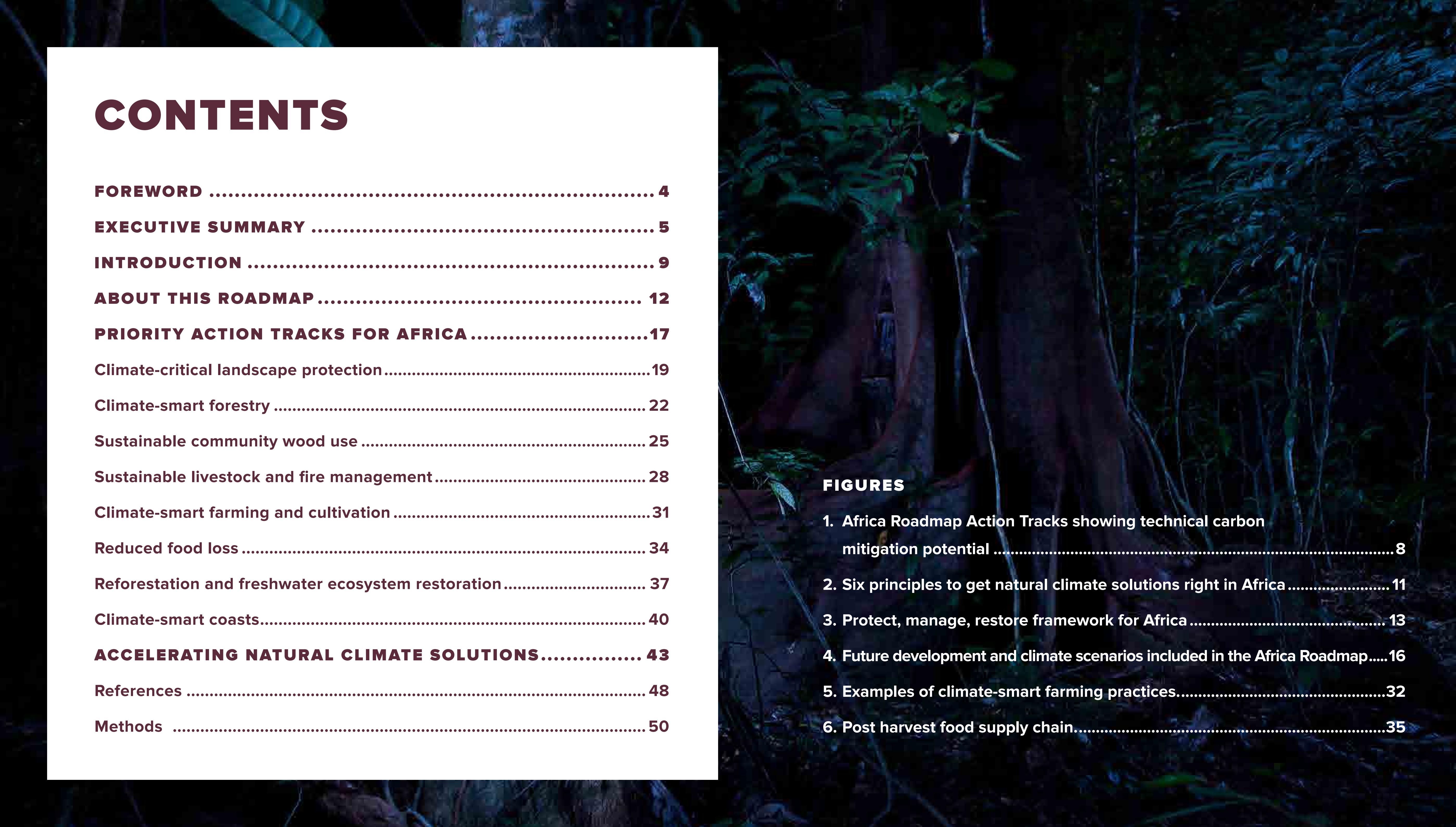
Lead editor: Duncan Geere, klimat.studio

Lead designer: Alex Parrott, NoOneRightAnswer.co.uk

Date of publication: February 2026

Citation: Conservation International and Future Ecosystems for Africa, 2026.

Contributing authors and reviewers: Babatunde Abiodun, Petronila Adihambo, Leonard Akwany, Tilahun Amede, Lina Barrera, Mark Beeston, Ethan Belair, Ermias Betemariam, Maira Bezerra, Tim Bromfield, Valentine Ebua, Kurt Fesenmyer, Christina Ender, Bronson Griscom, Seif Hamisi, Ashleigh Ho, Dave Hole, Juliette Jacquemont, Lissa Karanja, Kiryssa Kasprzyk, Julia Levin, Jemimah Maina, Jimmiel Mandima, Edwin Mwashinga, Mark Njeru, Laura Pereira, Alice Ruhweza, Amos Thiongo, Elijah Toirai, Francesco Tubiello, Beatrice Wamalwa, Mike Wolosin.



CONTENTS

FIGURES

FOREWORD

Africa is well-positioned to play a central role in shaping global biodiversity, climate, and development outcomes. The continent's iconic ecosystems, landscapes, and seascapes are a rich natural capital bedrock of its economies and societies, while also being pivotal for global climate stability and biodiversity conservation. Achieving a fair, just, and equitable balance between protecting, managing, and restoring nature, and satisfying the economic growth agenda, will be essential to securing Africa's sovereignty and positioning the continent as a leader in delivering both natural climate resilience and the wellbeing of its people through nature-positive livelihoods and businesses.

The African Union clearly acknowledges the transformative role of nature in Agenda 2063, while the United Nations underscores the urgency of accelerating natural climate solutions to meet the Sustainable Development Goals and the Paris Agreement targets. This regional Roadmap builds on these commitments, translating ambition into action across Africa. Led by African institutions and voices, the Roadmap offers a continent-wide framework for action. It provides a coherent strategy for integrating natural climate solutions into national and regional policy agendas, aligning cross-sectoral efforts, and mobilizing public and private finance at scale. For policymakers, the Roadmap is a practical tool to guide legislative and regulatory reforms, inform investment decisions, and foster multi-stakeholder partnerships.

Within Africa's landscapes and seascapes lies the potential not only to safeguard the continent's future, but to inspire the world through opportunity and hope. By investing in natural climate solutions, governments and institutions can unlock resilient development pathways that protect both people and nature. We invite governments, regional institutions, the private sector, civil society, and communities to co-own this agenda. The time for coordinated, strategic action is now – and Africa is ready to lead.

Jimmiel Mandima
Conservation International

Many people in Africa today live within and alongside nature. The rest of the world can learn from their experiences when implementing natural climate solutions that have the potential to provide huge benefits to the continent if applied appropriately. To help achieve this, this Roadmap has mobilized a team of partners who can provide the domain expertise, the Africa-specific datasets and models, and – most importantly – the innovative scenario planning and futures thinking that will ensure that these solutions turn out to be of benefit to nature and to people in the long-term.

Guided by the 'Six Principles to Get Natural Climate Solutions Right in Africa',[1] this Roadmap provides new numbers that evidence best practices for the protection, management, and restoration of ecosystems in sub-Saharan Africa. Its goal is three-fold: first, to mobilize enthusiasm and funding from the international community to drive positive change in Africa through climate mitigation efforts. Second, to assist governments and communities across the continent to speak with stronger, aligned voices that are backed by evidence. Third, to inspire novel approaches to natural climate solutions globally by defining best practices. We look forward to using this Roadmap in our activities within and beyond the continent to drive positive change, and guide development into nature-supporting pathways.

Laura Pereira and Sally Archibald
Future Ecosystems for Africa,
Wits University

EXECUTIVE SUMMARY

Africa's contribution to the causes of global climate change is minimal,[2] but its people and iconic natural capital face disproportionate impacts that impede sustainable development and compromise continental sovereignty. Africa's ecosystems, if appropriately protected, managed, and restored, can support people and nature while simultaneously contributing to global efforts to reach net zero emissions from nature by 2050.[3]

Led by African scientists who give a voice to the continent's priorities and needs, Africa's Nature Transition: A Roadmap for People, Nature, and Climate (hereafter referred to as the Africa Roadmap) establishes the continent's position as a solutions provider and investment destination in the global climate response. It describes how unified efforts to leverage nature as a proven climate solution can build resilience, mitigate climate change, and provide critical co-benefits to ensure a prosperous and just nature transition. Importantly, the Africa Roadmap is aligned with the African Union's Agenda 2063, which outlines a vision for inclusive and sustainable development across Africa, emphasizing that integrated efforts to protect biodiversity, water, food security, human well-being, and climate resilience lead to better outcomes.

The aim of the Africa Roadmap is to accelerate action and investment in climate mitigation across sub-Saharan Africa by aligning global climate ambitions with the region's key priorities and needs, avoiding perverse outcomes, and emphasizing both carbon and non-carbon benefits across livelihoods, biodiversity, climate adaptation, water, and food security. The Africa Roadmap supports governments to identify and maximize opportunities to reform national policies to embed nature-focused targets within key national guidance documents, such as nationally determined contributions, national adaptation plans, and national biodiversity strategy and action plans.

Furthermore, the Africa Roadmap seeks to catalyze local and national stakeholders and international actors into action to support natural climate solutions – but to do so in a way that is guided by six key principles[1] that ensure due consideration is given to people, nature and climate, thereby increasing the likelihood of adoption and durability.

These principles are:

Principle 1: **Acknowledge Africa's development priorities and needs**

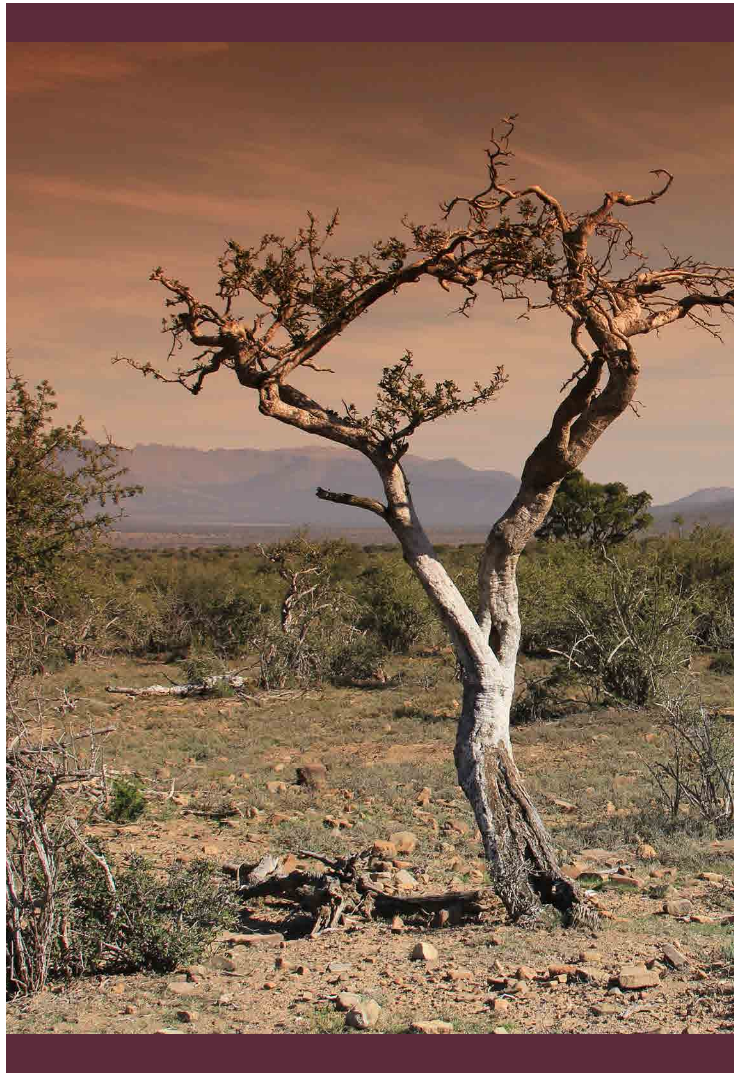
Principle 2: **Allocate financial resources to solutions that generate the biggest co-benefits**

Principle 3: **Prioritize solutions that maintain options for the future**

Principle 4: **Be transparent about opportunity costs and trade-offs associated with interventions**

Principle 5: **Implement interventions with the greatest degree of local buy-in about the desired future state**

Principle 6: **Use data that accurately reflect the situation in Africa**



With these six principles as a guide, the Africa Roadmap quantifies carbon mitigation potential across a “protect, manage, and restore” framework, within a regional context, while accounting for future socio-economic trends and climate change. Specifically, it identifies eight pathways to action that spotlight groups of people who are intimately connected to nature by living and working on the land and recommends priorities and actions to maximize benefits for people, nature and climate. These eight “Action Tracks” provide a realistic estimate of the climate mitigation potential that nature can deliver, while also sustaining the continent’s human wellbeing and development needs.

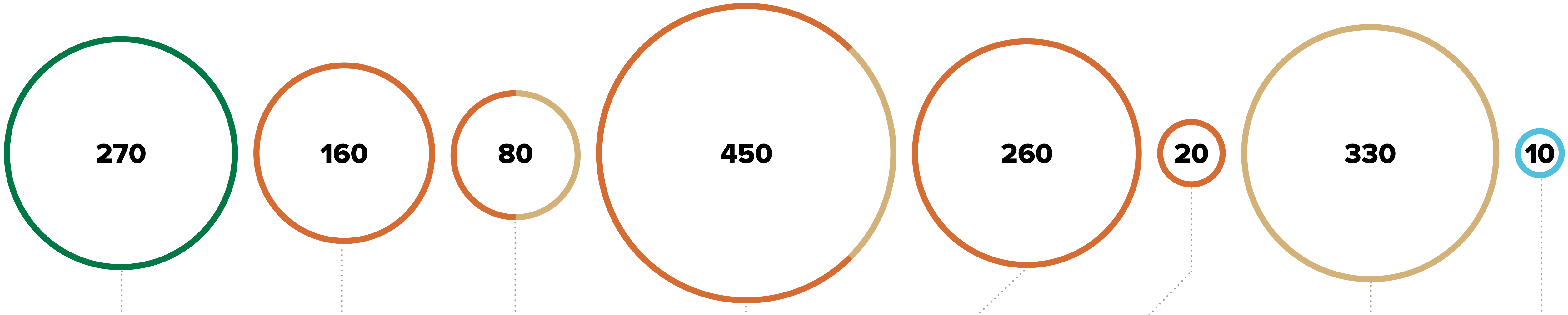
Considering future trade-offs between people, carbon, and nature as well as the intricacies of climate-critical landscapes and non-forest ecosystems across Africa, the total technical mitigation potential of sub-Saharan Africa is conservatively estimated at **1.6 Gt CO_2e** per year (Figure 1).

Climate adaptation benefits associated with these eight Action Tracks are equally important, along with biodiversity, freshwater, human well-being, and food security co-benefits highlighting the importance of nature-linked livelihoods. Each Action Track is discussed in detail and includes case studies and priority actions, providing a snapshot of the current situation and a launching pad for further engagement.

While the Africa Roadmap is intended to provide a science-based analysis of carbon mitigation potential across its eight Action Tracks, it is also very much a call to action to elevate the critical role that Africa plays in sustaining people, nature, and climate, and to attract investment in all three of these areas. To advance natural climate solutions in Africa, collaboration within and across sectors is essential. The scientific community is called upon to amplify African voices in global climate discussions, enhance data accessibility, and foster regional coordination. National and local governments can support policies and provide incentives that support implementation of inclusive natural climate solutions. Financial institutions play a critical role in bridging climate finance gaps by expanding green bond markets, leveraging development banks, and ensuring equitable benefit-sharing through strengthened carbon markets. Local, national, and global non-governmental organizations must continue to urge decision makers at all levels to safeguard Africa’s natural capital amid growing threats from land use change and biodiversity loss. Together, these actions can deliver inclusive, effective, and locally grounded natural climate solutions that address important global climate challenges while supporting just and sustainable development across the continent.

FIGURE 1

Africa Roadmap Action Tracks showing technical carbon mitigation potential ($MtCO_2e/yr$)



Climate-critical landscape protection
Creating and improving management of new protected areas and other effective area-based conservation measures.

Climate-smart forestry
Improving management of working forests, mainly through reduced-impact logging for climate.

Sustainable community wood use
Better managing and restoring savanna and woodland systems through sustainable fuelwood use, and combating bush encroachment by harvesting, increased browsing, and fire.

Sustainable livestock and fire management
Improving management of livestock grazing or browsing, including impacts on fire frequency, by pastoralists and other land users on native grasslands, savanna, and shrublands.

Climate-smart farming and cultivation
Implementing agroforestry, agroecology, farmer-managed natural regeneration, and conservation agriculture.

Reduced food loss
Reducing the amount of food that gets spilled, spoilt or otherwise lost, or incurs a reduction of quality and value before reaching the final product stage.

Reforestation and freshwater ecosystem restoration
Implementing assisted natural regeneration of tree cover in historically forested areas, and direct planting of native trees and wetland plants.

Climate-smart coasts
Protecting, managing, and restoring blue carbon ecosystems, including the creation of new marine protected areas, climate-smart coastal aquaculture and mariculture, and direct planting of mangroves and wetland plants.

PROTECT 270 $MtCO_2e/yr$ **MANAGE** 800 $MtCO_2e/yr$ **RESTORE** 480 $MtCO_2e/yr$ **OCEANS** 10 $MtCO_2e/yr$

TOTAL MITIGATION POTENTIAL 1.6 $GtCO_2e/yr$

INTRODUCTION

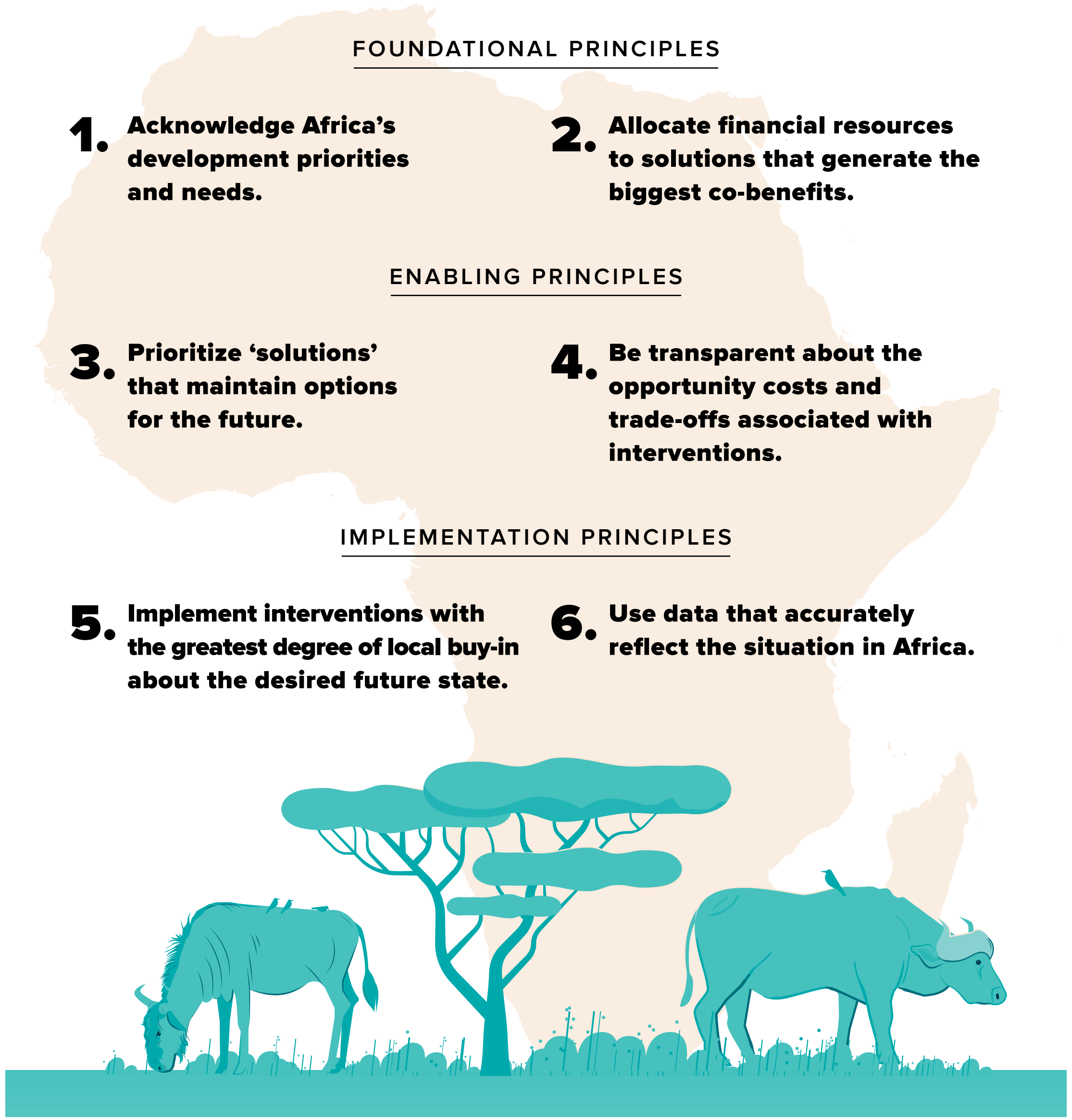
In 2015, the African Union agreed to a strategic framework called Agenda 2063, charting a path towards inclusive and sustainable development across the continent.[4] It includes a set of seven aspirations – the first of which is “a prosperous Africa based on inclusive growth and sustainable development.” Its goals are supported by evidence that efforts to protect biodiversity, safeguard water supply, maintain food security, improve human well-being, and address climate change result in better outcomes.

As African stakeholders advance towards Agenda 2063’s aspirations, the continent is receiving increased attention from global and regional actors eager to leverage Africa’s potential to contribute to climate mitigation. Climate change is an existential threat to humanity and mitigating it requires concerted and coordinated efforts. Nowhere is this more relevant than in sub-Saharan Africa where climate change is already impacting all aspects of life, including food and water security, human health, and livelihoods.

While the potential of Africa’s rich and diverse natural capital to contribute to mitigating and adapting to global climate change has been well documented, its value is still poorly measured and remains largely untapped.[5] Africa contains 65 percent of the world’s uncultivated arable land, as well as valuable and iconic natural assets including the longest and second largest rivers (the Nile and by volume the Congo, respectively), the second largest tropical forest (the Congo Basin),[2] and some of the most ecologically-diverse grassland (Ethiopia’s montane grasslands), woodland (southern Africa’s miombo) and shrubland (South Africa’s fynbos) ecoregions. Africa is also home to approximately one quarter of the world’s biodiversity, including 40,000 – 70,000 plant species, 2,000 bird species, and 4,700 mammal species, and is the only continent to retain a full complement of large and medium-sized megaherbivores.[6] When this natural capital is protected and restored, and multi-functional landscapes and areas under protection are managed with care, Africa and its nature can play a key role in delivering carbon mitigation that simultaneously meets the needs and aspirations of its people.

FIGURE 2

Six principles to get natural climate solutions right in Africa
Adpated from Pereira, L.M., *et al*. 2025



Natural climate solutions, defined as "...deliberate human actions that protect, restore, and improve management of forests, wetlands, grasslands, oceans, and agricultural lands to mitigate climate change,"[7] have attracted global interest for their potential to address climate change by enhancing carbon storage and reducing emissions through sustainable land use. This is reflected in the number of these types of projects, which has increased by an average of 15 percent annually from 2012 to 2021.[5] Natural climate solutions prioritize ecosystem protection, management of working lands, and restoration of degraded areas.[8]

While the framework of "protect, manage, restore" is useful, applying it in Africa is complex due to blurred boundaries between natural and agricultural landscapes, contested definitions of degradation, and the presence of productive human communities within conservation areas. For example, people are living and working productively within many protected conservation areas, and productive rangelands often represent intact socio-ecological systems that need to be conserved as well as managed. The thresholds of use of these lands that result in degradation are not always clear, and restoration projects are often disputed as actually causing degradation. One common example is the pushback against afforestation of open grassy ecosystems, but there are many others, both terrestrial and aquatic.

Africa faces the dual challenge of mitigating climate change while meeting pressing development needs. Population growth and increasing demands for food, fiber, and fuel intensify competition for land and resources, creating trade-offs between environmental conservation and human wellbeing. To navigate these pressures, Africa must adopt nature-positive development pathways that balance global and national climate goals with local priorities. This requires identifying climate-critical landscapes and seascapes that deliver multiple benefits – carbon mitigation, biodiversity conservation, and improved livelihoods – through integrated, context-sensitive land use strategies. These strategies and specific interventions should be guided by six key principles (Figure 2) and based on African-specific evidence to inform interventions that are ecologically appropriate, socially just, and aligned with the continent's development trajectory.[1]

ABOUT THIS ROADMAP

Building on the global Exponential Roadmap for Natural Climate Solutions, the Africa Roadmap sets out a just systems transformation for sub-Saharan Africa that benefits both its nature and its people. Like the global roadmap, the Africa Roadmap recognizes that there is no viable path to meeting climate goals without massive deployment of actions that increase carbon storage and/or avoided greenhouse gas emissions from forests, wetlands, grasslands, and agricultural lands.[9] It uses the global roadmap's "protect, manage, restore" framework for characterizing types of actions that can be taken to support climate action (Figure 3) by enabling actors (such as policymakers, the finance sector, businesses, and civil society) and people on the ground (primarily farmers, ranchers, foresters, indigenous peoples and local communities, and public land managers).

This global framework is complicated for Africa, however, by the reality that people live in and use many of the protected areas on the continent, and biodiversity conservation and protection is still a priority in many of the multi-functional landscapes where wildlife, livestock, and people co-exist. To accommodate this, the Action Tracks have been localized to the African context.

This Roadmap aims to quantify ecosystem interventions that can help reduce atmospheric greenhouse gas concentrations while considering whether these interventions are positive or negative for the people and biodiversity involved. This entails incorporating co-benefits and trade-offs of proposed interventions and defining their climate mitigation potential within the African context. Climate mitigation outcomes and ecological and social outcomes are differentiated to ensure that they are given equal consideration.

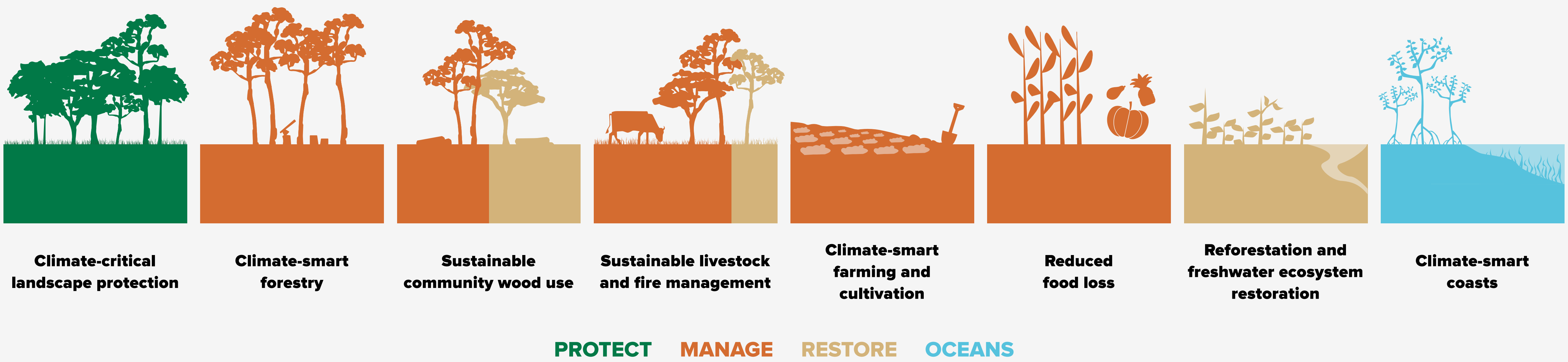
The Africa Roadmap differs from the global roadmap in two more important respects. The first is that while it centers the importance of carbon mitigation as a pathway for directing global climate finance, it does so within the context of Africa's development priorities (Principle 1) and focuses equally on the non-carbon benefits associated with each track (Principle 2), with illustrative case studies taken from around the continent. It recognizes that

natural climate solutions can and should look different in the different places that Africans live and work (Principle 5) – this is reflected in the analysis, selection of case studies, and in the Action Track-specific recommendations (Principle 6). This holistic approach illustrates how nature can contribute to mitigating global climate change while simultaneously delivering services valued by people on the ground.

The second way in which the Africa Roadmap departs from the global roadmap is by recognizing that a shift in development toward nature-supporting pathways is essential but must be considered within the context of a rapidly changing continent (Principle 3). This requires an honest assessment of often-competing priorities related to climate mitigation and adaptation, and agricultural production, among many other critical factors (Principle 4). Quantifying future demand, where possible, aims to highlight the impact of shifting to these pathways, and sets the stage for further engagement with African stakeholders to include their aspirations around climate and biodiversity.

FIGURE 3

Protect, manage, restore framework for Africa



AFRICAN PRIORITIES

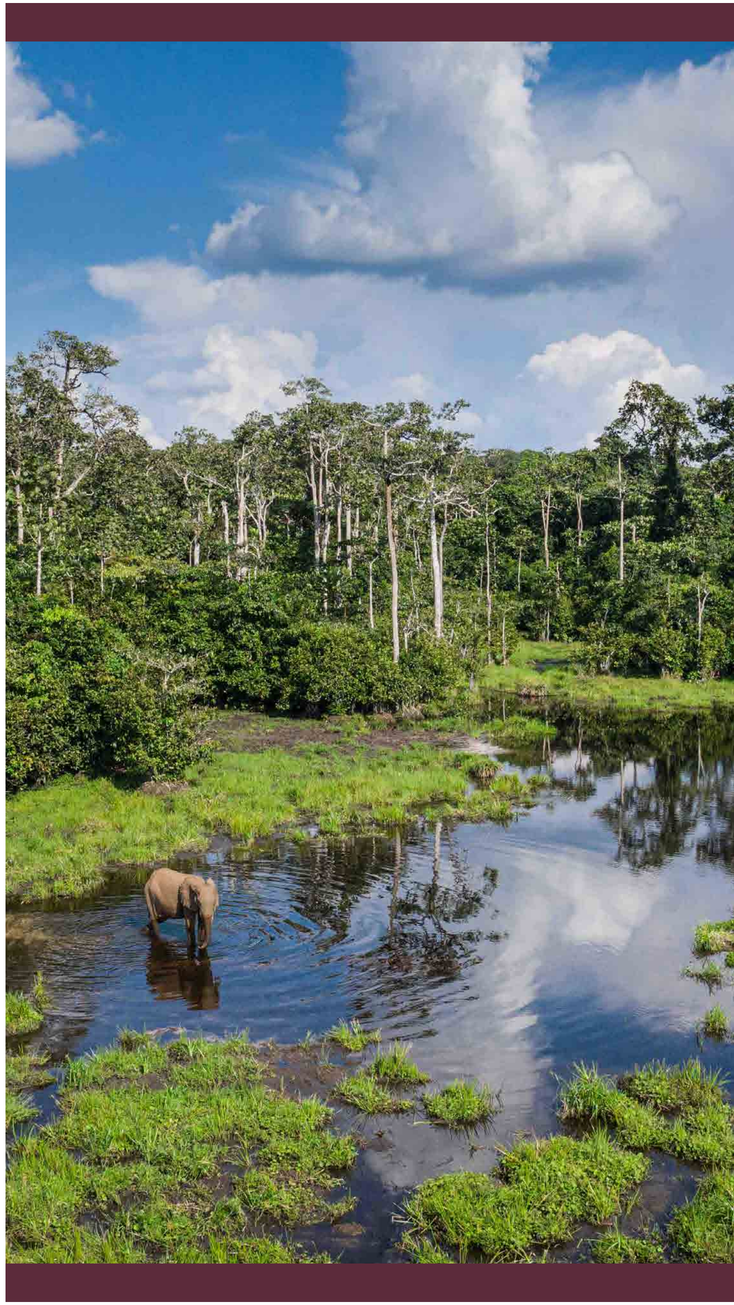
Given the breadth of priorities across regions and countries, including those underlined in the African Union's Agenda 2063, the partner organizations behind the Africa Roadmap convened a series of workshops during its development, with two primary goals. First, to establish a smaller set of non-carbon development priorities that must be considered when implementing natural climate solutions. Second, to leverage the best available Afro-centric science to lay out a framework for action led by a unified African voice. The values listed below emerged as important non-carbon priorities; they are discussed in each Action Track, recognizing that a full appreciation and accounting of these factors is beyond the scope of this report.

Livelihoods and Wellbeing

Natural ecosystems in sub-Saharan Africa provide essential resources that people use to secure income and meet basic needs. An estimated 62 percent of Africa's GDP is reliant on ecosystem services, with 70 percent of communities in sub-Saharan Africa dependent on forests and woodlands for their economic security.[10] Nature's important contribution to human wellbeing through material (e.g. food, fuel), regulating (e.g. pollination, climate regulation), and non-material benefits (e.g. cultural significance, recreation) is a constant theme throughout the Roadmap.

Biodiversity

In the African context, biodiversity is not just about protecting threatened species, but about supporting healthy, culturally valued species, and prioritizing ecosystem function and integrity so that people can live in harmony with nature. To achieve the aspirations outlined in Agenda 2063, it is necessary to support the multicultural knowledge systems that place the needs of indigenous people and local communities at the forefront of conservation. Biodiversity is a theme that is woven throughout this report. It's reflected across Action Tracks, as well as at the national scale where countries are urged to develop and implement national robust biodiversity strategies and action plans, and develop approaches such as biodiversity credits, that serve the priorities of African people.



Climate Adaptation

Climate change poses a serious threat to the people and places of sub-Saharan Africa. While this is true for many parts of the world, Africa has the additional challenges of higher sensitivity, greater exposure, and lower adaptive capacity than many other places, resulting in severe vulnerability to climate impacts.[11] On average, climate-related hazards cause African countries to lose two to five percent of their GDP annually, with many diverting up to nine percent of their budgets to respond to climate extremes.[12] Natural climate solutions and ecosystem-based adaptation are recommended throughout this Roadmap for their ability to provide climate adaptation benefits.

Freshwater

Sub-Saharan Africa has rich freshwater resources consisting of substantial river basins and associated watersheds, large freshwater lakes, wetlands, peatlands, and floodplains important for people, biodiversity, and carbon storage. These ecosystems provide access to water for millions, support agriculture and fisheries, and are integral to building resilient communities. They provide buffers against storm surges and seasonal floodwater while regulating local climates. They're also culturally important – globally, like the Okavango Delta, and locally, like the numerous headwater basins, riparian areas, floodplains, and regional water towers. These freshwater resources underpin water security and sovereignty in Africa and are considered "high value freshwater ecosystems" that present opportunities to align with climate action.[13]

Food Security

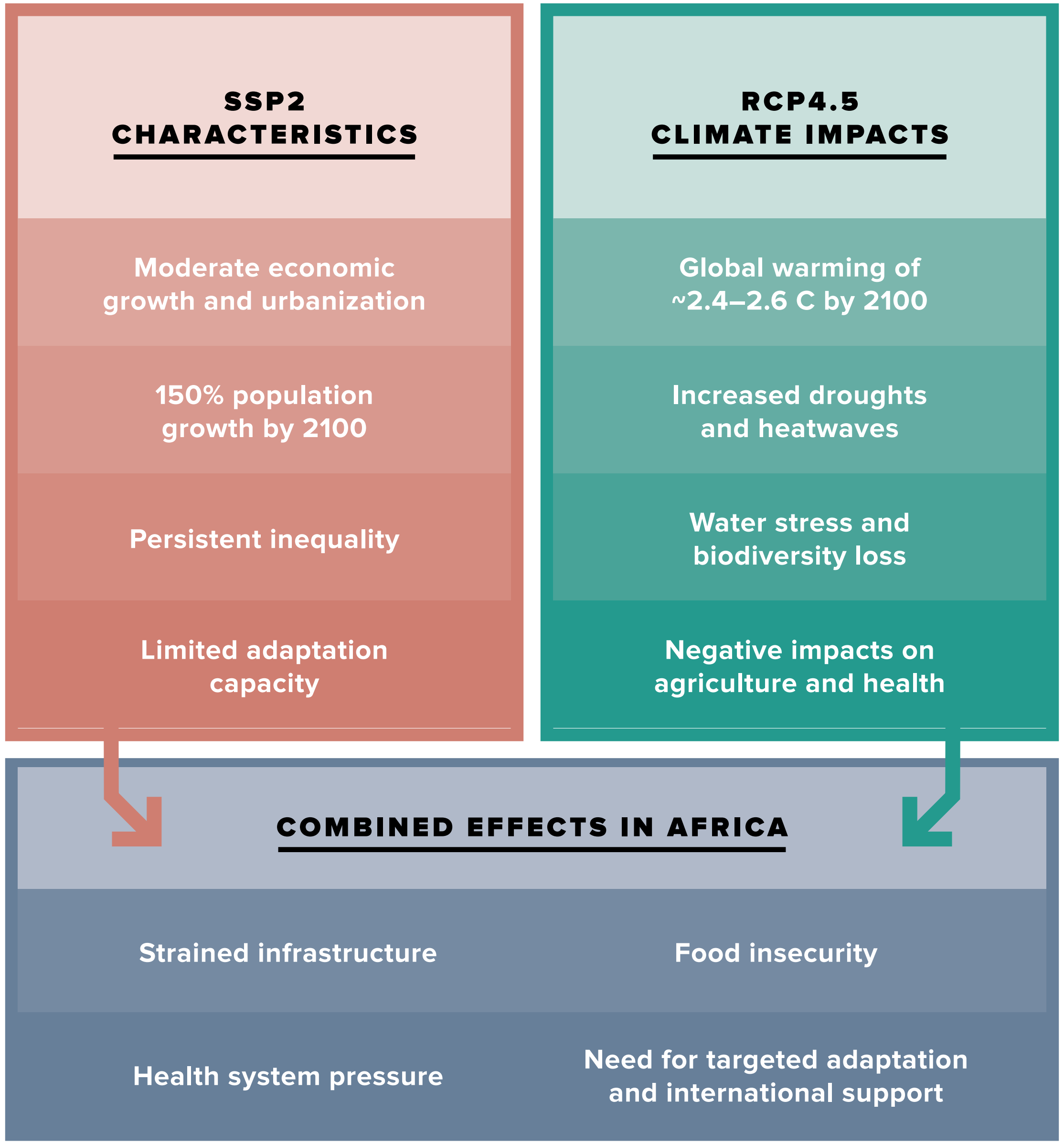
Food security is inextricably linked with human health, livelihoods, and wellbeing. Securing and transforming food systems is critical for sub-Saharan Africa given the food crisis, where up to a quarter of the population experienced acute food insecurity in 2024.[14] With a population expected to grow to 2.1 billion by 2050,[15] Agenda 2063 emphasizes the need to eliminate food insecurity and hunger. Strategies aimed at enhancing the availability, accessibility, utility, and stability of food systems are essential, while pairing indigenous perspective with practices that enhance food security. The use of indigenous climate-resilient crops and wild-crop relatives is important – not only for maintaining the caloric and nutritional needs of Africans, but also to maintain and support cultural heritage.

ENSURING ACTION TRACK DURABILITY

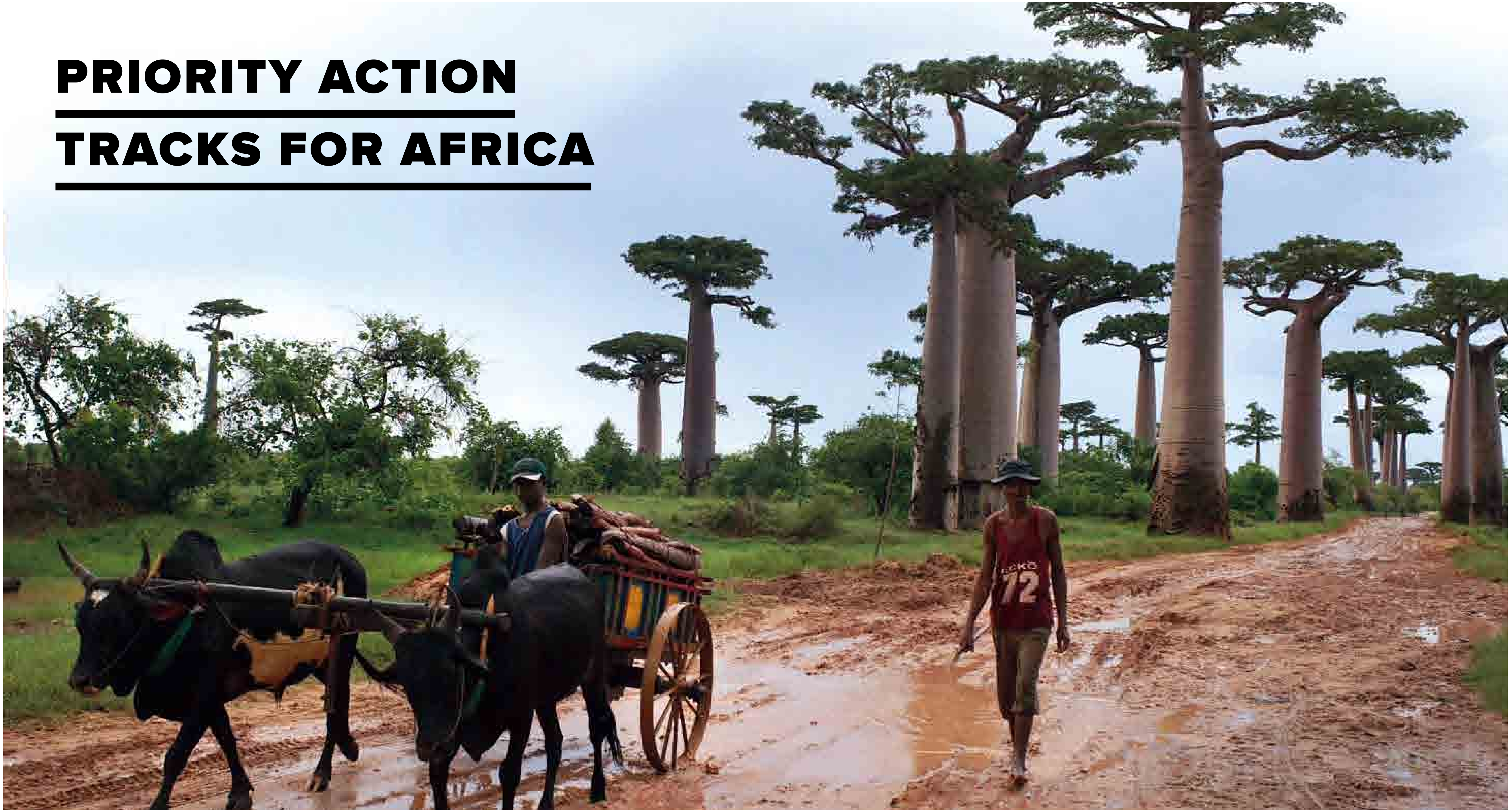
Striking a balance between Africa's climate adaptation and mitigation ambitions while ensuring development outcomes is essential for the long-term sustainability of any natural climate solution. To account for the reality of future development pressure, this Roadmap uses the Intergovernmental Panel on Climate Change's Shared Socioeconomic Pathway 2 (SSP-2) and future climate Representative Concentration Pathway 4.5 (RCP-4.5) scenarios in its analyses (Figure 4). This represents a middle-of-the-road future, with moderate economic growth and reasonable climate action, indicating a realistic balance between development and climate change. In this scenario, Africa is expected to experience significant population growth and moderate economic progress with persistent inequity, while temperatures are expected to increase by approximately 2.5°C by the end of the century, leading to an increase in heatwave and drought conditions. Incorporating these scenarios is a way to future-proof the analysis and inform decision makers of the risks, trade-offs, and opportunities for long-term sustainability of natural climate solutions across the continent but should in no way be seen as predictions. In fact, many of the Action Tracks, if implemented at the scale that is possible, might help to shift the pathway of Africa away from SSP-2 towards an alternative with lower climate risk.

FIGURE 4

Future development and climate scenarios included in the Africa Roadmap



PRIORITY ACTION TRACKS FOR AFRICA



Eight Action Tracks connect natural climate solutions to key actors and decision makers on natural and working lands, reflecting African priorities and future scenarios. Each track outlines its technical potential for carbon mitigation, highlights non-carbon benefits, and includes case studies.

These solutions are designed to be implemented by land-based communities – such as farmers, foresters, and fisherfolk – and scaled by policymakers, financial institutions, businesses, and civil society. Developed through expert consultation, data analysis, modeling, and a review of the literature, each Action Track aims to support thriving livelihoods and cultural integrity while preserving nature across African landscapes.

→ Climate-critical landscape protection

Creation of new protected areas and other effective area-based conservation measures such as biodiversity agreements. Improved management of existing protected areas, buffer areas and corridors connecting transboundary and non-transboundary landscapes.

→ Climate-smart forestry

Reduced-impact logging for climate (RIL-C) techniques. Carbon estimates do not include liana (vine) removal from selectively logged forests, however this and other practices are discussed as additional practices to stimulate absorbtion of carbon.

→ Sustainable community wood use

Opportunities to increase above-ground biomass through sustainable fuelwood use, as well as techniques to combat bush encroachment by harvesting, thinning, increased browsing and fire. It is aligned with both management and restoration goals.

→ Sustainable livestock and fire management

Improved management of livestock grazing or browsing, including impacts on fire frequency, by pastoralists and other land users. It focuses largely on native grasslands, savanna, and shrublands, aiming to increase carbon sequestration without biodiversity trade-offs, and aligns with both management and restoration goals.

→ Climate-smart farming and cultivation

Agroforestry, agroecology, farmer-managed natural regeneration, and conservation agriculture (including no-till, cover cropping, drip irrigation, and use of planting basins). The aim is to improve soil health, increase sequestration, and reduce waste of crop residues.

→ Reduced food loss

Measures to reduce the amount of food that gets spilled, spoilt or otherwise lost, or incurs a reduction of quality and value in food supply chains before reaching the final product stage. It includes loss along the entire food value chain, from production to post-harvest, processing, and distribution.

→ Reforestation and freshwater ecosystem restoration

Assisted natural regeneration of tree cover in historically forested areas (using consensus maps of historical forest distributions), and direct planting of native trees and wetland plants.

→ Climate-smart coasts

Actions identified in the preceding tracks that focus on blue carbon ecosystems are analyzed separately in this track to highlight the unique and varied potential of these vital but often-overlooked seascapes. Includes creation of new formal and informal marine protected areas in blue carbon ecosystems, coastal aquaculture and mariculture, direct planting of native trees/mangroves/wetland plants, and the use of green-gray infrastructure such as anti-erosion measures in wetlands and coastal ecosystems.

CLIMATE-CRITICAL LANDSCAPE PROTECTION

270 $MtCO_2$/yr

Climate-critical landscape protection is about preventing the loss or degradation of natural areas that are critical for preserving biodiversity and important for a range of ecosystem services. Some natural areas hold carbon reserves that, if disturbed, are rapidly released and may take decades – or even centuries – to recover.[16] However, many of these critically important ecosystems are increasingly threatened by human activities, driven by unequal resource distribution, population growth, uneven economic development, rapid urbanization, and other mounting pressures.[17, 18] Strategic planning and allocation of land for protection is necessary to ensure that Africa's future economic development aligns with climate change mitigation goals and is centered around African needs and priorities.

Considering threats to these ecosystems in combination with agreed biodiversity targets and priorities, the protection of landscapes in sub-Saharan Africa can mitigate **0.7 Gt CO_2e by 2030** and **4 Gt CO_2e by 2050**. This includes establishing new protected areas and other effective area-based conservation measures, and improved management of existing areas, including buffers and corridors that connect both transboundary and non-transboundary areas.

While landscapes under protection hold higher amounts of carbon on average compared to unprotected areas,[19, 20] these efforts are far more effective when the expansion of protected areas is guided by long-term planning that accounts for future social and ecological demands and is done in consultation with local people and other key stakeholders. In sub-Saharan Africa, this means not only addressing current population needs but also planning for future growth and considering historical injustices, including the forcible

The Guassa Community Conservation Area in Ethiopia's Central Highlands is a community-driven and managed conservation area that is based on the centuries-old Qero system. This system involves the creation of an inclusive indigenous regulatory framework for environmental and food governance over a presiding resource or biodiversity system. The area secures Afro-alpine grassland, its unique biodiversity and nature's contributions to people, and maintains customary access, particularly to the locally important Festuca grasses that the area is named after.[40] The Guassa Community Conservation Area also incorporates ecotourism – a portion of which enhances overall community development.[41]

removal of people from their land to create protected areas. By proactively aligning conservation strategies with development goals, it is possible to reduce future land-use pressures, safeguard key ecosystem services, and still meet human needs.

Effective and durable climate mitigation benefits will require rapid, large-scale efforts to protect and conserve healthy ecosystems supported by strategic land-use planning. In addition to storing carbon and preventing emissions from land conversion, strategically expanding protected areas and other effective area-based conservation measures can deliver critical co-benefits and ecosystem services – such as biodiversity conservation, water security, climate adaptation, and the protection of culturally significant landscapes.

Improving management and enforcement of new and existing protected areas is a critical part of this. Across sub-Saharan Africa, many protected areas face chronic underfunding, insufficient staffing, and weak institutional capacity[21] which significantly limit their effectiveness in preventing deforestation, land degradation, and other emissions-driving activities. Designing and implementing sustainable financing mechanisms for these areas can ensure a diversity of finance streams that recognize the multiple benefits they have to offer. Strengthening governance, enhancing monitoring systems, and investing in long-term management capacity will ensure that stored carbon remains secure well into the future.

Landscape and seascape protection,[22, 23] has been shown to generate positive spillover effects that enhance biodiversity in surrounding areas[24, 25, 26] – an outcome particularly important for highly mobile or migratory species. Protecting and restoring forests and wetlands enhances freshwater quality by decreasing runoff and sediment, nitrogen, phosphorous, and heavy metals.[27, 28, 29, 30] Protected areas are also critical for improving livelihoods and adaptative capacity for people living within and beyond their boundaries. For example, terrestrial protected areas[31] which support agricultural livelihoods and well-managed marine protected areas can generate positive spillover effects in neighboring fisheries. Protecting natural areas can also reduce vulnerability to climate change impacts such as landslides, wildfires, heatwaves, tsunamis, and flooding.

Governments play a central role in enabling inclusive and durable conservation measures. By integrating natural climate solutions into national development and climate strategies, governments can help reconcile ecological objectives with economic and human well-being priorities. This includes embedding ecological targets into land-use planning

Sacred forests across Africa exemplify how people and nature live in harmony. These areas are protected by the community from degradation and destruction because of their cultural, spiritual, religious, and ancestral connections.[37] Sacred forests and other sacred areas are often built upon the maintenance and enhancement of customary rights of indigenous peoples and local communities with benefits for both carbon and biodiversity.[38] For instance, Benin's 2012 Sacred Forest law protects these forests whose management is overseen by local communities.[39]

and policy decisions, ensuring secure land tenure, aligning policies across sectors, making sustained investments in conservation infrastructure, and implementing climate mitigation programs such as REDD+ where applicable.

Historically many protected areas have been established and managed without the meaningful participation of local communities, often to the detriment of those communities and of nature itself.[32] Centering the knowledge, rights, and stewardship of indigenous peoples and local communities should be the bedrock of any protection intervention[33, 34] including the co-development of conservation efforts.

Financial institutions and corporations also have a role to play by reinforcing accountability and helping to scale natural climate solutions by channeling capital toward nature-positive activities and by supporting transparent environmental reporting.[35] Companies should align their operations and supply chains with sustainability principles – reducing pressures on high-value ecosystems, sourcing from suppliers that avoid land-conversion, and actively supporting conservation outcomes.[36]

PRIORITY ACTIONS

- → Integrate measures to protect climate critical ecosystems into national and sub-national planning.
- → Create sustainable income sources using market and non-market approaches that benefit local people and communities.
- → Support secure land and resource rights for indigenous peoples and local communities to encourage stewardship.
- → Increase capacity and investment to better manage, monitor, and enforce existing protected areas.

CLIMATE-SMART FORESTRY

160 $MtCO_2$/yr

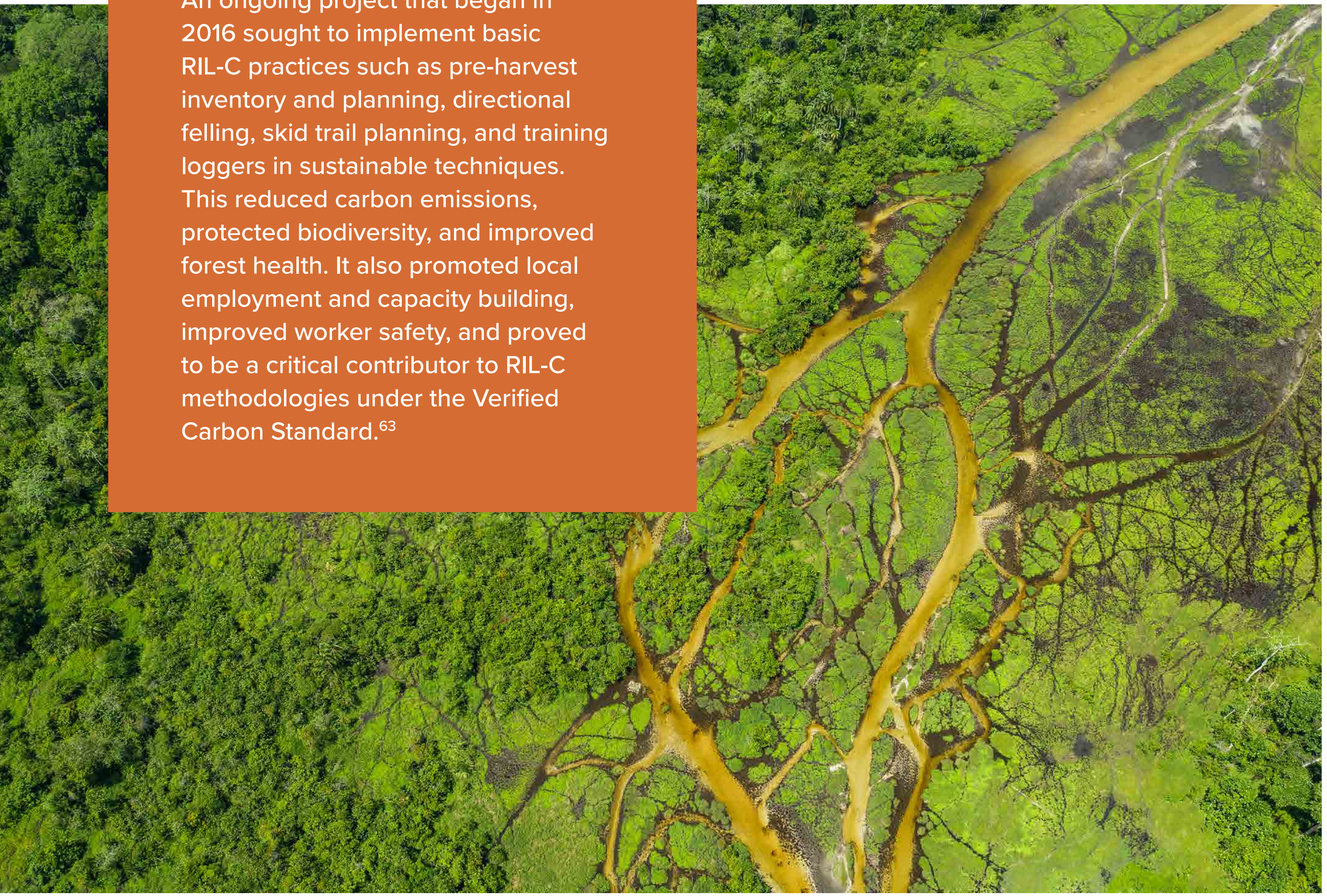
Climate Smart Forestry builds on the concepts of sustainable forest conservation and management by safeguarding biodiversity, increasing carbon storage in forests, and limiting the exploitation of wood products, alongside enhancing other ecosystem services.[42] Africa is covered by the world's second-largest tropical rainforests, whose carbon storage plays a crucial role in the global carbon cycle.[43,44] Selective commercial logging of natural forests is an important part of many African countries' economies. Managing this activity to reduce emissions is therefore a key natural climate solution for sub-Saharan Africa, which contains the world's second-largest continuous block of tropical forest.[45]

The carbon emission reduction potential of this Action Track in sub-Saharan Africa is estimated to be approximately **0.8 Gt CO_2e by 2030** and **3.9 Gt CO_2e by 2050**.

These estimates are based on implementing a collection of techniques that are collectively known as Reduced Impact Logging for Climate (RIL-C), and do not explicitly include projected land-use pressure or climate change as the demand for wood products coming from Africa is not expected to significantly increase in future scenarios. This Action Track also does not include designation of set-aside areas for protection from logging activity, extended harvest rotations, increased post-harvest sequestration rates, nor potential emission reductions from activities such as liana cutting in selectively logged forests, which has the potential to sequester additional carbon across Africa.

RIL-C consists of practices aimed at maximizing wood utilization during selective logging, while reducing collateral damage to non-commercial trees and improving the safety of workers. Depending on the characteristics of the forests

The Congo Basin region, the world's largest carbon sink and home to the second largest tropical rainforest, has in partnership with The Nature Conservancy and World Wildlife Fund, successfully reduced logging impacts across three forest concessions (Kabo, Pokola, Loundoungou-Toukoulaka). An ongoing project that began in 2016 sought to implement basic RIL-C practices such as pre-harvest inventory and planning, directional felling, skid trail planning, and training loggers in sustainable techniques. This reduced carbon emissions, protected biodiversity, and improved forest health. It also promoted local employment and capacity building, improved worker safety, and proved to be a critical contributor to RIL-C methodologies under the Verified Carbon Standard.[63]



where logging is occurring, it can describe various practices.[44] These include creating harvest plans based on forest inventories that mitigate climate change without reductions in timber yields, and planning trails to minimize soil and vegetation disturbance.

In addition to climate mitigation, these practices also have positive impacts on biodiversity, livelihoods, and human wellbeing. While RIL-C approaches do not assure long-term timber yield sustainability,[46] their adoption reduce adverse environmental impacts (such as soil compaction and erosion, and collateral stand damage) and enhance worker safety.[47] For example, forests where RIL-C techniques are practiced have lesser alterations of forest habitat and structure compared to conventional forestry practices.[48] This reduces negative impacts on forest plants and animals, many of which are important to local people.[49, 50]

Forests and forest resources also play an important role in Africa's socioeconomic development. In the case of natural forests, this includes timber and non-timber forest products, habitats for wildlife, beekeeping, unique natural ecosystems, and genetic resources.[51] Moreover, the formal forestry sector contributes to rural economies and employment[52] and RIL-C techniques can generate financial benefits for logging operations from reduced wood waste and increase operational efficiency, though many of these profits and benefits are context-dependent.[53]

To grow climate-smart forestry practices in Africa on existing natural forests, it is essential for governments and forest managers to establish and enforce policies that promote sustainable management, including the integration of RIL-C techniques with Forest Stewardship Council standards.[50] Other management techniques can mitigate additional carbon, such as extending the period between planting and harvesting of a forest stand, improving the productivity of poorly performing natural forests, and leaving material behind and planting trees to ensure forests continue to absorb CO_2 after selective logging.[54] Designating set-aside areas for protection from logging activity, or widespread adoption of treatments such as liana (vine) cutting in selectively logged forests has the potential to sequester an additional 141 Mt CO_2e in Africa.[55]

Policies can also be designed to support community ownership of forested lands and participatory forest management, which have proven effective in improving conservation outcomes,[56] as well as reform of concession structures to recognize multiple land uses, local land rights, and ensure compliance and transparency.[57] Sustainable land-use planning must also be prioritized to integrate forestry into broader land management systems, assess trade-offs, and maximize long-term ecological and socio-economic benefits.

In the Republic of Gabon, forestry practices and the timber industry contribute significantly to GDP. To improve the quality of emissions estimates from the forestry sector and design a strategy to reduce forestry emissions at a national scale, the government of Gabon collaborated with the World Bank to design RIL-C practices which were implemented by the Agency of National Parks. Collaborations such as these in Gabon have maintained carbon sequestration by forests, reduced emissions related to forest degradation, and improved inclusive forest governance by placing local communities at the center of benefit sharing.

Strengthening governance frameworks and law enforcement is critical. This means developing and/or improving regulations for the forest sector and building capacity for forest managers and institutions and ensuring accountability and transparency in all forestry operations.[58] Emerging technologies, including systems like the 'Forest Intelligent Data Acquisition System' using remote sensing, can significantly improve forest data collection and address gaps in ground-based surveys.[59]

Community-based forestry and artisanal logging schemes empower local communities to manage and benefit from forest resources while supplying local timber markets. Participation in international initiatives, such as the EU's Forest Law Enforcement, Governance and Trade Action Plan[60] can further promote sustainable practices and combat illegal logging.

Finally, promoting the adoption of forest certification schemes can drive improved forest management practices while enabling producers to capture higher value for wood products over time. In parallel, innovative financing mechanisms, including payment for ecosystem services, carbon market and non-market approaches, or performance-based payments, can mobilize resources for improved forest management while maintaining environmental integrity through conservative and verifiable crediting methods.[61, 62]

PRIORITY ACTIONS

- Invest in training foresters and loggers in RIL-C and other climate-smart management techniques to increase capacity.
- Recognize local and indigenous land rights, integrate traditional knowledge, and promote collaborative governance of forest resources.
- Encourage market and non-market-based incentives to drive and reward climate-smart forestry practices.
- Integrate climate-smart forestry measures into national climate commitments and development planning.

SUSTAINABLE COMMUNITY WOOD USE

80 $MtCO_2$/yr

Savannas, woodland, and grassland ecosystems cover vast swaths of sub-Saharan Africa and provide critical resources for millions of people, while storing considerable amounts of carbon above and below ground.[64, 65, 66] The coexistence of trees and grasses in these landscapes is essential for the continued delivery of vital ecosystem services. Pressure is expected to increase in the future on these critical ecosystems due to land transformation, while areas that remain untransformed may degrade if the proportion of woody vegetation becomes imbalanced.[67] Sustainable community wood use refers to the process of maximizing carbon mitigation by extracting woody plants in a socio-ecologically appropriate manner – allowing for continued human access to resources while maintaining ecological integrity and carbon sequestration.

In the non-forested areas of Africa that evolved with fire and elephants, dynamic tree populations are the norm, and human use and extraction can be aligned with ecosystem functioning. For this Action Track, current wood fuel use is compared with expected historical rates of tree turnover to assess which interventions and climate mitigation pathways are most appropriate.

Based on this analysis, it is estimated that the implementation of sustainable community wood use practices can store **0.6 Gt CO_2e of carbon above-ground by 2030** and **2.1 Gt CO_2e by 2050**, while maintaining community wellbeing and enhancing ecological resilience. While there will likely be an increase in local demand for wood resources in the future, there is potential to manage this while maintaining

> The Kulera REDD+ and cookstoves project in Malawi combines forest protection with the distribution of clean cookstoves to conserve 170,000 hectares of forest. Every household in the project zone has received fuel-efficient cookstoves to reduce wood use, while 8.6 million trees have been planted as an alternative source of fuel, supporting sustainable livelihoods for 32,000 households. The project mitigates approximately 210 Kt CO_2e each year. In addition, 30,000 people have received training on sustainable natural resources and biodiversity management to produce sustainably harvested honey, coffee, and macadamia, shifting livelihoods away from subsistence.[86]

the ecological integrity of landscapes,[68, 69, 70] and accounting for predicted expansion of agricultural production only decreases these estimates by a maximum of 0.1 Gt CO_2e. Given sub-Saharan Africa's reliance on wood resources, a systems-level approach towards extraction and use – particularly related to energy services[71] – is essential. [72]

In places where woody cover is lower than desired, solutions should focus on reducing extraction of wood in a way that doesn't compromise household and community cooking and housing needs. This can be done by reducing demand for extraction (through increasing access to and use of more efficient wood fuels or alternate fuel stoves)[73] but also by increasing supply (through coppice management and fire management in harvested landscapes). The combinations of these approaches have the potential to increase the retention of biomass in multi-functional landscapes. Using alternative building materials can simultaneously reduce extraction while promoting climate-smart building practices where housing needs are increasing.[74] These interventions can be local and context-specific, however licensing and management of commercial companies that extract charcoal for sale in large urban centers will also be essential and this requires very different high-level national policy interventions.

Reducing woody cover can achieve conservation outcomes and sequester carbon in contexts where bush encroachment has degraded landscapes and ecosystem services. This can be implemented by enabling access to woody fuels for communities, developing sustainable charcoal value chains, and investing in biochar projects that can sequester carbon from woody materials that are too small for cookstoves.[70] Concurrently, increased browsing by wild grazers or livestock and increasing fire frequency through prescribed burns and reduced fire suppression can help to maintain these ecosystems and increase soil carbon (see the Sustainable Livestock and Fire Management Action Track).[75, 76] A particularly promising natural climate solution is to bring these solutions together by using wood fuel or sustainable charcoal from bush thinning in areas where wood harvest is decreasing.[71, 77]

Preventing afforestation in non-forest ecosystems in Africa is also essential as the complex relationship between tree cover and carbon balances in non-forested ecosystems can result in soil organic carbon losses from carbon-rich grassland soils that are afforested. Understanding tree-grass ratios is critical – when tree-grass ratios are more balanced and above-ground biomass goes down, overall ecosystem carbon can still increase through positive impacts on soil organic carbon, which also brings important co-benefits for people and nature.

Bush encroachment has grown by eight percent over the past 30 years,[78] so reducing this rate would help to restore balance in ecosystems disrupted by the loss of wild herbivores that forage on woody plants, like elephants and giraffes. Solutions include protecting and restoring populations of these animals in designated areas and drawing on traditional ecological knowledge systems that underpin indigenous harvesting practices. Sustainable bush thinning by local people can mimic natural browsing and can have co-benefits that include increased water infiltration and higher streamflow.[70] Where reduced fuelwood use and increased woody biomass are the desired goal, participation and buy-in from local communities is crucial to the success of projects that provide alternative fuel sources or increase efficiency of existing sources.

It is important to distinguish wood harvesting by communities for local use versus large-scale wood harvesting by companies for sale in large urban centers. Large-scale commercial extraction can create regulatory challenges that require local and national government support to implement effective checks and balances of sustainable wood use as a natural climate solution. Community associations, like Zambia's Forest and Farm Facility, can support producers of sustainable charcoal through shared knowledge and collective power.[79] Local and national governments can create and implement comprehensive policies and legal frameworks that guide value chain activities,[80, 81] while the private sector and financial institutions can support local green economies by investing in efficient technologies, tailored financial tools, and infrastructure that promotes sustainably.[82]

Sustainable community wood use boosts livelihoods and wellbeing and can also enhance climate resilience. Sustainable charcoal and biochar production presents significant opportunities for developing local green economies in Africa,[83] while improved cookstoves that reduce the use of fuelwood can reduce household air pollution, leading to health benefits.[84, 85] Preserving savanna woodland canopies that lower temperatures and wind speeds can decrease heat stress and soil erosion,[86] while also enhancing the resilience of birds, mammals, and people during extreme climate events.[87]

South Africa's elephant population has been increasing over the last century (unlike in most of Africa) with around 44,000 elephants currently. These elephants play a key role in bush thinning, and deliver other ecosystem services such seed dispersal, maintaining moderate fire patterns, and felling trees which become habitat for other species. Evidence from Kenya's Borana rangelands suggests that people can mimic elephants and other browsing species via targeted wood harvesting, increasing carbon storage by up to 1000 percent and soil organic carbon by 150 percent.[70, 80, 89]

PRIORITY ACTIONS

- → Support local communities to either increase or decrease woody biomass using a diversity of efforts to achieve ecologically optimal densities.
- → Mobilize private sector and financial institutions to build green local economies by investing in fuel efficient technologies, biochar, and sustainable charcoal harvesting.
- → Encourage governments to provide economic and other incentives, alongside robust regulatory frameworks to develop and certify sustainable wood production and expand clean energy technologies.
- → Establish and strengthen community associations to support sustainable wood harvesting, charcoal production, carbon projects, and biochar initiatives.

SUSTAINABLE LIVESTOCK AND FIRE MANAGEMENT

450 $MtCO_2$/yr

Almost 70 percent of sub-Saharan Africa is covered by grassy biomes. These areas, which include grasslands, savannas, and shrublands, and which are often used as rangelands,[90, 91] evolved with herbivores and fire as well as indigenous peoples and local communities who are key actors in their management. Today, livestock farmers include both smallholder pastoralists and larger-scale commercial grazing operations. Smallholders keep livestock for multiple uses, including as a buffer against poverty.[92] Livestock farming communities have a close and intricate relationship with nature and trust traditional grazing practices and local indigenous knowledge to guide this relationship and maintain productive use of their rangelands. Given the importance of these pastoralist systems, sustainable livestock and fire management practices are a critical pathway for mitigating climate change in sub-Saharan Africa. In this Action Track, sustainable livestock management amounts to a 30 percent reduction in grazing intensity[93] through grazing management and/or stocking rate, plus the effect this has on fire using a process-based model.

Using cost-effective estimates, sustainable livestock management has the potential to sequester up to **2.7 Gt CO_2e by 2030** and **11.3 Gt CO_2e by 2050**. Approximately equal contributions are attributed to above-ground plant biomass and soil organic carbon, with lower inputs (and losses in some cases) from below-ground biomass. Increases in ecosystem carbon are not predicted to have trade-offs for biodiversity, such as woody plant encroachment. Management of grazing intensity will change the percentage of biomass removed during grazing, decreasing carbon emissions and encouraging sequestration. Optimizing grazing intensities in this way

Conservation International and Peace Parks Foundation are partnering in seven countries across southern and eastern Africa on a community-driven livestock management program known as Herding for Health. It combines livestock management and market support with rangeland restoration to increase carbon sequestration in soil and improve livelihoods through enterprises like local leather production. Through the program, local herders have reintroduced traditional grazing methods, such as maboella in South Africa, where livestock are moved between grazing and non-grazing areas throughout the growing season. This approach mimics the natural movement of wildlife and has led to better grazing practices and livestock sales. To date, the program has restored nearly one million hectares of land and generated US$8.2 million for herders.

increases carbon storage in soil by promoting root and plant development and reducing disturbance. It is important to recognize that this adjusted grazing intensity recognizes the interaction between grazing and fire. It assumes that fire frequency and seasonality will not be suppressed but rather managed to occur within the ecological bounds of different biomes across Africa and as per the available fuel load, so that vegetation structure and diversity are maintained.[94]

To implement sustainable grazing for a given area of land, much of Africa requires a reduction in grazing pressure. This can be realized through various management methods like adjusting stocking rates, supplementing forage, resting pasture lands for regrowth, and rotational grazing. Other mitigation techniques include relying on climate-resilient livestock breeds with reduced emissions, using prescribed burns to prevent huge brush fires and combat woody plant encroachment, and mixing livestock species to efficiently graze different vegetation types (e.g., cattle for herbaceous plants, goats for woody material, and sheep for both).[95] It is important that these approaches are incentivized by policy, markets, and finance mechanisms.

Strategic improvements in how land is grazed will increase livestock productivity by enhancing the quality and availability of forage, improving soil health, and reducing land degradation, ultimately leading to more sustainable and resilient livestock systems. For example, planned grazing in Kenya's rangelands has resulted in an increased presence (44 percent) and species richness (53 percent) of hoofed wild animals, as well as improved cattle weight gain (more than 71 percent) during dry periods when cattle were in relatively poor condition.[96] These gains directly translate into improved food security and economic resilience for pastoral households.[97]

Well-managed grazing also helps to create varied habitats essential for biodiversity. In East African savannas, for example, moderate grazing helps to maintain plant diversity by preventing any single species from dominating,[98] supporting a greater variety of grassland bird species and protecting cultural heritage. Grazing animals can also reduce woody plant encroachment, even at reduced grazing pressure. Similarly, controlled burning creates patches of habitat at different stages of growth, which benefits a wide range of wildlife from insects to large herbivores.[98]

These practices also improve the relationship between indigenous peoples and local communities, and the grasslands that support their well-being and livelihoods.[99] However, land managers introducing new livestock management practices should note that doing so requires an appreciation of and sensitivity to traditional cultural practices of herding communities and a deep understanding of local economic and development priorities. Solutions must be tailored to the local context by ensuring that grazing methods are appropriate for the area and incorporate local knowledge.[99]

Similarly, policies that promote sustainable grazing must ensure that herders benefit financially from improved management practices. This could include, for example, government recognition of land and access rights for herders to prevent conflict with farmers and ensure access to quality grazing lands. Policymakers should also motivate the animal products market to value climate-smart production, and develop infrastructure for increased access to local, regional, and global markets.[100, 101]

Governments and financial actors can promote sustainable grazing practices by supporting carbon markets and payments for ecosystem services from grazing lands. While it is essential that these efforts are focused on increased carbon sequestration, it is important to acknowledge that sustainable grazing can only offset about two percent of greenhouse gas emissions from the ruminant livestock sector. This means that manure management is an important part of livestock management. It is also critical that carbon and ecosystem service payment schemes consider the non-carbon benefits for people in their design (via improved livestock management and growing the resilience of pastoralists and surrounding communities), as well as biodiversity.

> In Tanzania, two dominant grazing strategies exist amongst indigenous Sukuma agropastoralists. One of the strategies, the ancestral "ngitili" practice, has enabled better management of nature while simultaneously improving the well-being of communities in the Shinyanga region. Households perceived "ngitili" as important to improving their livelihood by providing their livestock sufficient grazing, emphasizing the critical benefits beyond mitigation.[102]

Finally, market-based finance mechanisms should be designed to balance the time gap between the long-term nature of carbon sequestration and the shorter investment horizons needed to scale improved livestock management practices. While there is a tradeoff, high-integrity removal credits are sought after on the carbon market, and present an opportunity to be leveraged by government, including through bilateral cooperation under Article 6 of the Paris Agreement.

PRIORITY ACTIONS

- → Improve land rights for herders to incentivize climate smart production and develop infrastructure that supports increased access to markets.
- → Reduce grazing pressure by adjusting stocking rates, supplementing forage, resting pastureland for regrowth, and practicing rotational grazing.
- → Collaborate with indigenous peoples and local communities to incorporate local knowledge into proposed grazing methods.
- → Incorporate sustainable grazing and other greenhouse gas emissions reducing livestock activities into climate and development planning strategies.

CLIMATE-SMART FARMING AND CULTIVATION

260 $MtCO_2$/yr

Climate smart farming and cultivation refers to farming and aquaculture practices that improve crop yields, boost climate resilience, and reduce agriculture's greenhouse gas emissions.[103] Approximately half of the workforce in sub-Saharan Africa engages in farming, with 33 million smallholders forming the heart of the continent's agriculture sector.[104] The region's fertile and productive croplands have a significant role to play in delivering just and equitable natural climate solutions. Transitioning to climate-smart farming practices is critical given rapid population growth and rising food demand in the coming decades.

Climate-smart farming and cultivation in sub-Saharan African has the potential to mitigate **1.1 Gt CO_2e by 2030** and **6.5 Gt CO_2e by 2050**. Although the future climate impact on food systems due to increased drought conditions and changing agricultural suitability was not explicitly included in these calculations, ample evidence suggests that combining mitigation and adaptation activities in agricultural landscapes can help short term farm gains while ensuring long term resilience.[106] These findings align with other results indicating that if 50 percent of smallholder farmers were to adopt regenerative agriculture practices across the continent, it would not only prevent 4.4 Gt CO_2e of emissions by 2040 but also bring wide-ranging co-benefits including a 13 percent increase in yields, a 30 percent reduction in soil loss, and five million new jobs in agriculture.[107]

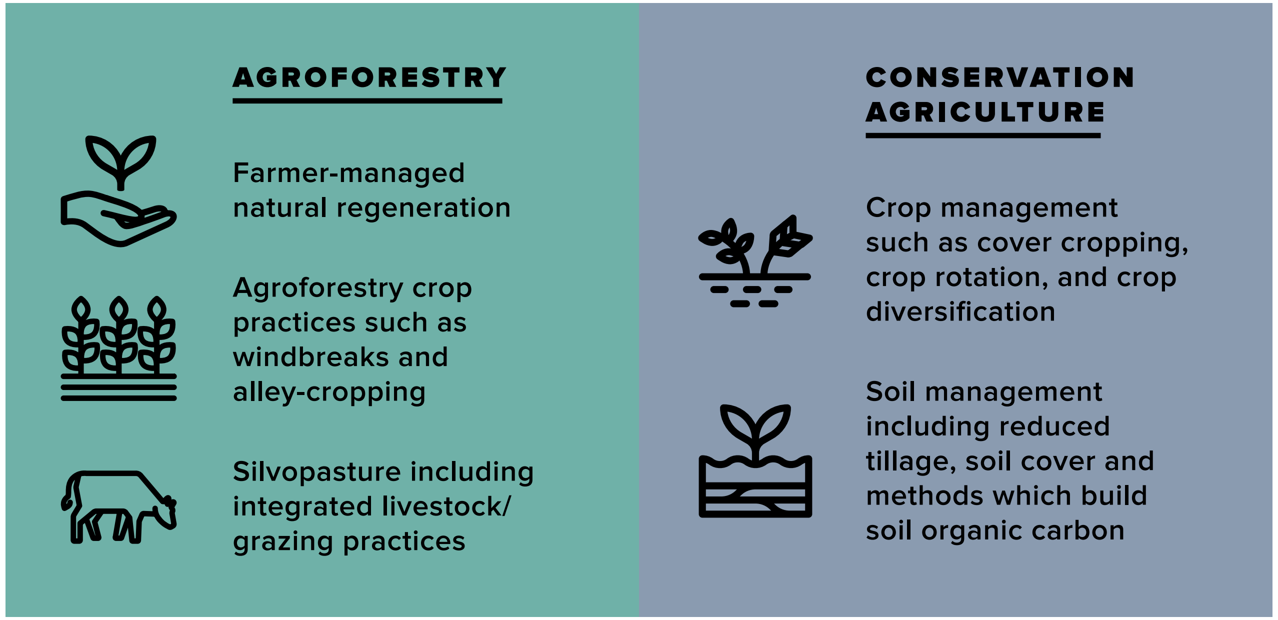
Natural climate solutions for agriculture can be broadly grouped into two categories: the first is focused on actions that contribute to soil retention and restoration that are known as conservation agriculture, such as cover crops, reduced or no-till farming, and crop rotation. The second is made up of solutions

that integrate trees into working lands, known as agroforestry. This includes natural regeneration, lining the edges of farms with trees, and integrating trees into grazing lands (Figure 5). These interventions are a subset of sustainable farming[108] that are aimed at carbon mitigation and work alongside other sustainable farming practices to build resilient, sustainable and responsive agricultural systems that benefit both the people and the environment, particularly in smallholder systems that dominate sub-Saharan Africa.

Farmer-driven planting or natural regeneration of agroforests can sequester carbon in places where woodland has previously been cleared for agriculture. It is important to note that indiscriminate use of fast-growing non-native trees or fruit trees for agroforestry (as opposed to native trees), or increasing tree cover too much, can create unintended negative consequences like loss or devaluation of native species or significant reduction in crop yields and could hamper the long-term uptake of agroforestry approaches.[109]

FIGURE 5

Examples of climate-smart farming practices



Balancing carbon mitigation and production is particularly important given the lower-than-average crop yield in Africa and the need to increase production to feed a growing population. There is an opportunity to invest in technology and knowledge transfer to improve productivity in areas that still contribute to climate mitigation.

In addition to carbon mitigation benefits, climate-smart farming practices can also reduce erosion, improve soil health, and increase water retention, all of which improve crop yields.[110, 111] These yield increases improve livelihood security for farmers and resilience to food shocks.[111, 112] Climate smart farming also promotes the health of freshwater ecosystems by decreasing run-off and increasing the rate that water soaks into the soil.[113]

Cover crops and agroforestry have also been shown to boost biodiversity in croplands and adjoining areas,[113, 114] while trees in agricultural lands provide shade and a windbreak for crops and farmers – buffering the impacts of increasing temperatures due to climate change. They also reduce soil erosion, improve the supply and quality of drinking water, and act as pest barriers and fodder for livestock.[115] These benefits can be enhanced through indigenous farming practices and climate-resistant indigenous crops, which can improve both food security and adaptation while highlighting the importance of indigenous knowledge systems.[116, 117]

Luxury chocolate brand Original Beans partnered with the Sustainable Agroforestry Development Initiative to protect the ecosystem around Virunga National Park in the Democratic Republic of Congo. Through a special “Women of Virunga” bar, the company sourced cocoa beans from agroforestry production intended to boost women’s incomes and prevent further deforestation in the area while retaining 30-40 percent canopy cover. To date, the project has planted nearly 300,000 trees across 2,500 hectares of abandoned agricultural land in the park’s buffer zone and raised typical farming incomes per hectare from US$200 to US$1,000.[124]

Farmers and growers play a crucial role in the successful implementation of climate-smart farming and cultivation by selecting climate-adapted varietals (prioritizing indigenous crops), choosing native tree species for planting as part of agroforestry efforts, and sharing their knowledge with fellow farmers. Emphasizing and magnifying the incorporation of indigenous and local knowledge of African farmers into these interventions is crucial as they have built-in acceptance in local communities and are already being employed for adaptation to risks.[118]

Financial institutions and policymakers are critical for supporting and scaling adoption of climate smart agriculture through, for example, integration of these practices into broader plans for major investments and flagship programs. Development finance institutions, donors, and banks can de-risk investments in green projects and unlock farmers' participation, using financial instruments like loan guarantees and farmer-friendly financial products that account for agricultural cycles.[119]

Policymakers can also work to legally recognize farmers' land and tree rights, integrate agroforestry into climate and biodiversity targets, and expand support and training in new techniques to encourage adoption of agroforestry practices.[120] They can also phase out harmful subsidies and redesign incentives – such as tax breaks or low interest loans – to promote environmentally sustainable and economically beneficial practices. Policies can also be developed to support incentives that encourage the application of traditional farming knowledge, such as preserving heritage foods,[121] and encouraging symbiotic land use for farmers and herders[122] as well as pathways to value local and indigenous expertise to influence agricultural policies for soil management and farming practices.[123]

> In Zimbabwe's Umguza District, smallholder farmers have increasingly adopted climate-smart agriculture to cope with recurrent droughts and erratic rainfall. Key practices include shifting from maize to drought-tolerant small grains such as sorghum and millet, conservation farming techniques to improve soil moisture retention, and diversifying livelihood income. These strategies have enhanced resilience, stabilized yields under climate stress, and supported household food security. Scaling remains constrained by limited access to quality seed, inadequate extension support, and weak institutional backing.

PRIORITY ACTIONS

- Secure farmers' land tenure rights to incentivize long term climate-smart actions while promoting farm-level technical innovations.
- Incentivize farmers to select climate-adapted crops and tree species for agroforestry that incorporates traditional knowledge and indigenous plants.
- De-risk green investments and support farm-level participation through innovative farmer-friendly financing mechanisms.
- Integrate agroforestry and climate-smart farming into national climate and biodiversity targets and policies, ensuring to align agricultural incentives with their achievement.

REDUCED FOOD LOSS

20 $MtCO_2$/yr

Food loss refers to food that is spilled, spoilt, reduced in quality and value, or otherwise lost at any point in the value chain before it reaches its final product stage.[125] Food loss translates directly into increased greenhouse gas emissions along each stage of the food supply chain (during production, storage and transportation, and post-harvest operations) (Figure 6), and these losses are exacerbated by climate change.[126] Food loss has a significant carbon footprint as it leads to unintended deforestation, land conversion, and wastage of water, nutrients, and biodiversity. The post-harvest rate of food loss in Africa (between 37 and 50 percent) is greater than the global average (roughly 33 percent).[127] Solving this problem is key to achieving both food security and carbon emissions reductions, benefiting both people and nature.

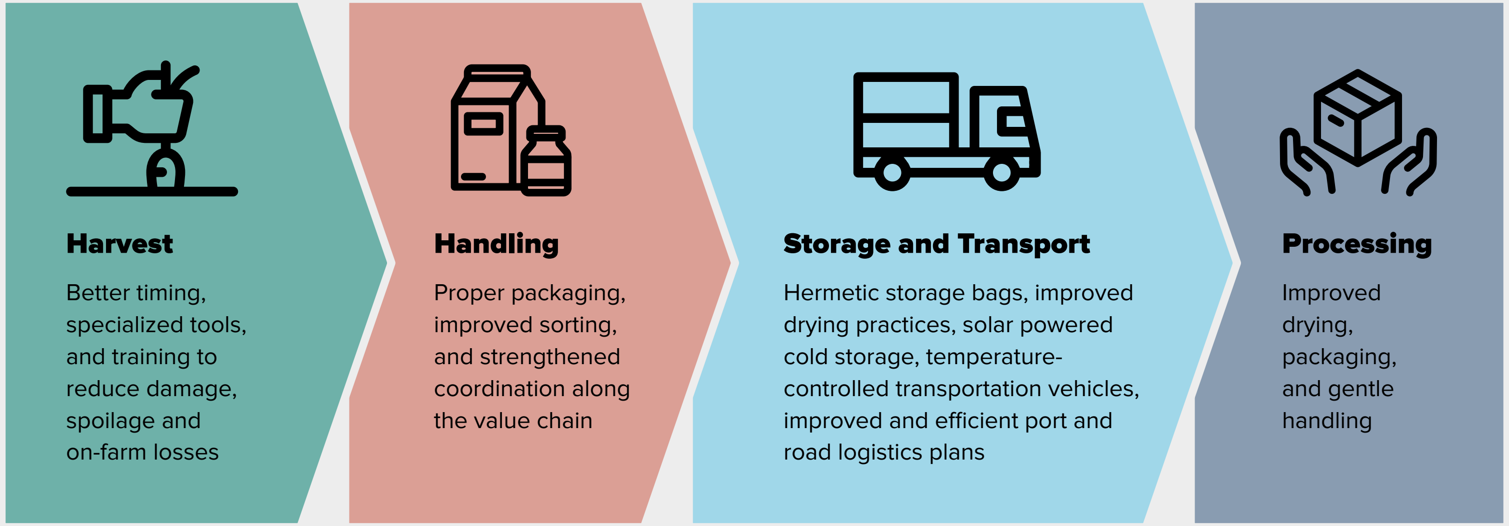
Reducing food loss in sub-Saharan Africa has the potential to contribute **0.1 Gt CO_2e of carbon mitigation by 2030 and 0.6 Gt CO_2e by 2050**. Emissions from food lost along the supply chain represents a percentage of total emissions from agricultural production which is expected to rise with increased population and food demand.[128] This Action Track assumes food production increases while the proportion of food loss decreases, resulting in greater food security with reduced emissions in the future.

Opportunities to reduce the rate of food loss exist across various stages of the supply chain (during harvest, handling and storage).[129] Emissions from agrifood systems in Africa have increased 40 percent since 2002, however low productivity per unit of land, water, and other inputs reflects high emission

Nigerian startup Cold Hubs produces solar-powered walk-in cold rooms to extend the shelf life of fruits and vegetables to 21 days, up from the two days that are standard in many Nigerian market towns. The service operates a pay-as-you-store model at an affordable price and has expanded to over 50 facilities across the country. In 2021, Cold Hubs estimates that it saved 62,000 tons of produce from 5,000 food vendors from spoiling, with corresponding benefits for human health from eating unsafe food and an estimated 1,150 tonnes of CO_2e in avoided emissions, with plans to scale across all 36 of Nigeria's states in the coming years.[147]

FIGURE 6

Post-harvest food supply chain



rates as the continent ranks highest in terms of emissions per value of agricultural production (6.0 kg CO_2e/I$).[130] Reducing post-harvest food loss provides a realistic opportunity for decreasing intensity and pressure on productive land and increasing agricultural production. Key solutions include optimizing the timing of harvests, finding buyers for imperfect foods, streamlining product distribution by reducing transit time and on-hand inventory, improving temperature monitoring in transit, and upcycling scraps and by products.[131]

Farms are a crucial place to focus efforts. Harvesting crops at the proper maturity stage and at peak quality, using proper harvesting equipment, and avoiding damage from unfavorable weather conditions between harvest and storage can prevent loss of food that otherwise might be considered suitable for consumption.[132] Another potential farm-centric solution is upcycling scraps and byproducts, using insects to convert them into feed or food.[133, 134] In addition to carbon mitigation, these actions can improve the quality of the food products, increasing their value and ultimately the income of farming households.[135] Reducing post-harvest losses can significantly improve people's ability to meet their nutritional needs, particularly for calories and proteins.[136]

Beyond the production and harvesting stages, improving storage, handling, and distribution systems can also prevent food loss. Better storage techniques, particularly those that focus on hermetic bags or silos, can increase the amount of usable food from a harvest.[137, 138, 139] Improved access to pre-cooling and cold storage facilities, particularly those that are powered by renewable energy and available at an affordable price, can also reduce food loss.[140, 141] Finally, developing better transportation infrastructure that reduces the time in transit can minimize losses during post-harvest handling.

Addressing food loss also reduces pressure on water resources, forests and biodiversity by reducing land conversion, optimizing trade-offs for agricultural land required to produce additional food.[142] In sub-Saharan Africa, food loss and waste consume approximately 16 percent of water use.[143] Halving food loss could reduce water consumption by an estimated 12 percent[144] and provide benefits for biodiversity through reduced nitrogen load, and for human health through reduced air pollution.[144] Reducing food loss can also decrease the pressure for expansion of food production into fragile ecosystems and minimize harmful impacts from resulting land use change and deforestation.[145]

Farmers and producers play a key role in reducing food loss by increasing efficiencies of food production and the handling and storage stages where most food loss happens.[146] While many of the solutions are known and in-demand, particularly sealed bags for grain and cold storage rooms, adoption is greatly impeded by a lack of funding and implementation capacity. To address this, policymakers can develop incentives, clear guiding policies and/or regulations, and build capacity to boost infrastructure for storage and transportation to enable more widespread adoption. Improving access to technology, incentivizing knowledge-sharing, and promoting the creation of new markets (including for upcycled products and imperfect produce) also play an important role in scaling-up these climate-mitigation measures.

Technology transfer and development initiatives that form alliances between governments, non-governmental organizations, industries, and academics can provide sustainable solutions to cold-chain challenges. In Kenya, for example, the Africa Centre of Excellence for Sustainable Cooling and Cold Chain trained over 300 farmers in cold chain operations, logistics and market pricing strategies and provided cold chain equipment to store and haul a range of produce, including broccoli, cauliflower, carrots, spinach, cabbages, leeks, and potatoes.

PRIORITY ACTIONS

- Create and support public-private partnerships to expand access to affordable, climate resilient storage technologies, cold chain services, and reliable transport options.
- Enforce standardized regulations for food handling, storage, and transport while strengthening institutional capacity, data systems, and inspection mechanisms.
- Strengthen farmer training on post-harvest handling and quality management to maintain product quality and reduce spoilage.
- Develop markets for recycled food scraps, byproducts, and imperfect produce to reduce waste and build stronger food systems.

REFORESTATION AND FRESHWATER ECOSYSTEM RESTORATION

330 $MtCO_2$/yr

This Action Track focuses on the ecological restoration of forests and freshwater ecosystems. Ecological restoration is the process of assisting the recovery of a native ecosystem that has been degraded, damaged, or destroyed.[148] Restoration solutions are characterized based on effort and cost required, which ranges from spontaneous natural regeneration, to assisted natural regeneration, to direct planting of native species. The appropriate approach in each area will depend on the ecological state of the landscape, the extent of degradation, any ongoing risk of further degradation (including impacts from climate change), and the resources available.[149]

The mitigation potential and examples in this chapter focus on freshwater ecosystem restoration and reforestation efforts in native forest areas. This is to ensure that important non-forest ecosystems, such as savannas and woodlands, are not misclassified as degraded forests and erroneously targeted for reforestation efforts. The restoration of non-forest ecosystems is addressed in the 'Sustainable Community Wood Use' Action Track.

Restoration of forests and freshwater ecosystems in sub-Saharan Africa has the potential to mitigate **1.6 Gt CO_2e by 2030** and **8.2 Gt CO_2e by 2050**.

Degradation and conversion of natural ecosystems is a global problem that endangers biodiversity and accounts for almost a third of anthropogenic carbon emissions. While sub-Saharan Africa retains some of the largest intact ecosystems in the world, most are facing growing pressures due to human development, agricultural expansion, and climate change. Six percent of eastern and southern Africa's

wetlands have been degraded in the past 20 years alone,[150] and nearly three million hectares of forests are lost annually.[151]

In degraded forest landscapes, reforestation approaches can vary considerably according to local conditions. On one end of the spectrum, unassisted regeneration can recover forest cover based on the prior ecosystem type and surrounding landscape.[152] In the tropics, this approach can be much more cost- and labor-effective than direct planting/seeding,[153] but it is more likely to be effective in remote areas, on steep slopes, and near forest fragments or recently deforested areas.[151] On the other end of the spectrum, interspersed sowing of seeds with sporadic planting of seedlings can be a cost-effective but more labor-intensive way to reforest land, where ecologically appropriate. Assisted natural regeneration of forests is a middle-ground approach, which typically leads to the establishment of a high percentage of native species.

Reforestation and freshwater ecosystem restoration improves the condition and area of natural ecosystems by creating physical and ecological connections that typically benefit biodiversity.[154–160] Freshwater and wetland ecosystem restoration involves similar considerations around the costs and benefits of different restoration approaches, but the movement of water adds another layer of complexity. To address this, natural infrastructure like wetlands and riparian forests can be used to stop erosion and allow water to return to carbon-rich freshwater ecosystems. Wetland restoration supports terrestrial freshwater resources and biodiversity while enhancing water quality. Africa is home to approximately 40 million hectares of peatlands (eight percent of the global total), and the Congo basin is home to some of the largest tropical peat carbon stocks globally. Restoring these wetlands offers tremendous potential for climate mitigation and adaptation, since peatlands not only store carbon but maintain water flows, reduce flood risks, and buffer communities against drought. Restoring degraded freshwater ecosystems to their natural historical state can also help people minimize risks related to natural disasters.[30, 161–165]

Reforestation and freshwater ecosystem restoration can improve water quality[30] and pollinator availability,[166] both of which can benefit agricultural livelihoods and enhance the resilience of agricultural systems. The use of indigenous food plants and practices[167] in restoration efforts can not only help avoid potential negative impacts of non-native species, but also provide additional sources of nutrition and jobs, reducing impacts of climate shocks to food

Communities and other stakeholders in the Lake Alaotra region in Ambatondrazaka, Madagascar have restored 5,000 hectares of degraded catchments in collaboration with the government. By incorporating traditional systems of restoration and considering ethnobotany, these restoration efforts have increased biodiversity and provided employment locally to more than 500 inhabitants.

An effort to plant 16 million trees over seven years is currently underway in central Cameroon. The Green Reforestation Project[171] plans to re-establish tree cover across previously deforested areas to sequester 7.8 Mt CO_2e over the lifetime of the project by working with local communities to plant a mix of indigenous trees alongside fruit and nut bearing trees. Beyond carbon mitigation, the project includes benefits to local communities through market and healthcare access and community training.

systems. Scaling up restoration efforts requires a close collaboration between land managers, indigenous peoples and local communities, policymakers, and financial institutions.

Land managers need to be actively engaged in restoration efforts from the conception phase, through public and community consultations, as projects under local ownership and driven by local needs are more successful and durable.[168, 169] Public institutions and their partners (such as non-governmental organizations and private companies) must work closely with the local community and address practical constraints to restoration and remove barriers. It is also important to consider the length of time it takes for restoration efforts to yield benefits, which can be particularly challenging for project developers and local communities. For this reason, financers of restoration projects should establish long-term finance systems and foster the creation of local businesses that can carry out labor-intensive restoration projects, to create rural jobs and focus benefits within the community. Finally, governments can promote cross-border and cross-landscape collaboration (such as the African Forest Landscape Restoration Initiative, the Central African Forest Initiative, and the Freshwater Challenge) to enhance cooperation and foster economies of scale, while simultaneously addressing the underlying drivers of deforestation and degradation.

PRIORITY ACTIONS

- → Anchor restoration action in well-recognized ecological restoration principles and standards and ensure that restored landscapes meet the needs of local communities.
- → Foster the growth of small businesses that can implement labor-intensive restoration projects and improve seed supply systems for direct restoration.
- → Promote natural regeneration of ecosystems as a cost- and labor-effective alternative to direct planting.
- → Promote collaboration across borders and landscapes to scale up restoration efforts.

CLIMATE-SMART COASTS

10 $MtCO_2$/yr

Blue carbon refers to carbon that passes through, and is stored in, coastal ecosystems with rooted vegetation – including salt marshes, mangroves, and seagrasses.[173, 174] These ecosystems store carbon at a rate up to five times higher than forests on land[175] and are also critical for supporting biodiversity, ecosystem services and the livelihoods of local people. Africa contains substantial blue carbon resources – 20 percent of the world's mangroves are found within 34 African countries, three quarters of which are on the west coast.[176, 177] Mozambique, Madagascar and South Africa all contain salt marshes (with Mozambique ranking sixth globally in terms of total area),[178] while Guinea, Guinea-Bissau, and Seychelles have robust seagrass beds that are vital for fisheries.[179]

These vital ecosystems are threatened by conversion to aquaculture, agriculture, and urban development, unsustainable extractive uses, and indirect climate impacts like sea level rise and shoreline erosion.[180, 181, 182, 187] Increasing population density along African coasts is putting pressure on these carbon-rich ecosystems which are being squeezed between rising sea levels and expanding cities. Coastal areas are highly sensitive to climate variability and are expected to be threatened by both sea level rise and extreme weather events,[184] making widespread coastal protection and restoration critical for climate adaptation.[183, 185] Their protection and restoration are critical for supporting people and nature.

Protection and restoration of mangroves and tidal marshes has the potential to mitigate **0.04 Gt CO_2e by 2030** and **0.19 Gt CO_2e by 2050**.

The carbon mitigation potential of future climate and development pressure was not

Kenya's locally managed marine areas demonstrate the power of local management that is funded and supported effectively by both governmental and non-governmental agencies. For instance, on Wasini Island, the Wasini Women's Group manages the restoration of mangrove forests and coral reefs with support from the Coastal Development Authority, Kenya Forest Services, Kenya Marine and Fisheries Research Institute, and National Environment Management Facility. The women who lead and run the group, with support from these agencies, have established nurseries, mapped areas for restoration, and planted seedlings to restore degraded areas and protect mangroves under threat. This has improved marine biodiversity, including fisheries, and provided opportunities for tourism along the Wasini Women's Group boardwalk.[206]

explicitly included in this Action Track. However, other coastal and marine phenomena, like macroalgae, marine sediment, and unvegetated tidal flats are emerging as potential ecological mechanisms for blue carbon ecosystems[182] and could provide added carbon mitigation benefits beyond those highlighted in this Roadmap.

Blue carbon ecosystems should be incorporated into the design and management of marine protected areas.[186] Other effective conservation mechanisms, including locally managed marine areas, also provide fair and effective carbon mitigation through local ownership, use, control, and incorporation of traditional management practices.[187] For example, coastal communities in Mozambique see clear ecosystem service benefits to incentivize protection of seagrasses.[188]

Coastal restoration involves the recovery and rehabilitation of vegetation in mangrove forests, seagrass beds, and tidal marshes. The exact process varies by ecosystem type and local factors, but generally involves restoring the tidal water flow, managing sediment, and seeding and replanting native vegetation. Green-gray infrastructure is an ecosystem-based adaptation solution that employs ecosystem restoration with conventional human-engineered infrastructure to optimize co-benefits (e.g., habitat, water quality) and strengthen community resilience. Developing such approaches simultaneously promotes both climate mitigation and adaptation. Because these ecosystems are often located near fishing communities, it is essential to work with them to jointly develop and implement durable restoration strategies.[189]

Although Africa's coast extends over 40,000 kilometers and covers 38 island and continental countries, blue carbon ecosystems represent a relatively small area compared to terrestrial forests. Nonetheless, they provide significant benefits beyond climate mitigation.[183] Conserving and restoring blue carbon ecosystems helps protect coastal communities from extreme weather by buffering wave energy and reducing the impacts of sea-level rise.[190, 191]

Protecting seascapes has also been found to improve the health of fisheries around protected marine areas,[192, 199] to increase regional food security,[193, 194] and support biodiversity, habitats, and feeding grounds for other marine, brackish, and terrestrial species. Because these ecosystems provide so many services to coastal populations, their sustainable management can directly support livelihoods and cultural practices[195] and help communities adapt to climate change impacts.[196] Additional indirect benefits arise from improved governance and capacity-building associated with community projects[197] funded by carbon payments and tourism revenues.[198]

Blue carbon ecosystems play a central role in supporting coastal populations' livelihoods, including contributions to food security, harvesting of natural products, and cultural practices. Because these systems often overlap across statutory and customary tenure systems, relying solely on formal legal frameworks to design conservation initiatives is often

West Africa Blue is working to protect and restore mangroves in West African coastal ecosystems, developing a blue carbon project covering over 74,000 hectares of mangroves in the Moyamba and Bonthe districts of Sierra Leone in partnership with local communities and chiefdoms, the national government, and multiple local and international partners. The project aims to not only mitigate 0.1 - 1.0 Mt CO_2e per year but also provide opportunities for employment and protect endangered species.[207]

inadequate.[199] Co-management between the government, private sector, and coastal populations, with tenure retained and managed by the populations themselves, is effective.[200]

National governments can support the implementation and scaling of these projects by ensuring that blue carbon stocks and flows are considered in their climate and biodiversity commitments, and by working with communities to create inventories of these critical resources.[201, 202] Non-market approaches under Article 6.8 of the Paris Agreement also offer opportunities for increased investment, improved technology, and capacity building. Local and regional governments are key to establishing, managing, and enforcing regulations for protected areas that encompass blue carbon ecosystems. These sub-national governments are also well-placed to monitor benefits-sharing arrangements.

Blue carbon projects are attractive for the carbon finance market. In mangrove ecosystems alone, around 20 percent of existing conservation projects (2.5 million hectares globally) could qualify for blue carbon financing.[210] As of 2025, blue carbon crediting projects were under development in Kenya, Tanzania, Benin, Cameroon, Madagascar, Senegal, the Gambia, Guinea, Sierra Leone, Nigeria, and Mozambique among others.[203, 210] The scientific community can help advance more of these projects by prioritizing research on both the carbon and non-carbon benefits of established and emerging blue carbon ecosystems – especially in Africa – to give potential investors greater confidence in their viability. Open-access global databases such as Global Mangrove Watch[204] are informing the development of new blue carbon interventions.[205]

PRIORITY ACTIONS

- **Highlight the benefit of mangroves, seagrasses, and saltmarshes as natural infrastructure to local communities.**
- **Support the establishment and maintenance of protected areas by embedding blue carbon in national climate and biodiversity policies.**
- **Invest in blue carbon inventories and leverage climate finance such as Article 6 of the Paris Agreement, voluntary carbon markets, and blended finance mechanisms.**
- **Encourage private and financial sector interest by investing in data and capacity to model the economic value of blue carbon ecosystems for fishing, tourism, and disaster risk reduction.**


ACCELERATING NATURAL
CLIMATE SOLUTIONS

This Roadmap outlines a collaborative framework for sub-Saharan Africa to lead global climate mitigation efforts while advancing the sustainable development priorities outlined in the African Union's Agenda 2063. Refining and deepening the understanding of natural climate solutions – grounded in the lived experiences of African people and their relationship with nature – requires careful stewardship of Africa's natural capital.

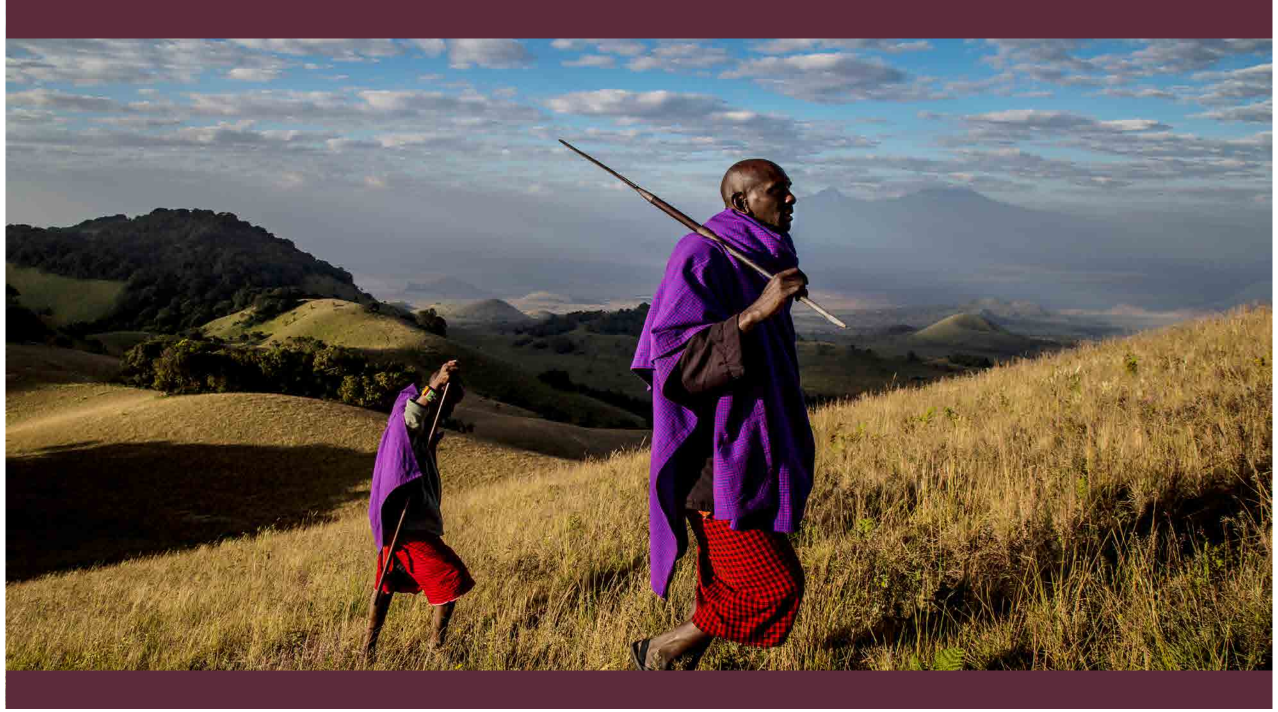
Effective solutions must be context-specific, reflecting the cultural, regional, and climate ambitions unique to each setting. Each Action Track in this Roadmap identifies priority actions, recognizing that specific actions must be locally relevant and developed through extensive consultation with stakeholders and experts. The science is clear – Africa has the potential to take a leading role in global climate mitigation efforts while securing sustainable development and climate adaptation outcomes.

However, it is also clear that the transformational change needed to support Agenda 2063 goals and achieve national and international targets for climate and biodiversity is only possible through substantive and sustained shifts in thoughts, actions, and collaborations across scales and sectors. That means that governments, financial actors, academics, civil society, and businesses must leverage their individual strengths while also engaging in cross-sector communication and collaboration. This chapter outlines some of the highest priority actions that can be taken to accelerate natural climate solutions on the ground to support a prosperous future for Africa.

Create positive economic incentives to support ecosystem protection, sustainable management, and restoration
Governments can create policies that encourage environmental protection by designing incentives that make sustainable practices more attractive and easier to implement. These policies help turn environmental initiatives from temporary efforts into lasting, integrated approaches that become a natural part of how society operates. Climate- and biodiversity-focused measures should be defined and integrated into a country's nationally determined contributions, national adaptation plans, national biodiversity strategy and action plans, and national development plans. Aligning national climate, biodiversity, and development targets will reinforce their importance, maximize synergistic outcomes, channel funding, and act as a policy touchstone for decision-making.

Under Article 6 of the Paris Agreement, market and non-market approaches offer opportunities for enhanced cooperation and investments. Market mechanisms (Article 6.2 or 6.4) enable bilateral cooperation through the transfer of emissions reductions or removals, while non-market avenues (Article 6.8) facilitate climate action and support sustainable development in the form of capacity-building, technology transfer, climate finance, or debt-for-nature swaps, among others. Additional financial opportunities to support implementation of the Roadmap include development of performance-based payments or actively scaling carbon projects into compliance systems, the voluntary carbon market, and the international carbon market, such as the Carbon Offsetting and Reduction Scheme for International Aviation.

At a national level, policy reforms can promote the transition to a green and nature-positive economy. This includes, but is not limited to, low-interest loans for the agricultural transition, early investment in climate-smart businesses, reforming environmentally harmful incentives, and scaling up payments for ecosystem services. Importantly, many of these actions simultaneously support climate mitigation, adaptation, sustainable development objectives, and biodiversity conservation. Buffering against climate shocks, diversifying livelihoods, and assuring water quality, for example, are all important climate adaptation measures that can be facilitated by policy actions. Such policy measures lay the foundation for resilient, inclusive, and climate-aligned growth across Africa.



Recognize and protect the rights of indigenous peoples and local communities
Africa's indigenous peoples and local communities are vital custodians of natural resources and ecosystems. Their rights to land and resources are deeply tied to cultural identity, livelihoods, biodiversity conservation, and climate stability. Indigenous peoples and local communities need to be able to use their agency and knowledge to inform and guide decision-making processes. Given the long history of land and water stewardship, indigenous and local knowledge and practices are strongly tied to the health of nature and can be the source of innovative ideas which, when scaled broadly, can unlock more opportunities for climate mitigation.

To ensure the long-term sustainability of natural climate solutions in Africa, other actors need to support, empower, and center the rights and perspectives of indigenous peoples and local communities. Policymakers and investors must ensure legal recognition of customary land rights, uphold the principle of free, prior, and informed consent, and promote inclusive decision-making. Civil society needs to build legal awareness and capacity while recognizing the power of indigenous and local knowledge. Information and knowledge providers need to account for indigenous and local knowledge that can illuminate both the barriers to sustainable resource management and provide additional avenues to strengthen the social foundations of climate resilience.

Elevate African perspectives in global science and support African civil society

Knowledge generation and sharing is a critical part of the decision-making process that can transform our relationship with nature, and influence both climate mitigation and the ability for nature to provide for people. Given the power it holds, this knowledge needs to be based on the lived experiences of African people and their relationship with nature. Despite making up 18 percent of the global population, African researchers remain underrepresented in major climate science, such as the Intergovernmental Panel on Climate Change Assessment Reports, AR6 reports, where they comprised only nine percent of authors.[208] While African participation in forums like the United Nations Framework Convention on Climate Change is growing, stronger regional coordination is needed to balance diverse national interests and increase influence. Policymakers and financiers need to increase funding for African scientists and elevate and amplify African voices in international climate dialogues. Identifying strategic opportunities for coordinated engagement, and ensuring free access to high quality scientific resources, will allow Africans to help generate much needed data to shape global climate policy and ensure that their needs and priorities are reflected in relevant decisions.

Steer public and private sector finance towards natural climate solutions

Africa faces a climate adaptation financing gap of US$166 – US$260 billion from international sources between 2020 and 2030 and an infrastructure financing gap of US$68 - 108 billion per year.[209] While the agriculture, forestry, and land-use sector is projected to be a US$1 trillion market by 2030, it receives only nine percent of public funding.[210] A multi-pronged approach is therefore essential to steer financing towards natural climate solutions.

1. **Mobilize domestic capital and expand green bond markets**
   A strong domestic capital market is critical for unlocking private investment. For example, national development banks can issue sustainability-linked bonds, de-risk commercial lending to small businesses working on natural climate solutions and catalyze domestic green bond markets to develop a pipeline of investable projects.

2. **Leverage development banks and international finance institutions**
   Regional and national development banks are vital connectors, linking natural climate solutions with international finance. Multilateral climate funds play a unique role by providing grant-based funding to countries with limited private sector activity and supporting countries at high risk of debt distress through tools like debt-for-climate swaps, which free up fiscal space for investment in natural climate solutions. For example, the Green Climate Fund can provide funding to de-risk project development and attract private capital.

3. **Support the development of market and non-market approaches**
   Africa should prioritize market and non-market carbon mechanisms as pathways to generate climate finance, assure sustainable development and drive low-emission, nature-positive growth. Africa's share of the global voluntary carbon market grew from 10 percent in 2021 to 26 percent in 2023,[211] however, structural issues – such as weak market integrity, opaque intermediaries, and poor benefit-sharing with communities – limit its potential. The Africa Carbon Markets Initiative estimates Africa could generate up to US$6 billion per year by 2030 from carbon-credit revenues if the right rules are in place.[212]
   To address these challenges, governments can adopt strong regulatory frameworks, as seen in Kenya and the Seychelles, and set fair public revenue rates (around 30 percent) while ensuring meaningful benefits reach local communities.[213] Buyers can drive reform by insisting on transparency, equitable benefit-sharing clauses, and the right to revoke credits if integrity standards are violated.

4. **Scale up climate budget tagging**
   A major barrier to scaling climate finance in Africa is data scarcity. Only 17 countries currently implement climate budget tagging, which tracks public climate spending.[37] Expanding and standardizing this practice across the continent can help governments to identify existing climate-related expenditures, better estimate the costs of investment-ready plans, create a secure foundation for blended finance, and offer greater transparency for investors.

Actions that mobilize finance for nature, reform national policies, or strengthen capacity and knowledge sharing among key land users – including land managers and indigenous peoples and local communities – are essential for creating durable natural climate solutions, grounded in local realities. When these efforts are informed by the values, knowledge, and sense of agency of indigenous peoples and local communities, and other land users, they can effectively guide decision-makers and custodians of nature toward protecting, managing, and restoring ecosystems for healthier lands, waters, and communities.

APPENDICES

METHODS

Climate-critical landscape protection

We determine carbon sequestration potential by focusing on areas that are at risk of conversion based on future projections.
We use a modified version of an integrated spatial planning framework[214] that allocates land for conservation, croplands, and pasturelands. The framework takes the SSP2-RCP4.5 as the baseline and explores alternative spatial planning scenarios that maximize carbon sequestration potential in conjunction with biodiversity conservation, while maintaining food production.
The calculated carbon mitigation is the difference between the optimized scenario and the baseline scenario.

Lead Institution: Conservation International

Climate-smart forestry

We extracted carbon mitigation potential for sub-Saharan Africa from the Climate Smart Forestry pathway in NatureBase.[215] This dataset is based on the estimated emissions from selective logging and the reduction of these emissions if Reduced Impact Logging for Climate (RIL-C) practices were to be implemented. Emissions and emission reductions are calculated based on country-scale estimates of timber harvest volumes from selective logging and the biome type in that country. The annual carbon mitigation potential from RIL-C is determined by allocating these reductions in emissions to areas/pixels where selective logging could occur.

Lead Institution: The Nature Conservancy

Sustainable community wood use

We generated carbon mitigation estimates for above-ground and soil organic carbon potential for non-forested landscapes across sub-Saharan Africa in areas with less than 30 percent cultivation at the catchment level. In these areas, we compare the current state of ecosystem characteristics to a reference state which is based on ecologically relevant levels of the major processes driving tree/grass ratios.
Climate mitigation potential from changes in above-ground carbon was assessed by comparing observed current biomass distributions in each catchment of the continent with the biomass distributions of this ‘reference state’.
Climate mitigation potential from changes in soil organic carbon was assessed through modelled predictions of the impacts of changed tree cover on soil organic carbon stocks (CENTURY model).

Lead Institution: Future Ecosystems for Africa, Wits University

OPPENHEIMER GENERATIONS

Sustainable livestock and fire management

We compared a scenario of reduced grazing intensity with a reference scenario where grazing intensity was unchanged to derive the carbon mitigation potential to 2050 under SSP2-RCP4.5. Based on the impacts of grazing intensity on ecosystem carbon derived for sub-Saharan Africa,[215] we imposed a 30 percent reduction in grazing intensity in Af-Range[216] – a spatially-explicit process-based model that incorporates the relationships between grazing, vegetation, fire, and other biogeochemical processes. Carbon mitigation estimates of improved grazing management include above-ground, below-ground, and soil carbon, and accounts for environmental and climatic variations over space and time.

Lead Institution: Conservation South Africa, University of Cape Town

Climate-smart farming and cultivation

We extracted the carbon mitigation potential for Climate-Smart Farming and Cultivation in sub-Saharan Africa from the Total Cropland pathway in NatureBase.[4] This pathway combines carbon mitigation estimates from three natural climate solution pathways following an accounting narrative to avoid double counting. Cropland-Based Agroforestry combines expert elicitations to identify maximum tree cover potential in agricultural lands[218] with regionally-specific carbon sequestration estimates.[219] Increased Soil Carbon in Croplands applies IPCC Tier One emissions factors for cover crops, reduced tillage, and biochar to soil carbon stock maps. Finally, Reduced Emissions in Cropland incorporates emissions reduction from improved rice cultivation and nutrient management.[220]

Lead Institution: The Nature Conservancy

Reduced food loss

We extracted regional emissions data for crops and energy use in agriculture and compared them to regional food production. Data from several domains across the UN Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) were used for this Action Track analysis, namely: Production, Food Balances, Agri-Food Systems Emissions, and Farm Gate.[221] We then extracted total food losses across the region to understand how much of the emissions from crops and energy use in agriculture are in essence 'wasted' due to food being spoiled on farms, or in post-harvest supply chains. We compared these to regional emissions indicators (per capita and per value of agricultural production) to understand Africa's potential to reduce food losses on-farm and post-harvest.

Lead Institution: Conservation International

Reforestation and freshwater ecosystem restoration

We extracted carbon mitigation potential for reforestation from the Reforestation natural climate solutions pathway in NatureBase.[4] The reforestation potential is limited to previously forested areas and further limited based on practical or precautionary constraints.[222] The mitigation potential from forest regrowth is then calculated based on estimates of above- and below-ground carbon sequestration during the first 30 years of forest regrowth[223] and reduction of climate mitigation potential from changes in albedo.[224]

Lead Institution: The Nature Conservancy

Climate-smart coasts

We combined carbon mitigation potential from the Avoided Coastal Wetland Impacts pathway and the Coastal Wetland Restoration pathways from NatureBase[4] for this Action Track. The Avoided Coastal Wetland Impacts pathway was generated from extent maps of mangroves and tidal marshes, national loss rates, spatially explicit biomass and soil carbon stock, and emission factors. Carbon mitigation estimates are therefore based on avoided loss of above- and below-ground carbon for mangroves and soil organic carbon loss, for both mangroves and tidal marshes that were determined to be at risk. The Coastal Wetland Restoration pathway includes mangrove and tidal marsh restoration based on global estimates of restorable areas and drivers of loss.[204, 225] The mitigation potential estimate includes above-ground biomass, below-ground biomass, and soil organic carbon using IPCC sequestration rates.

Lead Institution: The Nature Conservancy

REFERENCES

1. Pereira, Laura M., et al. “Six Principles to Get Natural Climate Solutions Right in Africa.” *Nature Sustainability*, vol. 8, no. 11, Nov. 2025, pp. 1238–41. *www.nature.com*, https://doi.org/10.1038/s41893-025-01652-3.

2. Tabash, Mosab I., et al. “Dynamic Linkage between Natural Resources, Economic Complexity, and Economic Growth: Empirical Evidence from Africa.” *Resources Policy*, vol. 78, Sep. 2022, p. 102865. *ScienceDirect*, https://doi.org/10.1016/j.resourpol.2022.102865.

3. Zickfeld, Kirsten, et al. “Net-Zero Approaches Must Consider Earth System Impacts to Achieve Climate Goals.” *Nature Climate Change*, vol. 13, no. 12, Dec. 2023, pp. 1298–305. *www.nature.com*, https://doi.org/10.1038/s41558-023-01862-7.

4. “Our Aspirations for the Africa We Want.” Africa Union, https://au.int/agenda2063/aspirations

5. Collins, Natasha, et al. "Growing Resilience: Unlocking the Potential of Nature-Based Solutions for Climate Resilience in Sub-Saharan Africa". *World Bank*, 2025, https://doi.org/10.1596/42952.

6. Africa Center for Strategic Studies. “African Biodiversity Loss Raises Risk to Human Security.” *Africa Center*, 7 Dec. 2022, https://africacenter.org/spotlight/african-biodiversity-loss-risk-human-security/.

7. Griscom, Bronson W., et al. “Natural Climate Solutions.” *Proceedings of the National Academy of Sciences*, vol. 114, no. 44, Oct. 2017, pp. 11645–50, https://doi.org/10.1073/pnas.1710465114.

8. Cook-Patton, Susan C., et al. “Protect, Manage and Then Restore Lands for Climate Mitigation.” *Nature Climate Change*, vol. 11, no. 12, 12, Dec. 2021, pp. 1027–34. www.nature.com, https://doi.org/10.1038/s41558-021-01198-0.

9. Wolosin, Michael, et al. "Exponential Roadmap for Natural Climate Solutions." *Conservation International*, 20 Sep. 2022, https://cicloud.s3.amazonaws.com/docs/default-source/s3-library/publication-pdfs/exponential-roadmap-for-natural-climate-solutions.pdf.

10. “African Natural Capital Alliance stress tests exposure to nature-related risks across Africa.” Africa Natural Capital Alliance, 5 Dec. 2023. Africa Natural Capital Alliance 2023, https://africannaturalcapitalalliance.com/theancaplus/uploads/2023/12/ANCA-COP28-Report-Press-Release.pdf. Press release, PDF download.

11. Aurélien, Ateba Boyomo Henri. “Vulnerability to Climate Change in Sub-Saharan Africa Countries. Does International Trade Matter?” *Heliyon*, vol. 11, no. 4, Feb. 2025. *www.cell.com*, https://doi.org/10.1016/j.heliyon.2025.e42517.

12. “State of the Climate in Africa 2023.” World Meteorological Organization, 2024. https://library.wmo.int/records/item/69000-state-of-the-climate-in-africa-2023

13. Hashemi, M.G.Z., Shaad, K., Griffey, V. et al. Mapping global freshwater ecosystems to guide national restoration targets and nature-based solutions. *Nat Water* (2026). https://doi.org/10.1038/s44221-025-00573-x

14. Food Security Information Network and Global Network Against Food Crises. “Global Report on Food Crises 2025”. Rome, 2025. Food Security Information Network (FSIN), https://www.fsinplatform.org/grfc2025.

15. United Nations Department of Economic and Social Affairs, Population Division. "World Population Prospects 2024". United Nations, https://population.un.org/wpp/.

16. Noon, Monica L., et al. “Mapping the Irrecoverable Carbon in Earth’s Ecosystems.” *Nature Sustainability*, vol. 5, no. 1, 1, Jan. 2022, pp. 37–46. *www.nature.com*, https://doi.org/10.1038/s41893-021-00803-6.

17. Hurtt, George C., et al. “Harmonization of Global Land Use Change and Management for the Period 850–2100 (LUH2) for CMIP6.” *Geoscientific Model Development*, vol. 13, no. 11, Nov. 2020, pp. 5425–64, https://doi.org/10.5194/gmd-13-5425-2020.

18. Popp, Alexander, et al. “Land-Use Futures in the Shared Socio-Economic Pathways.” *Global Environmental Change*, vol. 42, Jan. 2017, pp. 331–45. *ScienceDirect*, https://doi.org/10.1016/j.gloenvcha.2016.10.002.

19. Duncanson, L., et al. “The Effectiveness of Global Protected Areas for Climate Change Mitigation.” *Nature Communications*, vol. 14, no. 1, Jun. 2023, p. 2908. *www.nature.com*, https://doi.org/10.1038/s41467-023-38073-9.

20. Bebber, Daniel P., and Nathalie Butt. “Tropical Protected Areas Reduced Deforestation Carbon Emissions by One Third from 2000–2012.” *Scientific Reports*, vol. 7, no. 1, Oct. 2017, p. 14005. www.nature.com, https://doi.org/10.1038/s41598-017-14467-w.

21. Coad, Lauren, et al. “Widespread Shortfalls in Protected Area Resourcing Undermine Efforts to Conserve Biodiversity.” *Frontiers in Ecology and the Environment*, vol. 17, no. 5, 2019, pp. 259–64. *Wiley Online Library*, https://doi.org/10.1002/fee.2042.

22. Nowakowski, Justin A., et al. “Protected Areas Slow Declines Unevenly across the Tetrapod Tree of Life.” *Nature*, vol. 622, no. 7981, Oct. 2023, pp. 101–06. *www.nature.com*, https://doi.org/10.1038/s41586-023-06562-y.

23. Cazalis, Victor, et al. “Effectiveness of Protected Areas in Conserving Tropical Forest Birds.” *Nature Communications*, vol. 11, no. 1, Sep. 2020, p. 4461. *www.nature.com*, https://doi.org/10.1038/s41467-020-18230-0.

24. Schmidt, Chloé, et al. “A Survey of Mammal and Fish Genetic Diversity Across the Global Protected Area Network.” *Conservation Letters*, vol. 18, no. 2, 2025, p. e13092. *Wiley Online Library*, https://doi.org/10.1111/conl.13092.

25. Geldmann, Jonas, et al. “Effectiveness of Terrestrial Protected Areas in Reducing Habitat Loss and Population Declines.” *Biological Conservation*, vol. 161, May 2013, pp. 230–38. *ScienceDirect*, https://doi.org/10.1016/j.biocon.2013.02.018.

26. Ament, Judith M., and Graeme S. Cumming. “Scale dependency in effectiveness, isolation, and social-ecological spillover of protected areas.” *Conservation Biology*, vol. 30, no. 4, 2016, pp. 846–55. *Wiley Online Library*, https://doi.org/10.1111/cobi.12673.

27. Acreman, Michael, et al. “Protected Areas and Freshwater Biodiversity: A Novel Systematic Review Distils Eight Lessons for Effective Conservation.” *Conservation Letters*, vol. 13, no. 1, 2020, p. e12684. *Wiley Online Library*, https://doi.org/10.1111/conl.12684.

28. Scanlon, Bridget R., et al. “Global Water Resources and the Role of Groundwater in a Resilient Water Future.” *Nature Reviews Earth & Environment*, vol. 4, no. 2, Feb. 2023, pp. 87–101. *www.nature.com*, https://doi.org/10.1038/s43017-022-00378-6.

29. Acreman, M, et al. “Evidence for the Effectiveness of Nature-Based Solutions to Water Issues in Africa.” *Environmental Research Letters*, vol. 16, no. 6, Jun. 2021, p. 063007. *Institute of Physics*, https://doi.org/10.1088/1748-9326/ac0210.

30. Lalonde, Morgane, et al. “Scientific Evidence of the Hydrological Impacts of Nature-Based Solutions at the Catchment Scale.” *WIREs Water*, vol. 11, no. 5, 2024, p. e1744. *Wiley Online Library*, https://doi.org/10.1002/wat2.1744.

31. Hipólito, Juliana, et al. “Valuing Nature’s Contribution to People: The Pollination Services Provided by Two Protected Areas in Brazil.” *Global Ecology and Conservation*, vol. 20, Oct. 2019, p. e00782. *ScienceDirect*, https://doi.org/10.1016/j.gecco.2019.e00782.

32. Adams, William. M., et al. “Biodiversity Conservation and the Eradication of Poverty.” *Science*, vol. 306, no. 5699, Nov. 2004, pp. 1146–49. *science.org (Atypon)*, https://doi.org/10.1126/science.1097920.

33. Oldekop, J. A., et al. “A global assessment of the social and conservation outcomes of protected areas.” *Conservation Biology*, vol. 30, no. 1, 2016, pp. 133–41. *Wiley Online Library*, https://doi.org/10.1111/cobi.12568.

34. Dawson, Neil M., et al. “The Role of Indigenous Peoples and Local Communities in Effective and Equitable Conservation.” *Ecology and Society*, vol. 26, no. 3, 2021, p. art19. *DOI.org (Crossref)*, https://doi.org/10.5751/ES-12625-260319.

35. Meattle, Chavi, et al. "Landscape of Climate Finance in Africa 2024." *Climate Policy Initiative*, 22 Oct 2024, https://www.climatepolicyinitiative.org/publication/landscape-of-climate-finance-in-africa-2024/

36. Carodenuto, Sophia, and Marcelyn Buluran. “The Effect of Supply Chain Position on Zero-Deforestation Commitments: Evidence from the Cocoa Industry.” *Journal of Environmental Policy & Planning*, vol. 23, no. 6, Nov. 2021, pp. 716–31. *Taylor and Francis+NEJM*, https://doi.org/10.1080/1523908X.2021.1910020.

37. International Union for Conservation of Nature. “Dynamic Governance Model in Ethiopia’s Central Highlands.” IUCN, 28 Jan. 2019, https://www.iucn.org/news/protected-areas/201901/dynamic-governance-model-ethiopias-central-highlands.; Yimer, Solomon. “Tested by COVID and War, an Indigenous Conservation System in Ethiopia Prevails.” Mongabay, 4 July 2023, https://news.mongabay.com/2023/07/tested-by-covid-and-war-an-indigenous-conservation-system-in-ethiopia-prevails/.

38. Teshome, Endalkachew, et al. “Current Community Based Ecotourism Practices in Menz Guassa Community Conservation Area, Ethiopia.” *GeoJournal*, vol. 86, no. 5, Oct. 2021, pp. 2135–47. *Springer Link*, https://doi.org/10.1007/s10708-020-10179-3.

39. Maru, Yoseph, et al. “Indigenous Sacred Forests as a Tool for Climate Change Mitigation: Lessons from Gedeo Community, Southern Ethiopia.” *Journal of Sustainable Forestry*, vol. 42, no. 3, Mar. 2023, pp. 260–87. *Taylor and Francis+NEJM*, https://doi.org/10.1080/10549811.2021.2007490.

40. Ur Rehman, Hafeez, et al. “A Carbon-Sink in a Sacred Forest: Biologically-Driven Calcite Formation in Highly Weathered Soils in Northern Togo (West Africa).” *CATENA*, vol. 198, Mar. 2021, p. 105027. *ScienceDirect*, https://doi.org/10.1016/j.catena.2020.105027. ; Sinthumule, Ndidzulafhi Innocent. “Sacred Forests as Repositories of Local Biodiversity in Africa: A Systematic Review.” *Forest Science and Technology*, vol. 20, no. 4, Oct. 2024, pp. 337–48. *Taylor and Francis+NEJM*, https://doi.org/10.1080/21580103.2024.2397522.

41. Shryock, Ricci. “Meet the People Safeguarding the Sacred Forests and Lagoons of West Africa.” *NPR*, 5 Feb. 2023, https://www.npr.org/sections/pictureshow/2023/02/05/1149824796/photos-of-sacred-forests-and-lagoons-of-west-africa.

42. Cuni-Sanchez et al. (2021). “High Aboveground Carbon Stock of African Tropical Montane Forests.” *Nature* 596 (7873): 536. doi:10.1038/s41586-021-03728-4.

43. Wei, X. et al., (2023). “Monitoring forest dynamics in Africa during 2000-2020 using a remotely sensed fractional tree cover dataset.” *International Journal of Digital Earth* 16(1): 2212–2232. doi.org/10.1080/17538947.2023.2220613.

44. Cuni-Sanchez, Aida, et al. “High Aboveground Carbon Stock of African Tropical Montane Forests.” *Nature*, vol. 596, no. 7873, Aug. 2021, pp. 536–42. *www.nature.com*, https://doi.org/10.1038/s41586-021-03728-4.

45. Malhi, Yadvinder, et al. “The Past, Present and Future of Africa’s Rainforests.” *Philosophical Transactions of the Royal Society B: Biological Sciences*, vol. 368, no. 1625, Sep. 2013, p. 20120293. *Silverchair*, https://doi.org/10.1098/rstb.2012.0293.

46. Ruslandi, et al. “Financial Viability and Carbon Payment Potential of Large-Scale Silvicultural Intensification in Logged Dipterocarp Forests in Indonesia.” *Forest Policy and Economics*, vol. 85, Dec. 2017, pp. 95–102. *ScienceDirect*, https://doi.org/10.1016/j.forpol.2017.09.005.

47. Umunay, Peter M., et al. “Selective Logging Emissions and Potential Emission Reductions from Reduced-Impact Logging in the Congo Basin.” *Forest Ecology and Management*, vol. 437, Apr. 2019, pp. 360–71. *ScienceDirect,* https://doi.org/10.1016/j.foreco.2019.01.049.

48. Ellis, Peter W., et al. “Reduced-Impact Logging for Climate Change Mitigation (RIL-C) Can Halve Selective Logging Emissions from Tropical Forests.” *Forest Ecology and Management*, vol. 438, Apr. 2019, pp. 255–66. *ScienceDirect*, https://doi.org/10.1016/j.foreco.2019.02.004.

49. Sullivan, Megan K., Jason Vleminckx, et al. “Low-Intensity Logging Alters Species and Functional Composition, but Does Not Negatively Impact Key Ecosystem Services in a Central African Tropical Forest.” *Global Ecology and Conservation*, vol. 53, Sep. 2024, p. e02996. *ScienceDirect*, https://doi.org/10.1016/j.gecco.2024.e02996.

50. Sullivan, Megan K., et al. “A Decade of Diversity and Forest Structure: Post-Logging Patterns across Life Stages in an Afrotropical Forest.” *Forest Ecology and Management*, vol. 513, Jun. 2022, p. 120169. *ScienceDirect*, https://doi.org/10.1016/j.foreco.2022.120169.

51. Chipeta, M.E., and G. Kowero. “An Overview of Intra-African Trade in Forest Products: Opportunities and Challenges.” *International Forestry Review*, vol. 17, no. 3, Sep. 2015, pp. 114–24. *IngentaConnect*, https://doi.org/10.1505/146554815816006983.

52. Bayol, Nicolas, et al. "Forest management and the timber sector in Central Africa." The Forests of the Congo Basin–State of the Forest 2010 (2012)

53. Medjibe, Vincent P., and Francis E. Putz. “Cost Comparisons of Reduced-Impact and Conventional Logging in the Tropics.” *Journal of Forest Economics*, vol. 18, no. 3, Aug. 2012, pp. 242–56. *ScienceDirect*, https://doi.org/10.1016/j.jfe.2012.05.001.

54. Kauppi, Pekka E., et al. “Managing Existing Forests Can Mitigate Climate Change.” *Forest Ecology and Management*, vol. 513, Jun. 2022, p. 120186. *ScienceDirect*, https://doi.org/10.1016/j.foreco.2022.120186.

55. Putz, Francis E., et al. “Liana Cutting in Selectively Logged Forests Increases Both Carbon Sequestration and Timber Yields.” *Forest Ecology and Management*, vol. 539, Jul. 2023, p. 121038. *ScienceDirect*, https://doi.org/10.1016/j.foreco.2023.121038.

56. Mbeche, Robert, et al. “Understanding Forest Users’ Participation in Participatory Forest Management (PFM): Insights from Mt. Elgon Forest Ecosystem, Kenya.” *Forest Policy and Economics*, vol. 129, Aug. 2021, p. 102507. *ScienceDirect*, https://doi.org/10.1016/j.forpol.2021.102507.

57. Karsenty, A., and C. Ferron. “Recent Evolutions of Forest Concessions Status and Dynamics in Central Africa.” *International Forestry Review*, vol. 19, no. 4, Dec. 2017, pp. 10–26. *IngentaConnect*, https://doi.org/10.1505/146554817822295957.

58. Tonouéwa, Jesugnon Fifamè Murielle Féty, et al. “Timber Traceability, Determining Effective Methods to Combat Illegal Logging in Africa: A Review.” *Trees, Forests and People*, vol. 18, Dec. 2024, p. 100709. *ScienceDirect*, https://doi.org/10.1016/j.tfp.2024.100709.

59. Goldman, Elizabeth, et al. "Predicting Future Forest Loss in the Democratic Republic of the Congo’s CARPE Landscapes." World Resources Institute, 2017, https://www.wri.org/predicting-future-forest-loss-democratic-republic-congos-carpe-landscapes

60. “What Is FLEGT? FLEGT Briefing Note.” *European Parliament*, 2007, https://www.europarl.europa.eu/meetdocs/2014_2019/documents/dcam/dv/what_is_flegt/what_is_flegten.pdf

61. Haya, Barbara K., et al. “Comprehensive Review of Carbon Quantification by Improved Forest Management Offset Protocols.” *Frontiers in Forests and Global Change*, vol. 6, Mar. 2023. *Frontiers*, https://doi.org/10.3389/ffgc.2023.958879.

62. Pagiola, Stefano, et al. “Assessing the Permanence of Land-Use Change Induced by Payments for Environmental Services: Evidence From Nicaragua.” *Tropical Conservation Science*, vol. 13, Jan. 2020, p. 1940082920922676. *SAGE Journals*, https://doi.org/10.1177/1940082920922676.

63. “Reducing Logging Impacts in the Congo Basin.” The Nature Conservancy, 27 Oct. 2025, https://www.nature.org/en-us/about-us/where-we-work/africa/stories-in-africa/reduced-impact-logging-congo/.

64. Tessema, Bezaye, et al. “Potential for Soil Organic Carbon Sequestration in Grasslands in East African Countries: A Review.” *Grassland Science*, vol. 66, no. 3, 2020, pp. 135–44. *Wiley Online Library*, https://doi.org/10.1111/grs.12267.

65. Naidoo, Laven, et al. “Estimating above Ground Biomass as an Indicator of Carbon Storage in Vegetated Wetlands of the Grassland Biome of South Africa.” *International Journal of Applied Earth Observation and Geoinformation*, vol. 78, Jun. 2019, pp. 118–29. *ScienceDirect*, https://doi.org/10.1016/j.jag.2019.01.021.

66. Sola, Phosiso, et al. “The Environmental, Socioeconomic, and Health Impacts of Woodfuel Value Chains in Sub-Saharan Africa: A Systematic Map.” *Environmental Evidence*, vol. 6, no. 1, Feb. 2017, p. 4. Springer Link, https://doi.org/10.1186/s13750-017-0082-2.

67. Fernandes, Geraldo Wilson, et al. “Afforestation of Savannas: An Impending Ecological Disaster.” *Natureza & Conservação*, vol. 14, no. 2, Jul. 2016, pp. 146–51. *ScienceDirect*, https://doi.org/10.1016/j.ncon.2016.08.002.

68. Gobelle, Siraj Kelil, and Abdella Gure. “Effects of Bush Encroachment on Plant Composition, Diversity and Carbon Stock in Borana Rangelands, Southern Ethiopia.” *International Journal of Biodiversity and Conservation*, vol. 10, no. 5, May 2018, pp. 230–45. *academicjournals.org*, https://doi.org/10.5897/IJBC2017.1143.

69. Kinyili, Benjamin Mutuku. “Potential of Agroforestry in Sustainable Fuelwood Supply in Kenya.” *Journal of Energy and Natural Resources*, vol. 11, no. 1, Jan. 2022, pp. 1–6. *www.sciencepublishinggroup.com*, https://doi.org/10.11648/j.jenr.20221101.11.

70. Zhou, Yong, et al. “Soil Carbon in Tropical Savannas Mostly Derived from Grasses.” *Nature Geoscience*, vol. 16, no. 8, Aug. 2023, pp. 710–16. *www.nature.com*, https://doi.org/10.1038/s41561-023-01232-0.

71. Njenga, Mary, et al. “Sustainable Woodfuel Systems: A Theory of Change for Sub-Saharan Africa.” Environmental Research Communications, vol. 5, no. 5, May 2023, p. 051003. *Institute of Physics*, https://doi.org/10.1088/2515-7620/acd0f3.

72. Steel, E. Ashley, et al. “Global Wood Fuel Production Estimates and Implications.” *Nature Communications*, vol. 16, no. 1, Jul. 2025, p. 6227. *www.nature.com*, https://doi.org/10.1038/s41467-025-59733-y.

73. Zieba Falama, Ruben, et al. “Investigating Sustainable Biofuel Cookstove Adoption in Sub-Saharan Africa: An Integrated Analysis of Clean Cooking Transitions.” *Energy Research & Social Science*, vol. 109, Mar. 2024, p. 103430. *ScienceDirect*, https://doi.org/10.1016/j.erss.2024.103430.

74. Göswein, V, et al. “Wood in Buildings: The Right Answer to the Wrong Question.” *IOP Conference Series: Earth and Environmental Science*, vol. 1078, no. 1, Sep. 2022, p. 012067. *Institute of Physics*, https://doi.org/10.1088/1755-1315/1078/1/012067.

75. Strydom, Tercia, et al. “High-Intensity Fires May Have Limited Medium-Term Effectiveness for Reversing Woody Plant Encroachment in an African Savanna.” *Journal of Applied Ecology*, vol. 60, no. 4, 2023, pp. 661–72. *Wiley Online Library*, https://doi.org/10.1111/1365-2664.14362.

76. Yusuf, Hasen M., et al. “Managing Semi-Arid Rangelands for Carbon Storage: Grazing and Woody Encroachment Effects on Soil Carbon and Nitrogen.” *PLOS ONE*, vol. 10, no. 10, Oct. 2015, p. e0109063. *PLoS Journals*, https://doi.org/10.1371/journal.pone.0109063.

77. Gobelle, Siraj Kelil. “Impacts of Bush Management on Herbaceous Plant Diversity and Biomass and, Soil Organic Carbon and Nitrogen in Borana Rangelands, Southern Ethiopia.” *Journal of Plant Sciences*, vol. 9, no. 2, Apr. 2021, pp. 38–45. *www.sciencepublishinggroup.com*, https://doi.org/10.11648/j.jps.20210902.12.

78. Venter, Z. S., et al. “Drivers of Woody Plant Encroachment over Africa.” *Nature Communications*, vol. 9, no. 1, Jun. 2018, p. 2272. *www.nature.com*, https://doi.org/10.1038/s41467-018-04616-8.

79. Wang, Lanhui, et al. “Striking a Balance between Livelihood and Forest Conservation in a Forest Farm Facility in Choma, Zambia.” *Forests*, vol. 13, no. 10, Oct. 2022. *www.mdpi.com*, https://doi.org/10.3390/f13101631.

80. Sola, Phosiso, et al. "Woodfuel policies and practices in selected countries in Sub-Saharan Africa—A critical review." *Bois et Forêts des Tropiques*, 2019, https://doi.org/10.19182/bft2019.340.a31690

81. Shackleton, Charlie, et al. “Fuelwood in South Africa Revisited: Widespread Use in a Policy Vacuum.” *Sustainability*, vol. 14, no. 17, Sep. 2022. *www.mdpi.com*, https://doi.org/10.3390/su141711018.

82. Hoffmann, Harry, et al. "Wood energy in Sub-Saharan Africa: how to make a shadow business sustainable." German Development Institute, 2016, https://www.idos-research.de/uploads/media/BP_14.2016.pdf.

83. Konz, J., Cohen, B., & Van Der Merwe, A. (2015). Assessment of the potential to produce biochar and its application to South African soils as a mitigation measure. *Environmental Affairs Department: Republic of South Africa: Pretoria, South Africa*.

84. Cuesta-Mosquera, Andrea, et al. “Improved Cookstoves Enhance Household Air Quality and Respiratory Health in Rural Rwanda.” *Scientific Reports*, vol. 15, no. 1, Jul. 2025, p. 26065. *www.nature.com*, https://doi.org/10.1038/s41598-025-09863-6.

85. Phillip, Eunice, et al. “Improved Cookstoves to Reduce Household Air Pollution Exposure in Sub-Saharan Africa: A Scoping Review of Intervention Studies.” *PLOS ONE*, vol. 18, no. 4, Apr. 2023, p. e0284908. *PLoS Journals*, https://doi.org/10.1371/journal.pone.0284908.

86. Zhou, Yingying, et al. “Leaf Thermal Regulation Strategies of Canopy Species across Four Vegetation Types along a Temperature and Precipitation Gradient.” *Agricultural and Forest Meteorology*, vol. 343, Dec. 2023, p. 109766. *ScienceDirect*, https://doi.org/10.1016/j.agrformet.2023.109766.

87. Boffa, Jean-Marc. "Agroforestry parklands in sub-Saharan Africa." Food & Agriculture Org., 1999,

88. "Kulera REDD+ and Cookstoves, Malawi." Climate Impact Partners, https://www.climateimpact.com/global-projects/kulera-redd-and-cookstoves-malawi/

89. Voysey, Michael D., et al. “The Role of Browsers in Maintaining the Openness of Savanna Grazing Lawns.” *Journal of Ecology*, vol. 109, no. 2, 2021, pp. 913–26. *Wiley Online Library*, https://doi.org/10.1111/1365-2745.13518.

90. Osborne, Colin P., et al. “A Global Database of C4 Photosynthesis in Grasses.” *The New Phytologist*, vol. 204, no. 3, 2014, pp. 441–46.

91. Briske, David D., et al. “It’s Time to Assign Nonforested, Nonagricultural Lands a Global Designation.” *Cambridge Prisms: Dryland*s, vol. 2, Jan. 2025, p. e5. *Cambridge University Press*, https://doi.org/10.1017/dry.2025.2.

92. Banda, Liveness Jessica, and Jonathan Tanganyika. “Livestock Provide More than Food in Smallholder Production Systems of Developing Countries.” *Animal Frontiers*, vol. 11, no. 2, Mar. 2021, pp. 7–14. *Silverchair*, https://doi.org/10.1093/af/vfab001.

93. Ren, Haiyan, et al. “Livestock Grazing Regulates Ecosystem Multifunctionality in Semi-Arid Grassland.” *Functional Ecology*, vol. 32, no. 12, 2018, pp. 2790–800. *Wiley Online Library*, https://doi.org/10.1111/1365-2435.13215.

94. Archibald, Sally, et al. “Defining Pyromes and Global Syndromes of Fire Regimes.” *Proceedings of the National Academy of Sciences*, vol. 110, no. 16, Apr. 2013, pp. 6442–47. *pnas.org (Atypon)*, https://doi.org/10.1073/pnas.1211466110.

95. du Toit, Johan T., et al. "Managing the livestock–wildlife interface on rangelands." Rangeland systems: Processes, management and challenges. Springer International Publishing, 2017.

96. Fuhlendorf, Samuel D., et al. “Pyric Herbivory: Rewilding Landscapes through the Recoupling of Fire and Grazing.” *Conservation Biology*, vol. 23, no. 3, 2009, pp. 588–98. *Wiley Online Library*, https://doi.org/10.1111/j.1523-1739.2008.01139.x.

97. Little, Michael A. "Pastorialism." *Basics in Human Evolution*, Academic Press, 2015, https://doi.org/10.1016/B978-0-12-802652-6.00024-4

98. Veblen, Kari E., et al. “Are Cattle Surrogate Wildlife? Savanna Plant Community Composition Explained by Total Herbivory More than Herbivore Type.” *Ecological Applications*, vol. 26, no. 6, 2016, pp. 1610–23. *Wiley Online Library*, https://doi.org/10.1890/15-1367.1.

99. Kazanski, Clare E., et al. “Context Is Key to Understand and Improve Livestock Production Systems.” *Global Food Security*, vol. 45, Jun. 2025, p. 100840. *ScienceDirect*, https://doi.org/10.1016/j.gfs.2025.100840.

100. Wang, Yue, et al. “Risk to Rely on Soil Carbon Sequestration to Offset Global Ruminant Emissions.” *Nature Communications*, vol. 14, no. 1, Nov. 2023, p. 7625. *www.nature.com*, https://doi.org/10.1038/s41467-023-43452-3.

101. Mostafa et al 2025 – forthcoming

102. Selemani, Ismail Saidi, et al. "The role of indigenous knowledge and perceptions of pastoral communities on traditional grazing management in north-western Tanzania." *African Journal of Agricultural Research*, vol. 7, no. 40. 2012, pp 5537-5547

103. "Climate-smart agriculture." Food and Agriculture Organization of the United Nations, https://www.fao.org/climate-smart-agriculture/en/

104. "Annual Development Effectiveness Review 2024: Investing in Africa's resilience and inclusive growth." Africa Development Bank, May 2024, https://www.ifad.org/thefieldreport/

105. Forslund, Agneta, et al. “Can Healthy Diets Be Achieved Worldwide in 2050 without Farmland Expansion?” *Global Food Security*, vol. 39, Dec. 2023, p. 100711. *ScienceDirect*, https://doi.org/10.1016/j.gfs.2023.100711.

106. Meena, Sriyaram, et al. "Adapting Agriculture to a Changing Climate: Mitigation and Resilience Strategies." *Sustaining Agriculture: Food Security, Biodiversity and Climate Change*, Feb 2025

107. "Regenerative Agriculture: An opportunity for businesses and society to restore degraded land in Africa." I Africa Regenerative Agriculture Study Group, 2021, https://iucn.org/sites/default/files/2022-06/regnererative_agriculture_in_africa_report_2021_compressed.pdf

108. Amede, Tilahun, et al. “Sustainable Farming in Practice: Building Resilient and Profitable Smallholder Agricultural Systems in Sub-Saharan Africa.” *Sustainability*, vol. 15, no. 7, Mar. 2023. *www.mdpi.com*, https://doi.org/10.3390/su15075731.

109. Tilahun, Girma, et al. “Impact of Adoption of Climate-Smart Agriculture on Food Security in the Tropical Moist Montane Ecosystem: The Case of Geshy Watershed, Southwest Ethiopia.” *Heliyon*, vol. 9, no. 12, Dec. 2023. *www.cell.com*, https://doi.org/10.1016/j.heliyon.2023.e22620.

110. Mupangwa, Walter, et al. “Crop Productivity, Nutritional and Economic Benefits of No-Till Systems in Smallholder Farms of Ethiopia.” *Agronomy*, vol. 13, no. 1, Dec. 2022. *www.mdpi.com*, https://doi.org/10.3390/agronomy13010115.

111. Frøslev, Tobias Guldberg, et al. “The Biodiversity Effect of Reduced Tillage on Soil Microbiota.” *Ambio*, vol. 51, no. 4, Apr. 2022, pp. 1022–33. *Springer Link*, https://doi.org/10.1007/s13280-021-01611-0.

112. Tabe-Ojong, Martin Paul Jr., et al. "‘Climate-Smart Agriculture and Food Security: Cross-Country Evidence from West Africa.’" *Global Environmental Change*, vol. 81, Jul. 2023, p. 102697. *ScienceDirect*, https://doi.org/10.1016/j.gloenvcha.2023.102697.

113. Nyasimi, Mary, et al. "Evidence of impact: climate-smart agriculture in Africa." CCAFS Working Paper. GIGAR Research Program on Climate Change, Agriculture and Food Security, 2014, https://hdl.handle.net/10568/51374

114. Moreno-García, Manuel, et al. “Long-Term Effects of No-Tillage on Arthropod Biodiversity in Rainfed and Irrigated Annual Crops.” *Agronomy*, vol. 14, no. 10, Sep. 2024. *www.mdpi.com*, https://doi.org/10.3390/agronomy14102192.

115. Parwada, Cosmas, et al. “Role of Agroforestry on Farmland Productivity in Semi-Arid Farming Regions of Zimbabwe.” *Research on World Agricultural Economy*, vol. 3, no. 2, May 2022, pp. 39–47. journals.*nasspublishing.com*, https://doi.org/10.36956/rwae.v3i2.515.

116. Akinola, Racheal, et al. “A Review of Indigenous Food Crops in Africa and the Implications for More Sustainable and Healthy Food Systems.” *Sustainability*, vol. 12, no. 8, Apr. 2020. *www.mdpi.com*, https://doi.org/10.3390/su12083493.

117. Solomon, Dawit, et al. “Indigenous African Soil Enrichment as a Climate-Smart Sustainable Agriculture Alternative.” *Frontiers in Ecology and the Environment*, vol. 14, no. 2, 2016, pp. 71–76. *Wiley Online Library*, https://doi.org/10.1002/fee.1226.

118. Leal Filho, Walter, et al. “The Role of Indigenous Knowledge in Climate Change Adaptation in Africa.” *Environmental Science & Policy*, vol. 136, Oct. 2022, pp. 250–60. *ScienceDirect*, https://doi.org/10.1016/j.envsci.2022.06.004.

119. "The role of DFIs in accelerating the mobilisation of green capital." Climate Bonds Initiative, 14 Nov 2024, https://www.climatebonds.net/data-insights/publications/role-dfis-accelerating-mobilisation-green-capital

120. "Improving livelihoods through forest landscape restoration: Securing tenure, forests and livelihoods in Madagascar and Cameroon." CIFOR, 2021, https://www.cifor-icraf.org/knowledge/publication/5053/

121. Maundu, Patrick. "Kenya's push to promote traditional food is good for nutrition and cultural heritage." The Conversation, 22 Feb 2022, https://theconversation.com/kenyas-push-to-promote-traditional-food-is-good-for-nutrition-and-cultural-heritage-176384

122. Audu, Christina Tanko, and Daniel Imoken-Asi Audu. “Exploring The Symbiotic Economic Benefits Between Farmers and Herders to Promote Peaceful Coexistence in Taraba State Nigeria.” *Advances in Social Sciences Research Journal*, vol. 10, no. 8, Aug. 2023, pp. 228–37. *DOI.org (Crossref)*, https://doi.org/10.14738/assrj.108.15299.

123. Dawoe, E. K., et al. “Exploring Farmers’ Local Knowledge and Perceptions of Soil Fertility and Management in the Ashanti Region of Ghana.” *Geoderma*, vols. 179–180, Jun. 2012, pp. 96–103. *ScienceDirect*, https://doi.org/10.1016/j.geoderma.2012.02.015.

124. Rasolofomboahangy, Valisoa. "Can a luxury chocolate company help a Congolese forest?" Mongabay, 16 Nov 2022, https://news.mongabay.com/2022/11/can-a-luxury-chocolate-company-save-a-congolese-forest/

125. Berjan, Sinisa, et al. “Food Losses and Waste: A Global Overview with a Focus on Near East and North Africa Region.” International Journal of Agricultural Management and Development 8(1), 1-16, 2018

126. Realpe, Nathalie Garavito, et al. “Exploring Risk Factors of Food Loss and Waste: A Comprehensive Framework Using Root Cause Analysis Tools.” *Cleaner and Circular Bioeconomy*, vol. 9, Dec. 2024, p. 100108. *ScienceDirect*, https://doi.org/10.1016/j.clcb.2024.100108.

127. Sheahan, Megan, and Christopher B. Barrett. “Review: Food Loss and Waste in Sub-Saharan Africa.” *Food Policy*, vol. 70, Jul. 2017, pp. 1–12. *ScienceDirect*, https://doi.org/10.1016/j.foodpol.2017.03.012.

128. Totobesola, Mireille, et al. “A Holistic Approach to Food Loss Reduction in Africa: Food Loss Analysis, Integrated Capacity Development and Policy Implications.” *Food Security*, vol. 14, no. 6, Dec. 2022, pp. 1401–15. *Springer Link*, https://doi.org/10.1007/s12571-021-01243-y.

129. Shafiee-Jood, Majid, and Ximing Cai. “Reducing Food Loss and Waste to Enhance Food Security and Environmental Sustainability.” *Environmental Science & Technology*, vol. 50, no. 16, Aug. 2016, pp. 8432–43. ACS Publications, https://doi.org/10.1021/acs.est.6b01993.

130. Sheahan, Megan, and Christopher B. Barrett. “Review: Food Loss and Waste in Sub-Saharan Africa.” *Food Policy*, vol. 70, Jul. 2017, pp. 1–12. *ScienceDirect*, https://doi.org/10.1016/j.foodpol.2017.03.012.

131. "Five strategies for reducing greenhouse gases through food waste reduction." ReFED, 19 Mar 2024, https://refed.org/articles/five-strategies-for-reducing-greenhouse-gases-through-food-waste-reduction/

132. Nath, Bidhan, et al. “Research and Technologies to Reduce Grain Postharvest Losses: A Review.” *Foods*, vol. 13, no. 12, Jun. 2024. *www.mdpi.com*, https://doi.org/10.3390/foods13121875.

133. Uhuami, Abdulbariu Ogirima, et al. “Insect-Based Biofuels and Animal Feed Additives: A Sustainable Energy and Agricultural Solution for Africa’s Future.” *Next Research*, vol. 2, no. 3, Sep. 2025, p. 100520. *ScienceDirect*, https://doi.org/10.1016/j.nexres.2025.100520.; Tanga, Chrysantus M, and Margaret O Kababu. “New Insights into the Emerging Edible Insect Industry in Africa.” *Animal Frontiers*, vol. 13, no. 4, Aug. 2023, pp. 26–40. *Silverchair*, https://doi.org/10.1093/af/vfad039.

134. Kiaya, Victor. "Post-harvest losses and strategies to reduce them." *Technical Paper on Postharvest Losses, Action Contre la Faim (ACF)*, 2014, https://res.cloudinary.com/actioncontrelafaim/images/v1756929078/uas-acf-prod/instit/technical_paper_phl__/technical_paper_phl__.pdf?_i=AA

135. Aragie, Emerta, et al. “Does Reducing Food Losses and Wastes in Sub-Saharan Africa Make Economic Sense?” *Waste Management & Research*, vol. 36, no. 6, Jun. 2018, pp. 483–94. *SAGE Journals*, https://doi.org/10.1177/0734242X18770247.

136. Gatto, Alessandro, and Maksym Chepeliev. “Global Food Loss and Waste Estimates Show Increasing Nutritional and Environmental Pressures.” *Nature Food*, vol. 5, no. 2, Feb. 2024, pp. 136–47. *www.nature.com*, https://doi.org/10.1038/s43016-023-00915-6.

137. De Groote, Hugo, et al. “Effectiveness of Hermetic Systems in Controlling Maize Storage Pests in Kenya.” *Journal of Stored Products Research,* vol. 53, Apr. 2013, pp. 27–36. *ScienceDirect*, https://doi.org/10.1016/j.jspr.2013.01.001.

138. Gitonga, Zachary M., et al. “Impact of Metal Silos on Households’ Maize Storage, Storage Losses and Food Security: An Application of a Propensity Score Matching.” *Food Policy*, vol. 43, Dec. 2013, pp. 44–55. *ScienceDirect*, https://doi.org/10.1016/j.foodpol.2013.08.005.

139. Baoua, I. B., et al. “Comparative Evaluation of Six Storage Methods for Postharvest Preservation of Cowpea Grain.” *Journal of Stored Products Research*, vol. 49, Apr. 2012, pp. 171–75. *ScienceDirect*, https://doi.org/10.1016/j.jspr.2012.01.003.

140. Makule, Edna, et al. “Precooling and Cold Storage Methods for Fruits and Vegetables in Sub-Saharan Africa—A Review.” *Horticulturae*, vol. 8, no. 9, Aug. 2022. *www.mdpi.com*, https://doi.org/10.3390/horticulturae8090776.

141. Zorya, Sergiy, et al. "Missing food: the case of postharvest grain losses in sub-Saharan Africa." The International Bank for Reconstruction and Development / The World Bank, 2011, https://documents1.worldbank.org/curated/en/358461468194348132/pdf/603710SR0White0W110Missing0Food0web.pdf

142. Marston, Landon T., et al. “Reducing Water Scarcity by Reducing Food Loss and Waste.” *Frontiers in Sustainable Food Systems*, vol. 5, Apr. 2021. Frontiers, https://doi.org/10.3389/fsufs.2021.651476.

143. Jalava, Mika, et al. “Diet Change and Food Loss Reduction: What Is Their Combined Impact on Global Water Use and Scarcity?” *Earth’s Future*, vol. 4, no. 3, 2016, pp. 62–78. *Wiley Online Library*, https://doi.org/10.1002/2015EF000327.

144. Guo, Yixin, et al. “Global Food Loss and Waste Embodies Unrecognized Harms to Air Quality and Biodiversity Hotspots.” Nature Food, vol. 4, no. 8, Aug. 2023, pp. 686–98. *www.nature.com*, https://doi.org/10.1038/s43016-023-00810-0.

145. Affognon, Hippolyte, et al. “Unpacking Postharvest Losses in Sub-Saharan Africa: A Meta-Analysis.” *World Development*, vol. 66, Feb. 2015, pp. 49–68. *ScienceDirect*, https://doi.org/10.1016/j.worlddev.2014.08.002.

146. Pharo, Per and Oppenheim, Jeremy, et al. "Growing better: Ten critical transitions to transform food and land use." The Food and Land Use Coalition, Sep 2019, https://foodandlandusecoalition.org/Growing%20Better%20-%20Ten%20Critical%20Transitions%20to%20Transform%20Food%20and%20Land%20Use.pdf

147. "ColdHubs is fixing food loss with off-grid cool rooms." Food Planet Prize, https://foodplanetprize.org/initiatives/coldhubs-coldhubs-is-fixing-food-loss-with-off-grid-cool-rooms/

148. Society of Ecological Restoration website. https://ser-rrc.org/what-is-ecological-restoration/ *(accessed January 18, 2026).*

149. Wilson, Sarah J., et al. "Assisted Natural Regeneration: A guide for restoring tropical forests." Conservation International, Oct 2022, https://www.conservation.org/research/guide-assisted-natural-regeneration

150. Rebelo, L.-M., & McCartney, M. "Earth observation data offers hope for Africa's wetlands." The Conversation, 27 Feb 2019, https://doi.org/10.64628/AAJ.c9kve6wmp

151. "Africa Forest Landscape Restoration Initiative (AFR100)." World Resources Institute, https://www.wri.org/initiatives/african-forest-landscape-restoration-initiative-afr100

152. Chazdon, Robin L., et al. "Partnering with nature: The case for natural regeneration in forest and landscape restoration." FERI Policy Brief, 2017, www.feri-biodiversity.org/resources

153. Chazdon, Robin L., and Manuel R. Guariguata. “Natural Regeneration as a Tool for Large-Scale Forest Restoration in the Tropics: Prospects and Challenges.” *Biotropica*, vol. 48, no. 6, 2016, pp. 716–30. *Wiley Online Library*, https://doi.org/10.1111/btp.12381.

154. Allek, Adriana, et al. “How Does Forest Restoration Affect the Recovery of Soil Quality? A Global Meta-Analysis for Tropical and Temperate Regions.” *Restoration Ecology*, vol. 31, no. 3, 2023, p. e13747. *Wiley Online Library*, https://doi.org/10.1111/rec.13747.

155. Benayas, José M. Rey, et al. “Enhancement of Biodiversity and Ecosystem Services by Ecological Restoration: A Meta-Analysis.” *Science*, vol. 325, no. 5944, Aug. 2009, pp. 1121–24. *science.org (Atypon)*, https://doi.org/10.1126/science.1172460.

156. Brancalion, Pedro H. S., et al. “Moving Biodiversity from an Afterthought to a Key Outcome of Forest Restoration.” *Nature Reviews Biodiversity*, vol. 1, no. 4, Apr. 2025, pp. 248–61. *www.nature.com*, https://doi.org/10.1038/s44358-025-00032-1.

157. Choksi, Pooja, et al. “Listening for Change: Quantifying the Impact of Ecological Restoration on Soundscapes in a Tropical Dry Forest.” *Restoration Ecology*, vol. 31, no. 4, 2023, p. e13864. *Wiley Online Library*, https://doi.org/10.1111/rec.13864.

158. Gazzea, Elena, et al. “Restoration of Forests Supports the Conservation of Pollinators in Intensively Managed Agricultural Landscapes.” *Biological Conservation*, vol. 302, Feb. 2025, p. 111008. *ScienceDirect*, https://doi.org/10.1016/j.biocon.2025.111008.

159. Ram, Mark, et al. “Restoring Mangrove Biodiversity: Can Restored Mangroves Support Fish Assemblages Comparable to Natural Mangroves over Time?” *Restoration Ecology*, vol. 33, no. 4, 2025, p. e70012. *Wiley Online Library*, https://doi.org/10.1111/rec.70012.

160. Kitchingman, Michaela E., et al. “Fish Use of Restored Mangroves Matches That in Natural Mangroves Regardless of Forest Age.” *Restoration Ecology*, vol. 31, no. 1, 2023, p. e13806. *Wiley Online Library*, https://doi.org/10.1111/rec.13806.

161. Ihinegbu, Christopher, et al. “Scientific Evidence for the Effectiveness of Mangrove Forests in Reducing Floods and Associated Hazards in Coastal Areas.” *Climate*, vol. 11, no. 4, Apr. 2023. *www.mdpi.com*, https://doi.org/10.3390/cli11040079.

162. Rebelo, Alanna J., et al. “Hydrological Responses of a Valley-Bottom Wetland to Land-Use/Land-Cover Change in a South African Catchment: Making a Case for Wetland Restoration.” *Restoration Ecology*, vol. 23, no. 6, 2015, pp. 829–41. *Wiley Online Library*, https://doi.org/10.1111/rec.12251.

163. Ruijsch, Jessica, et al. “The Local Cooling Potential of Land Restoration in Africa.” *Communications Earth & Environment*, vol. 5, no. 1, Sep. 2024, p. 495. *www.nature.com*, https://doi.org/10.1038/s43247-024-01650-x.

164. Donatti, Camila I., et al. “Grassland Restoration Impacts Human-Wildlife and Social Conflicts in the Chyulu Hills, Kenya.” *Frontiers in Environmental Science*, vol. 12, Feb. 2025. Frontiers, https://doi.org/10.3389/fenvs.2024.1431316.

165. Abrahms, Briana, et al. “Climate Change as a Global Amplifier of Human–Wildlife Conflict.” *Nature Climate Change*, vol. 13, no. 3, Mar. 2023, pp. 224–34. *www.nature.com*, https://doi.org/10.1038/s41558-023-01608-5.

166. López-Cubillos, Sofía, et al. “Optimal Restoration for Pollination Services Increases Forest Cover While Doubling Agricultural Profits.” *PLOS Biology*, vol. 21, no. 5, May 2023, p. e3002107. *PLoS Journals*, https://doi.org/10.1371/journal.pbio.3002107.

167. Wehi, Priscilla M., and Janice M. Lord. “Importance of including cultural practices in ecological restoration.” *Conservation Biology*, vol. 31, no. 5, 2017, pp. 1109–18. *Wiley Online Library*, https://doi.org/10.1111/cobi.12915.

168. Walters, G., et al. “The Power of Choice: How Institutional Selection Influences Restoration Success in Africa.” *Land Use Policy*, vol. 104, May 2021, p. 104090. *ScienceDirect*, https://doi.org/10.1016/j.landusepol.2019.104090.

169. Höhl, Markus, et al. “Forest Landscape Restoration—What Generates Failure and Success?” *Forests*, vol. 11, no. 9, Aug. 2020. *www.mdpi.com*, https://doi.org/10.3390/f11090938.

170. "Greenzone Reforestation Project - Cameroon." Green Earth, https://www.green.earth/projects/greenzone-reforestation-project-cameroon

171. "SER Standards Tools." Society for Ecological Restoration, https://www.ser.org/page/Standards-Tools

172. Schindler Murray, Lisa, Milligan, Ben, et al. "The blue carbon handbook: Blue carbon as a naturebased solution for climate action and sustainable development." High Level Panel for a Sustianable Ocean Economy, 2023, DOI: https://doi.org/10.69902/566a16de.

173. Howard, Jennifer, Ariana E. Sutton-Grier, et al. “Blue Carbon Pathways for Climate Mitigation: Known, Emerging and Unlikely.” *Marine Policy*, vol. 156, Oct. 2023, p. 105788. *ScienceDirect*, https://doi.org/10.1016/j.marpol.2023.105788.

174. Lovelock, Catherine E., and Carlos M. Duarte. “Dimensions of Blue Carbon and Emerging Perspectives.” *Biology Letters*, vol. 15, no. 3, Mar. 2019, p. 20180781, https://doi.org/10.1098/rsbl.2018.0781.

175. Leal, Marice and Spalding, Mark D., editors. "The State of the World's Mangroves 2024." Global Mangrove Alliance, 2024, DOI: https://doi.org/10.5479/10088/119867

176. Beeston, Mark, et al. "Mobilizing the Mangrove Breakthrough in West Africa." Global Mangrove Alliance, Nov 2025, https://www.mangrovealliance.org/_files/ugd/46cc4e_9be2ae924f8045998550e26af934c93a.pdf

177. Worthington, Thomas A., et al. “The Distribution of Global Tidal Marshes from Earth Observation Data.” *Global Ecology and Biogeography*, vol. 33, no. 8, 2024, p. e13852. *Wiley Online Library*, https://doi.org/10.1111/geb.13852.

178. Mwikamba, Edward Mutwiri, et al. “A Review of Seagrass Cover, Status and Trends in Africa.” *Estuaries and Coasts*, vol. 47, no. 4, Jun. 2024, pp. 917–34. *Springer Link*, https://doi.org/10.1007/s12237-024-01348-5.

179. Chanda, Abhra. “Threats to the Blue Carbon Ecosystems Adjoining the Indian Ocean.” *Blue Carbon Dynamics of the Indian Ocean: The Present State of the Art*, edited by Abhra Chanda et al., Springer International Publishing, 2022, pp. 255–303. *Springer Link*, https://doi.org/10.1007/978-3-030-96558-7_9.

180. Ideki, Oye, et al. “Scenario Analysis of Shorelines, Coastal Erosion, and Land Use/Land Cover Changes and Their Implication for Climate Migration in East and West Africa.” *Journal of Marine Science and Engineering*, vol. 12, no. 7, Jun. 2024.

181. Hanley, Mick E, et al. “The Gathering Storm: Optimizing Management of Coastal Ecosystems in the Face of a Climate-Driven Threat.” *Annals of Botany*, vol. 125, no. 2, Feb. 2020, pp. 197–212. *Silverchair*, https://doi.org/10.1093/aob/mcz204.

182. Bryan, Tanya, et al. “Blue Carbon Conservation in West Africa: A First Assessment of Feasibility.” *Journal of Coastal Conservation*, vol. 24, no. 1, Jan. 2020, p. 8. *Springer Link*, https://doi.org/10.1007/s11852-019-00722-x.

183. Naidoo, Gonasageran. “The Mangroves of Africa: A Review.” *Marine Pollution Bulletin*, vol. 190, May 2023, p. 114859. *ScienceDirect*, https://doi.org/10.1016/j.marpolbul.2023.114859.

184. Lovelock, Catherine E., and Ruth Reef. “Variable Impacts of Climate Change on Blue Carbon.” *One Earth*, vol. 3, no. 2, Aug. 2020, pp. 195–211. *www.cell.com*, https://doi.org/10.1016/j.oneear.2020.07.010.

185. Howard, Jennifer, Elizabeth McLeod, et al. “The Potential to Integrate Blue Carbon into MPA Design and Management.” *Aquatic Conservation: Marine and Freshwater Ecosystems*, vol. 27, Sep. 2017, pp. 100–15, https://doi.org/10.1002/aqc.2809.

186. Maini, Bani, et al. “Charting the Value and Limits of Other Effective Conservation Measures (OECMs) for Marine Conservation: A Delphi Study.” *Marine Policy*, vol. 147, Jan. 2023, p. 105350. *ScienceDirect*, https://doi.org/10.1016/j.marpol.2022.105350.

187. Amone-Mabuto, M., et al. “Coastal Community’s Perceptions on the Role of Seagrass Ecosystems for Coastal Protection and Implications for Management.” *Ocean & Coastal Management*, vol. 244, Oct. 2023, p. 106811. *ScienceDirect*, https://doi.org/10.1016/j.ocecoaman.2023.106811.

188. "Restoring coastal ecosystems in Tanzania: A community-led initiative." Ocean Conservation Trust, 19 Nov 2024, https://oceanconservationtrust.org/restoring-coastal-ecosystems-in-tanzania-a-community-led-initiative

189. Vierros, Marjo. “Communities and Blue Carbon: The Role of Traditional Management Systems in Providing Benefits for Carbon Storage, Biodiversity Conservation and Livelihoods.” *Climatic Change*, vol. 140, no. 1, Jan. 2017, pp. 89–100. *Springer Link*, https://doi.org/10.1007/s10584-013-0920-3.

190. Jacquemont, Juliette, et al. “Ocean Conservation Boosts Climate Change Mitigation and Adaptation.” *One Earth*, vol. 5, no. 10, Oct. 2022, pp. 1126–38. *www.cell.com*, https://doi.org/10.1016/j.oneear.2022.09.002.

191. Di Lorenzo, Manfredi, et al. “Assessing Spillover from Marine Protected Areas and Its Drivers: A Meta-Analytical Approach.” *Fish and Fisheries*, vol. 21, no. 5, 2020, pp. 906–15. *Wiley Online Library*, https://doi.org/10.1111/faf.12469.

192. Harrison, Ian J., et al. “Protected Areas and Freshwater Provisioning: A Global Assessment of Freshwater Provision, Threats and Management Strategies to Support Human Water Security.” *Aquatic Conservation: Marine and Freshwater Ecosystems*, vol. 26, no. S1, 2016, pp. 103–20. *Wiley Online Library*, https://doi.org/10.1002/aqc.2652.

193. Jacquemont et al. (forthcoming)

194. Okafor-Yarwood, Ifesinachi, et al. “The Blue Economy–Cultural Livelihood–Ecosystem Conservation Triangle: The African Experience.” *Frontiers in Marine Science*, vol. 7, Jul. 2020. *Frontiers*, https://doi.org/10.3389/fmars.2020.00586.

195. Armani, M., et al. "Enhancing climate change adaptation and mitigation actions on land in Africa." Future Ecosystems for Africa (FEFA), University of the Witwatersrand, 2022, https://www.researchgate.net/profile/Mohammed-Armani/publication/365396922_Enhancing_climate_change_adaptation_and_mitigation_actions_on_land_in_Africa/links/6373ad322f4bca7fd0610fc3/Enhancing-climate-change-adaptation-and-mitigation-actions-on-land-in-Africa.pdf

196. Aheto, Denis Worlanyo, et al. “Community-Based Mangrove Forest Management: Implications for Local Livelihoods and Coastal Resource Conservation along the Volta Estuary Catchment Area of Ghana.” *Ocean & Coastal Management*, vol. 127, Jul. 2016, pp. 43–54. *ScienceDirect*, https://doi.org/10.1016/j.ocecoaman.2016.04.006.

197. Huxham, Mark, et al. “Applying Climate Compatible Development and Economic Valuation to Coastal Management: A Case Study of Kenya’s Mangrove Forests.” *Journal of Environmental Management*, vol. 157, Jul. 2015, pp. 168–81. *ScienceDirect*, https://doi.org/10.1016/j.jenvman.2015.04.018.

198. Asante, Winston A., et al. “The Implications of Land Tenure and Ownership Regimes on Sustainable Mangrove Management and Conservation in Two Ramsar Sites in Ghana.” *Forest Policy and Economics*, vol. 85, Dec. 2017, pp. 65–75. *ScienceDirect*, https://doi.org/10.1016/j.forpol.2017.08.018.

199. Merk, Christine, et al. “The Need for Local Governance of Global Commons: The Example of Blue Carbon Ecosystems.” *Ecological Economics*, vol. 201, Nov. 2022, p. 107581. *ScienceDirect*, https://doi.org/10.1016/j.ecolecon.2022.107581.

200. Dencer-Brown, Amrit Melissa, et al. “Integrating Blue: How Do We Make Nationally Determined Contributions Work for Both Blue Carbon and Local Coastal Communities?” *Ambio*, vol. 51, no. 9, Sep. 2022, pp. 1978–93. *Springer Link*, https://doi.org/10.1007/s13280-022-01723-1.

201. Schindler Murray, Lisa, Milligan, Ben, et al. "The blue carbon handbook: Blue carbon as a naturebased solution for climate action and sustainable development." High Level Panel for a Sustianable Ocean Economy, 2023, DOI: https://doi.org/10.69902/566a16de.

202. Farahmand, Shekoofeh, et al. “The Rise and Flows of Blue Carbon Credits Advance Global Climate and Biodiversity Goals.” *Npj Ocean Sustainability*, vol. 4, no. 1, Jul. 2025, p. 39. *www.nature.com*, https://doi.org/10.1038/s44183-025-00141-6.

203. Bunting, Pete, et al. “Global Mangrove Extent Change 1996–2020: Global Mangrove Watch Version 3.0.” *Remote Sensing*, vol. 14, no. 15, Jul. 2022. *www.mdpi.com*, https://doi.org/10.3390/rs14153657.

204. Raw, J. L., et al. “Blue Carbon Sinks in South Africa and the Need for Restoration to Enhance Carbon Sequestration.” *Science of The Total Environment*, vol. 859, Feb. 2023, p. 160142. *ScienceDirect*, https://doi.org/10.1016/j.scitotenv.2022.160142.

205. “The Women of Wasini Coax Life Back into the Mangrove Forests.” The Star, 24 Sept. 2022, www.the-star.co.ke/counties/nairobi/2022-09-24-the-women-of-wasini-coax-life-back-into-the-mangrove-forests. Accessed 8 Jan. 2026.

206. “Projects – Sierra Leone.” West Africa Blue, 2023, www.westafricablue.org/projects-sierraleone.

207. IPCC, 2023. "Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." IPCC, 2023, doi: 10.59327/IPCC/AR6-9789291691647.

208. "Needs of African Countries Related to Implementing the UN Framework Convention on Climate Change and the Paris Agreement." Integral Consult, Jan 2021, https://unfccc.int/sites/default/files/resource/Needs%20Report_African%20counties_AfDB_FINAL.pdf.

209. Naran, Baysa, et al. "Global Landscape of Climate Finance 2025" *Climate Policy Initiative*, 23 June 2025, https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2025/.

210. Pagop, Sabrina C. and Savard, Luc. "Voluntary carbon markets in Africa: A deep dive into opportunities and challenges." Policy Center for the New South, April 2024, https://www.policycenter.ma/sites/default/files/2024-04/PP_05-24%20(Sabrina%20Camelia%20Pagop%20&%20Luc%20Savard).pdf.

211. “Africa Carbon Markets: Status and Outlook Report 2024-2025." Africa Carbon Markets Initiative, July 2024, https://africacarbonmarkets.org/wp-content/uploads/2024/07/ACMI_Status-and-Outlook-Report-2024-_v2.pdf

212. Inampudi, Kalyani. "Parliamentary guide to Article 6 and carbon markets." GLOBE Legislators, Aug 2025, https://globelegislators.org/wp-content/uploads/2025/08/Parliamentary-Guide-to-Article-6-and-Carbon-Markets-GLOBE.pdf

213. Brock, Cameryn, et al. “Balancing Land Use for Conservation, Agriculture, and Renewable Energy.” *Research Square*, version 1, n.d., doi:10.21203/rs.3.rs-3798412/v1. *Research Square*, https://www.researchsquare.com/article/rs-3798412/v1

214. “Naturebase.” Nature4Climate (developed by The Nature Conservancy et al.), June 6 2024, https://www.naturebase.org/.

215. Ren, Shuai, et al. “Historical Impacts of Grazing on Carbon Stocks and Climate Mitigation Opportunities.” *Nature Climate Change*, vol. 14, no. 4, Apr. 2024, pp. 380–86. *www.nature.com*, https://doi.org/10.1038/s41558-024-01957-9.

216. Boone, R. B., Conant, R. T., Sircely, J., Thornton, P. K., & Herrero, M. (2018). Climate change impacts on selected global rangeland ecosystem services. Glob Chang Biol, 24(3), 1382-1393. https://doi.org/10.1111/gcb.13995.

217. Sprenkle-Hyppolite, Starry, et al. “Maximizing Tree Carbon in Croplands and Grazing Lands While Sustaining Yields.” *Carbon Balance and Management*, vol. 19, no. 1, Jul. 2024, p. 23. *Springer Link*, https://doi.org/10.1186/s13021-024-00268-y.

218. Cardinael, Rémi, et al. “Revisiting IPCC Tier 1 Coefficients for Soil Organic and Biomass Carbon Storage in Agroforestry Systems.” *Environmental Research Letters*, vol. 13, no. 12, Dec. 2018, p. 124020. *Institute of Physics*, https://doi.org/10.1088/1748-9326/aaeb5f.

219. Folberth, Christian, et al. “Exploring the Potential for Nitrogen Fertilizer Use Mitigation with Bundles of Management Interventions.” *Environmental Research Letters*, vol. 19, no. 4, Mar. 2024, p. 044027. *Institute of Physics*, https://doi.org/10.1088/1748-9326/ad31d8.

220. FAO. 2025. Greenhouse gas emissions from agrifood systems – Global, regional and country trends, 2001–2023. FAOSTATA analytical Brief Series, No. 115. Rome. (https://doi.org/10.4060/cd7300en)

221. Fesenmyer, Kurt A., et al. “Addressing Critiques Refines Global Estimates of Reforestation Potential for Climate Change Mitigation.” *Nature Communications*, vol. 16, no. 1, Jun. 2025, p. 4572. *www.nature.com*, https://doi.org/10.1038/s41467-025-59799-8.

222. Cook-Patton, Susan C., Sara M. Leavitt, et al. “Mapping Carbon Accumulation Potential from Global Natural Forest Regrowth.” *Nature*, vol. 585, no. 7826, Sep. 2020, pp. 545–50. *www.nature.com*, https://doi.org/10.1038/s41586-020-2686-x.

223. Hasler, Natalia, et al. “Accounting for Albedo Change to Identify Climate-Positive Tree Cover Restoration.” *Nature Communications*, vol. 15, no. 1, Mar. 2024, p. 2275. *www.nature.com*, https://doi.org/10.1038/s41467-024-46577-1.

224. Buelow, Christina A., et al. “Ambitious Global Targets for Mangrove and Seagrass Recovery.” *Current Biology*, vol. 32, no. 7, Apr. 2022, pp. 1641-1649.e3. *www.cell.com*, https://doi.org/10.1016/j.cub.2022.02.013.

IMAGE CREDITS

P1 O. Langrand
P2 Benjamin Drummond
P3 Benjamin Drummond
P5 istockphoto
P6 Chris Marais
P7 Levi Norton
P9 Charlie Shoemaker
P10 Jonathan Irish
P12 Art Wolfe
P14 S.Ramsay/WCS
P15 Cristina Mittermeier
P17 Cristina Mittermeier
P19 Jonathan Irish
P20 Equator Initiative
P22 S.Ramsay/WCS
P23 Getty Images
P25 Benjamin Drummond
P27 M&M Pictures
P28 M&M Pictures
P29 Trond Larsen
P31 Benjamin Drummond
P32 Axel Fassio
P34 Benjamin Drummond
P36 The Clean Cooling Network
P37 Benjamin Drummond
P38 Valisoa Rasolofomboahangy
P40 Jonathan Irish
P41 Mikoko Pamoja
P43 Jonathan Irish
P44 Cristina Mittermeier
P45 Charlie Shoemaker
P47 Ami Vitale
P56 Rod Mast

CONSERVATION INTERNATIONAL